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#33

FIRST EDITION OF BOWDITCH'S GREAT
"NEW AMERICAN PRACTICAL NAVIGATOR"

BOWDITCH, Nathaniel. The New American Practical Navigator; being an Epitome of Navigation; containing all the tables necessary to be used with the Nautical Almanac, in determining the Latitude; and the Longitude by Lunar Observations; and keeping a complete reckoning at sea . . . 8vo, full contemporary calf, neatly rebacked. xvi, 17-246, (247-532), 533-589, (15) pp., folding map, 7 plates. In half morocco and linen fall-down-back box with gilt lettering on backstrip. 1st edition. Newburyport, (Mass.), Edmund M. Blunt, (Proprietor) for Cushing & Appleton, Salem, 1802

A fine copy of the first edition of Bowditch's first book, neatly rebacked and with the map strengthened. The distinguished mathematician and astronomer had worked on correcting and revising John H. Moore's "The New Practical Navigator," which was published in Newburyport in 1799 and 1800 from the 13th English edition. Moore was a former Royal Naval officer, hydrographer and teacher of navigation, and Bowditch's outstanding contribution to the first American edition of Moore's work was a chapter on a "New Method of Working a Lunar Observation." Bowditch found so many errors in "The New Practical Navigator" that he was compelled to produce an entirely new work, "The New American Practical Navigator."

1,750 -

This first epitome of practical navigation for the common man, which was simultaneously published in England, was acclaimed by the maritime world at once, and its use was extended to the English merchant marine and even to the English and French navies. The work was indispensable to the maritime and commercial expansion of the 19th century, and it is often termed the greatest book in the entire history of navigation.

All imprints of this edition - and no others - have a cartouche in the upper left corner of the folding map, depicting an eagle holding in its beak a banner upon which the title, "Chart of the Atlantic Ocean," appears. The plates of this edition are unsigned.

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Grolier Club List of One Hundred Influential American Books, 25   Howes B 657
Campbell, History and Bibliography of the New American Practical Navigator, pp. 75-78
Bennett, American Rare Book Guide, p. 41

BOWDITCH, NATHANIEL

New American Practical Navigator.
1st edition, Newburyport, Mass., 1801.

Bowditch was a distinguished mathematician turned navigator when he developed a simplified system for determining latitude at sea. His book became the first simple practical book on navigation that could be used by uneducated captains at sea. The work spread throughout the world and was indispensable to maritime expansion of the 19th Century. The tables were so accurate that they were still in use during World War II.

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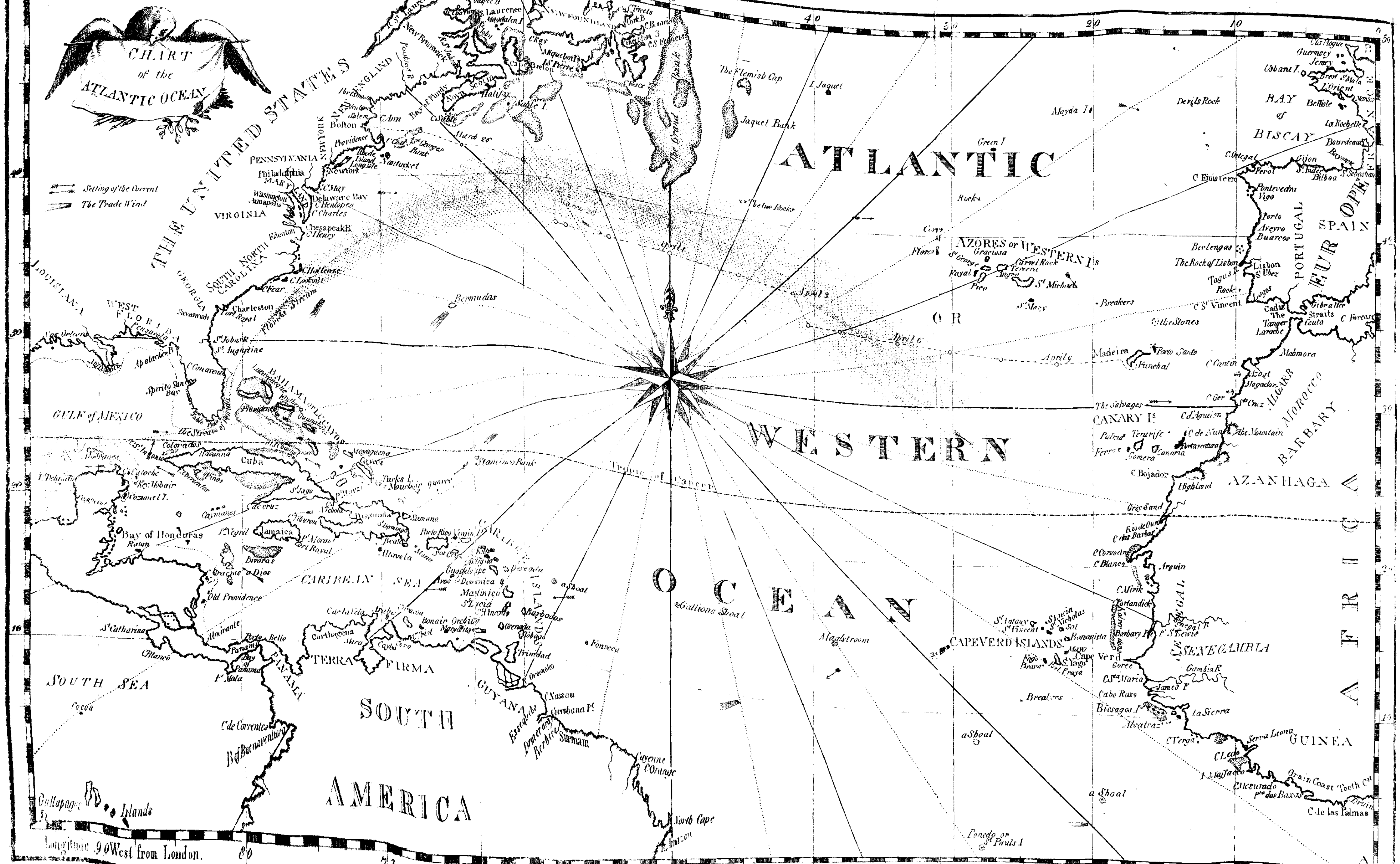


CHART of the ATLANTIC OCEAN
Setting of the Current
The Trade Wind
THE UNITED STATES
NEW ENGLAND
NEW YORK
PENNSYLVANIA
Philadelphia
MARYLAND
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
Charleston
Savannah
WEST FLORIDA
LOUISIANA
GULF of MEXICO
Boston
Providence
Nantucket
New York
Delaware Bay
C. Henlopen
C. Charles
Chesapeak B.
C. Henry
C. Hatteras
C. Lookout
C. Fear
Port Royal
St. Johns R.
St. Augustine
C. Canaveral
Spirito Santo Bay
Pensacola
Apalache B.
New Orleans
Florida Stream
The Stream of Florida
BAHAMA or LUCAYOS
Providence
Cuba
Havanna
Jamaica
Port Royal
St. Domingo
Porto Rico
Turks I.
Bermudas
Bay of Honduras
Old Providence
CARIBEAN SEA
CARIBEE ISLANDS
Guadeloupe
Dominica
Martinico
St. Lucia
St. Vincent
Barbados
Grenada
Tobago
Trinidad
Carthagena
Porto Bello
Panama
TERRA FIRMA
GUYANA
Surinam
Cayenne
North Cape
SOUTH AMERICA
SOUTH SEA
Gallapagos Islands
New Brunswick
Nova Scotia
Halifax
Sable I.
C. Sable
Cape Breton
NEWFOUNDLAND
The Grand Bank
The Flemish Cap
Jaquet Bank
I. Jaquet
Green I.
Mayda I.
Devils Rock
ATLANTIC
WESTERN
OCEAN
OR
AZORES or WESTERN Is.
Flores
Corvo
Graciosa
St. George
Fayal
Pico
Tercera
St. Michael
St. Mary
Breakers
Madeira
Porto Santo
Funchal
The Salvages
CANARY Is.
Teneriffe
Canaria
Fortaventura
Gomera
Palma
Ferro
C. Bojador
C. Blanco
Arguin
CAPE VERD ISLANDS
St. Antony
St. Vincent
St. Lucia
St. Nicholas
Sal
Bonavista
Mayo
St. Jago
Fogo
Brava
Cape Verd
Goree
Gallions Shoal
Maalstroom
Fonseca
a Shoal
Penedo or St. Pauls I.
Tropic of Cancer
BAY of BISCAY
Brest
L'Orient
Belleisle
la Rochelle
Bourdeaux
Bayonne
C. Ortegal
Ferol
C. Finisterre
Pontevedra
Vigo
Porto
Aveyro
Lisbon
St. Ubes
Berlengas
The Rock of Lisbon
Lagos
Cadiz
Gibraltar
Straits
Ceuta
C. St. Vincent
SPAIN
PORTUGAL
EUROPE
Mamora
Mogador
Santa Cruz
ALGARB
MOROCCO
BARBARY
AZANHAGA
SENEGAL
SENEGAMBIA
Gambia R.
James F.
Cabo Roxo
Bissagos Is.
Sierra Leona
GUINEA
Grain Coast
C. Mesurado
C. de las Palmas
AFRICA
Longitude 90 West from London.
80
70
60
50
40
30
20
10

THE NEW AMERICAN PRACTICAL NAVIGATOR;

BEING AN

EPITOME OF NAVIGATION;

CONTAINING ALL THE TABLES NECESSARY TO BE USED WITH THE

NAUTICAL ALMANAC,

IN DETERMINING THE

LATITUDE;

AND THE

LONGITUDE BY LUNAR OBSERVATIONS;

AND

KEEPING A COMPLETE RECKONING AT SEA:

ILLUSTRATED BY

PROPER RULES AND EXAMPLES:

THE WHOLE EXEMPLIFIED IN A

JOURNAL,

KEPT FROM

BOSTON TO MADEIRA,

IN WHICH ALL THE RULES OF NAVIGATION ARE INTRODUCED:

ALSO

The Demonstration of the most useful Rules of TRIGONOMETRY: With many useful Problems in MENSURATION, SURVEYING, and GAUGING: And a Dictionary of SEA-TERMS; with the Manner of performing the most common EVOLUTIONS at Sea.

TO WHICH ARE ADDED,

Some GENERAL INSTRUCTIONS and INFORMATION to MERCHANTS, MASTERS of VESSELS, and others concerned in NAVIGATION, relative to MARITIME LAWS and MERCANTILE CUSTOMS.

FROM THE BEST AUTHORITIES.

ENRICHED WITH A NUMBER OF

NEW TABLES,

WITH ORIGINAL IMPROVEMENTS AND ADDITIONS, AND A LARGE VARIETY OF NEW AND IMPORTANT MATTER:

ALSO,

MANY THOUSAND ERRORS ARE CORRECTED,

WHICH HAVE APPEARED IN THE BEST SYSTEMS OF NAVIGATION YET PUBLISHED.

BY NATHANIEL BOWDITCH,

FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

ILLUSTRATED WITH COPPERPLATES.

First Edition.

PRINTED AT NEWBURYPORT, (MASS.) 1802,

BY

EDMUND M. BLUNT, (Proprietor)

FOR CUSHING & APPLETON, SALEM.

SOLD BY EVERY BOOK-SELLER, SHIP-CHANDLER, AND MATHEMATICAL-INSTRUMENT-MAKER, IN THE UNITED STATES AND WEST-INDIES.

Report

Of the Committee, appointed by the EAST-INDIA MARINE SOCIETY of Salem, at their meeting on the 6th. of May, 1801, to examine a work called, "The New American Practical Navigator, by NATHANIEL BOWDITCH, F.A.A."

AFTER a full examination of the syſtem of Navigation preſented to the ſociety by one of its members, (Mr. Nathaniel Bowditch) they find, that he has corrected many thouſand errors, exiſting in the beſt European works of the kind; eſpecially thoſe in the Tables for determining the latitude by two altitudes, in thoſe of difference of latitude and departure, of the ſun's right aſcenſion, of amplitudes, and many others neceſſary to the Navigator. Mr. Bowditch has likewiſe, in many inſtances, greatly improved the old methods of calculation, and added new ones of his own. That of clearing the apparent diſtance of the moon, and ſun or ſtars, from the effect of parallax and refraction, is peculiarly adapted to the uſe of ſeamen in general, and is much facilitated (as all other methods are) in the preſent work, by the introduction of a proportional table into that of the corrections of the moon's altitude. His table nineteenth, of corrections to be applied in the lunar calculations, has the merit of being the only accurate one the committee are acquainted with. He has much improved the table of latitudes and longitudes of places, and has added thoſe of a number on the American coaſt hitherto very inaccurately aſcertained.

THIS work, therefore, is, in the opinion of the committee, highly deſerving of the approbation and encouragement of the ſociety, not only as being the moſt correct and ample now extant, but as being a genuine American production; and as ſuch they heſitate not to recommend it to the attention of Navigators, and of the public at large.

JONATHAN LAMBERT,
BENJAMIN CARPENTER,
JOHN OSGOOD,
JOHN GIBAUT,
JACOB CROWNINSHIELD,
} Committee.

Approved. BENJAMIN HODGES, Preſident.

A true copy. MOSES TOWNSEND, Sec'y.

Salem, May 13, 1801.

Advertisement.

THE decided preference given the American editions of the "NEW PRACTICAL NAVIGATOR," ſince its appearance in 1799, calls on the proprietor for his acknowledgments of gratitude. To the honour of the American mariners, and through the good offices of the American bookſellers, be it ſaid, that within two years ſeven thouſand copies have been ſold in the United States. He was preparing to put a third edition of the ſame work to preſs, but has ſince been induced to relinquiſh Moore's treatiſe for the preſent more correct and perfect work, furniſhed by Mr. BOWDITCH.

While he is tendering his thanks to ſuch as have aſſiſted in the eſtabliſhment of the work, it would be highly criminal to omit thoſe due to *John Hamilton Moore*; and with the greateſt frankneſs it is acknowledged that he contributed largely to its eſtabliſhment, as his late editions have been ſo erroneous that no perſon would hazard his intereſt, much leſs life, in navigating his veſſel by the rules there laid down, and it is well known that in all the Engliſh Weſt-India iſlands the American edition has invariably been purchaſed when a ſupply could be obtained.

EDMUND M. BLUNT.

Newburyport, Jan. 1802.

PREFACE.

THIS work was originally intended for a third American edition of the Practical Navigator of John Hamilton Moore, which had already passed through two large impressions in this country; but on a careful examination of that treatise, it was found so erroneous in the tables, and faulty in the arrangement, that it was concluded to take up the subject anew, and, without being confined to Moore's work, to have recourse to those authors whose writings would afford the best materials for the purpose—to introduce such additions and improvements of our own as a close attention to the subject suggested—and to ensure the accuracy of the Tables, by actually going through all the calculations necessary to a complete examination of them. From these labours has resulted the work now offered to the public. The particulars in which it differs from other works of the kind will be briefly stated, after giving a short account of the most popular treatises of Navigation.

THE most complete treatise we are acquainted with, is called the "Elements of Navigation," by John Robertson, published at London in 1750, in 2 vols. 8vo.; it contains the demonstrations of most of the theorems of navigation, with many practical examples, arranged in a natural order, but the collection of tables is very incomplete. The "Requisite Tables," published in 1766, 1781, and 1799, by Dr. Maskelyne, the present Astronomer Royal at Greenwich, who has rendered such important services to navigation by his various publications, contained nearly all that was wanting in Robertson's work; so that both of them combined formed a complete system of navigation both in theory and practice, but singly neither of them was complete; and much of Robertson's work was useless to most seamen, who in general care but little for the demonstrations of the rules they work by. Moore, noticing this circumstance, resolved to make his work on a different plan, to contain only such matter as might be useful to the mere practical navigator. To effect this, he copied most of the practical rules of Robertson, and the tables of Maskelyne, and formed a treatise, of moderate size and price, called, "The Practical Navigator," which had a great run in England and America, but rather from the principle of its construction, than from the execution of the work, which in many inſtances was extremely faulty: for, without correcting any errors in the works he copied from, he added many of his own, one of which has been fatal to ſeveral veſſels. The error alluded to is that in the tables of declination, which was corrected by the author of this work in the firſt and ſecond American editions. In addition to theſe faults of Moore's work, it may alſo be mentioned, that he abridged ſome of the tables,* and neglected others† of great importance. To remedy this defect, the author of this work has added forty-four pages to the tables uſed by Moore, and re-calculated the whole of them, making the laſt figure exact to the neareſt unit, a circumſtance very conducive to the accuracy of any calculation. In performing this, no leſs than EIGHT THOUSAND errors were diſcovered and corrected in Moore's work, and above TWO THOUSAND in Maſkelyne's Requiſite Tables. Moſt of the errors in Maſkelyne's collection were in the laſt decimal place, and the corrections in many inſtances would but little affect the reſult of any nautical calculation; but when it is conſidered that moſt of theſe tables are uſeful on other occaſions, where great accuracy is required, it will not be deemed a uſeleſs improvement to have corrected ſo great a number of ſmall errors.

The author had once flattered himſelf, that the tables of this collection which did not depend on obſervations would be abſolutely correct; but in the courſe of his calculations he has accidentally diſcovered ſeveral errors in two of the moſt correct works of the kind extant, viz. Taylor's and Hutton's Logarithms,‡ notwithſtanding the great care taken by thoſe able mathematicians in examining and correcting them: he therefore does not abſolutely aſſert that theſe tables are entirely correct, but feels conſcious that no pains have been ſpared to make them ſo. Any one who wiſhes to examine theſe calculations may do it by the formulæ uſed for this purpoſe, which will now be given with ſome additional remarks.

THE copy of Tables I. and II. was calculated by means of the natural ſines taken from the fourth edition of Sherwin's logarithms, having previouſly examined them by differences; when the proof-ſheets were examined, the numbers were again calculated by the natural ſines in the ſecond edition of Hutton's logarithms; and if any difference was found, they were compared and calculated a third time by Taylor's logarithms. By comparing theſe tables with thoſe publiſhed in Moore's Epitome, it

* As Table XXI. of this collection, which was only publiſhed to every 30".

† As Tables XIX. XXVI. XXVIII. and XXIX. of this collection.

‡ As it will be uſeful to thoſe who own theſe works to have a liſt of theſe errors, it is given in the laſt page of this work.

was found that there were above 3500 errors in that part of his work; most of them in the last decimal place, but many of greater moment.

TABLE III. contains the meridional parts for every degree and minute of the quadrant. The rule used in calculating this table is,

$$M = T \times 0.0007915704468,$$

in which T is the log-tangent of half the latitude increased by 45°, taken to seven places of figures reckoned as integers, and M is the meridional parts of that latitude in miles. In Moore's editions of this table were found fifty-seven errors. In this table (and in most of the other tables of this work) the degrees are marked at the bottom as well as at the top, and the space-lines are placed at every five lines distance, instead of ten as in Moore, which much facilitates the use of the tables, particularly when the numbers fall towards the bottom of the page.

TABLE IV. contains the latitudes and longitudes of several hundred places more than in Moore's table, and above one hundred on the coast of America, which are not in any European publication of the kind. Notwithstanding the care taken in correcting this table, it must, from the nature of it, be in a degree erroneous, owing to the uncertainty of the observations on which it is founded. Should any errors be discovered in this table by any person, he is requested to give information to the author or proprietor (by post or any way that may be convenient), in doing which he will render an essential service to them and to the public.

TABLE V. contains the declination of the sun, which was compared with the Nautical Almanacs for the years 1801, 1802, 1803, and 1804, and marked to the nearest minute. This table is one of the most important in this collection, because the latitude is generally determined by it: it was therefore a very criminal inattention of Moore, in publishing it so incorrectly in most of the late editions of his work; for by reckoning the year 1800 as leap-year, he had made an error of 23 miles in some of the numbers. This error was the cause of losing two vessels to the northward of Turk's Island, and bringing others into serious difficulties.

TABLE VI. contains the correction of the sun's declination, as was published by Dr. Maskelyne, excepting a small alteration in the bottom line. The correction taken from this table will never differ more than 16 or 17 seconds from the truth.

TABLE VII. contains the mean of the sun's right ascension, taken from the Nautical Almanacs for the years 1801, 1802, 1803, and 1804. This table is useful in finding the approximate time of the rising or setting of the stars, when a Nautical Almanac cannot be obtained. There is not a single number in Moore's table that agrees with that published in this work, his numbers being too great by 1, 2, 3, or 4 minutes.

TABLE VIII. contains the amplitudes of the sun for various latitudes and declinations, which was calculated by Taylor's logarithms, by this rule:

Log. sec. lat. + Log. sine declination—10.0000000 = Log. sin. amplitude.

In Moore's table of amplitudes are 434 errors of different values from 1′ to 23′.

TABLE IX. contains the right ascensions and declinations of 76 stars of the first and second magnitudes, with their annual variation, adapted to the beginning of the year 1800. This table was extracted from those published by Dr. Zach.

TABLE X. contains the time of the sun's rising and setting, which was calculated by Taylor's logarithms, by this rule:

Log. cos. hour = Log. tang. declin. + Log. tang. latitude—10.0000000.

In Moore's table are seventy errors.

TABLE XI. contains the distances at which any object is visible at sea. It was calculated by the rule given in § 195 of Vince's Astronomy, in which the terrestrial refraction was noticed; this circumstance was neglected by Robertson, Moore, and others, and of course their tables are erroneous. The rule given by Mr. Vince, expressed in logarithms, is this:

0.12155 + Half log. of height in feet = Log. of dist. in statute miles.

In reducing the rule to logarithms, I have called the radius of the earth 20911790 feet, which agrees nearly with the mean value given in La Lande's Astronomy.

TABLE XII. is a common table of proportional parts, the construction of which does not need any explanation.

TABLE XIII. contains the refraction of the heavenly bodies, calculated by Dr. Bradley's rule, supposing the refraction to be as the tangent of the apparent zenith distance of the object decreased by three times the refraction, the horizontal refraction being supposed equal to 33′. The rule expressed in logarithms is this:

Log. tang. (app. zen. dist. — 3 . refraction) — 8.2438534 = Log. of ref. in sec.

The numbers calculated by this rule agree nearly with those published in Table I. of Maskelyne's Requisite Tables.

TABLE XIV. contains the dip of the horizon for various heights, which was calculated by the rule in § 197 of Vince's Astronomy, in which the terrestrial refraction is allowed for: All the numbers of this table differ a little from those published by Dr. Maskelyne, who had made a different allowance for that refraction. The rule given by Mr. Vince, expressed in logarithms, is:

1.7712711 + half the log. of the height in feet = Log. dip in seconds.

TABLE XV. contains the sun's parallax in altitude, calculated by multiplying the natural sine of the apparent zenith distance by the sun's horizontal parallax $8\frac{3}{4}''$. The numbers in this table agree with those published by Dr. Maskelyne.

TABLE XVI. contains the augmentation of the moon's semi-diameter $= 15''.626 \times$ sine ☽'s altitude. This table agrees nearly with that published by Dr. Maskelyne.

TABLE XVII. contains the dip for various distances and heights, calculated by this rule,

$$D = \frac{3}{7}d + 0.56514 \times \frac{h}{d}$$

nearly; in which D represents the dip in miles or minutes, d the distance of the land in sea miles, and h the height of the eye of the observer in feet. These numbers differ a little from Dr. Maskelyne's, for the same reason that causes the difference in Table XIV.

TABLE XVIII. contains the corrections of the moon's altitude for parallax and refraction, and is similar to Table VIII. of the Requisite Tables, but more correct. The argument at the top is the moon's zenith distance, which was preferred to her altitude, because the corrections for the odd minutes of zenith distance, and odd seconds of parallax, are additive in the most useful parts of the table. The rules by which this table was calculated are these:

Sine par. in alt.=Sine hor. par. × Sine zen. dist.

Tabular correction=Par. in alt.—Refraction.

The numbers in the table were calculated by Taylor's logarithms to four places of decimals to every degree of zenith distance, and for 53′ and 62′ of parallax; the other numbers were found by interpolation. A number of small tables of proportional parts are now, for the first time, placed in the margin, by which the corrections for any odd minutes of zenith distance, or odd seconds of parallax, are expeditiously found.

Table XIX. contains a small correction used in working a lunar observation, and expresses the difference b, between the base B and the hypotenuse $B+b$ of a right-angled spheric triangle, whose third side P never exceeds 62′; the argument at the top of the table being B, and at the side P. The value of b being found by this rule by Taylor's logarithms:

$$\text{Log. } b \text{ in seconds} = \text{Log. co-tang. B} + \text{Log. vers. sine P} - 14.6855749$$
$$-\text{Diff. log. sines of B and } \overline{B+\tfrac{1}{2}b}$$

in which the last term may in most cases be neglected. This table was first given by Mr. Israel Lyons, and published by Dr. Maskelyne in both editions of his tables; but by a careful examination by the above rule, and by other methods, I have discovered no less than nine hundred thirty errors in this table, which only contains four pages; all of which are copied by Moore.

Table XX. for turning time into degrees, is the same as in other works of this kind.

Table XXI. was first constructed by Mr. Douwes of Amsterdam, about the year 1740, and for which he received £.50 of the Commissioners of longitude in England. This table was published in the first and second editions of the Requisite Tables; in the former edition it was carried as far as six hours, in the latter it was extended from six to nine hours. The numbers in this table are nothing more than the log. sines, log. co-secants, and log. versed sines, of the hour to which they correscond. Thus, if the time oppofite to any number of thefe tables turned into degrees, is H, we fhall have

$$\text{Log. } \tfrac{1}{2} \text{ elapfed time of H} = \text{Log. co-fecant H} - 10.0000000$$

$$\text{Log. middle time H} = \text{Log. fine H} - 4.6989700$$

$$\text{Log. rifing H} = \begin{cases} \text{Log. verfed fine H} - 5.0000000 \\ 2 \times \text{log. fine } \tfrac{1}{2}\text{ H} - 14.6989700 \end{cases}$$

By means of thefe formulæ, the numbers of Table XXI. were calculated by Sherwin's, Hutton's, and Taylor's logarithms, and a great number of errors were difcovered; there being no lefs thon 1024 in the fecond edition of the Requifite Tables, moft of which are in the additional three hours (from fix to nine hours), not publifhed in the firft edition. About two thirds of thefe additional numbers differ from their true values by one or two units. Moore did not publifh this table complete, and never corrected any errors in that he did publifh.

Table XXII. was compared with Sherwin's and Hutton's table, and a few errors corrected.

Table XXIII. contains the proportional logarithms for three hours. Any number of this table is found by fubtracting the logarithm of the time in feconds from the log. of 10800″; or, which is the fame thing, by the following rule:

Prop. log T=4.0334 738—log. of T in feconds, neglecting the three right hand figures of the remainder.

In both editions of the Requifite Tables were found fix hundred and eighty errors, in the laft decimal places, all of which were implicitly copied by Moore.

Table XXIV. contains the common logarithms of numbers, which was compared with Sherwin's, Hutton's, and Taylor's logarithms.

Table XXV. contains the common log. fines, tangents, fecants, &c. This was compared with Sherwin's, Hutton's, and Taylor's tables, and two hundred and ten errors were difcovered in Moore's work, fome of which are of great importance. Two additional columns are given in this table, which are very convenient in finding the time from an altitude of the fun, independent of the natural fines. The number of degrees is marked to 180° which faves the trouble of fubtracting the given angle from 180° when it exceeds 90°. This is a convenience in working an azimuth, or regulating a watch.

TABLE XXVI. was calculated by proportioning the daily variation of the time of the moon's paſſing the meridian. This table is not given in Moore's work, but there is a ſimilar one in the Requiſite Tables, though very inaccurately printed.

TABLE XXVII. contains the mean correction of the moon's altitude for parallax and refraction, correſponding to the parallax 57′ 30″

TABLES XXVIII. and XXIX. are taken from the Requiſite Tables, with a few corrections, being common tables of proportional parts. They are not given by Moore.

BESIDES theſe alterations in the tables, there are alſo great additions to the body of the work, taken from uſeful publications; the moſt remarkable of which are—The demonſtrations of the moſt uſeful propoſitions of Geometry and Trigonometry, from Patoun's Navigation, with alterations—The Dictionary of Sea-Terms, compiled from various authors—The manner of performing the moſt common evolutions at ſea, taken from a ſmall treatiſe on "Seamanſhip," publiſhed at London in 1795—The laws and cuſtoms relative to marine inſurance and mercantile matters, taken from the "Ship-Maſter's Aſſiſtant," publiſhed at London in 1798, with ſome alterations to adapt them to our laws—A collection of uſeful queſtions in menſuration, gauging, and ſurveying—And a variety of pieces taken from Robertſon, Maſkelyne, &c. on various ſubjects.

ALL the examples of the preſent work are adapted to American places. The method of conſtructing the problems of Middle-Latitude Sailing is more ſimple than in Moore's work. The Journal is entirely new. The examples of the Lunar Obſervations are adapted to the year 1804, which will ſave the learner the expenſe of purchaſing an old, and otherwiſe uſeleſs, Nautical Almanac. A new method of working a Lunar Obſervation is given in this work, which was publiſhed in both American editions of Moore's treatiſe; it was invented by the author of this work in the year 1795, and taught by him to a number of perſons in the year 1796, he not having then ſeen any method poſſeſſing the peculiar advantage of uniformity in applying the corrections; but ſince that time he has ſeen a method ſomewhat ſimilar, publiſhed by Mr. Mendozo y Rios in the Philoſophical Tranſactions for the year 1797.

FROM the great care taken in examining the proof-ſheets, the author preſumes that there are not many errors in the work: ſhould any hereafter be diſcovered they will be carefully corrected.

SALEM, *Dec.* 1801. N. BOWDITCH.

Contents.

ARRANGEMENT OF THE TABLES.

MARKS AND ABBREVIATIONS USED IN THIS WORK.

$+$ Signifies *more*, or the ſign of addition: it ſhews that whatever number or quantity follows this ſign, muſt be added to thoſe that go before it, thus $9+8$, ſignifies that 8 is to be added to 9. Or, $A+B$ implies that the quantities repreſented by A and B are to be added.

$-$ Signifies *leſs*, and is uſed as the ſign of ſubtraction; it denotes that the number following it muſt be ſubtracted from thoſe going before it, as $7-5$, or 5 ſubtracted from 7.

$\times$ The ſign of Multiplication, and ſhews that the numbers placed before and after it are to be multiplied, thus 7×9 ſignifies 7 multiplied by 9, which make 63, and $7\times 8\times 2$ which make 112. Multiplication is alſo denoted by placing a point between the quantities to be multiplied; thus, A . B ſignifies that A is to be multiplied by B.

$\div$ This mark ſtands for Diviſion, and ſignifies that the number that ſtands before it is to be divided by the number following it, as $72\div 12$ ſhews that 72 is to be divided by 12. Or thus, $\frac{72}{12}$. It is alſo denoted by placing two points between the numbers, thus, 72 : 12 repreſents 72 divided by 12.

( ) or ——. Either of theſe marks is uſed for connecting numbers together, thus, $\overline{3+4}\times 6$, or $(3+4)\times 6$, ſignifies that the ſum of 3 and 4 is to be multiplied by 6.

$=$ The ſign of equality: it ſhews that the numbers or quantities placed before it are equal to thoſe following it, thus, $8\times 12=96$. Or 8 multiplied by 12 are equal to 96, and $\overline{7+2}\times 4=36$.

: :: : Proportion, and is read thus, 7 : 14 :: 10 : 20, that is, as 7 is to 14, ſo is 10 to 20. Or A : B :: C : D, that is, as A is to B, ſo is C to D.

° Signifies Degrees; thus, 45° repreſents 45 degrees.

′ Signifies Minutes; thus, 24′, or 24 minutes.

″ Signifies Seconds; thus, 44″, or 44 ſeconds.

S. Signifies Sine. N. S. Signifies Natural Sine.

Sec. Signifies Secant.

Tan. Signifies Tangent.

Each of theſe laſt with Co- before it, ſignifies the complement, as Co-ſine, Co-tangent, Co-ſecant.

∠ Signifies Angle; with an s at top, Angles, ∠ˢ.

∠ᵈ Angled.

△ Signifies Triangle. △s Triangles.

□ Signifies a Square.

Z is frequently put to ſignify the ſum of two lines or numbers.

X Signifies their difference.

☉ The Sun. ☾ the Moon. ✱ a Star. L. L. Lower Limb. U. L. Upper Limb. N. L. Neareſt Limb. S. D. Semidiameter. P. L. Proportional Logarithm. N. A. Nautical Almanac. Z. D. Zenith Diſtance. D. R. Dead Reckoning.

DECIMAL ARITHMETIC.

MANY persons who have acquired considerable skill in common Arithmetic, are however unacquainted with the method of calculating by decimals, which is of great use in navigation ; for which reason it was thought proper to prefix the following brief explanation of their use :

Fractions or *Vulgar Fractions* are expressions for any assignable part of an unit ; they are usually denoted by two numbers, placed one above the other, with a line between them ; thus, $\frac{1}{4}$ denotes the fraction one-fourth, or one part out of four of some whole quantity, considered as divisible into four equal parts. The lower number 4 is called the *denominator* of the fraction, shewing into how many parts the whole or integer is divided ; and the upper number 1, is called the *numerator*, and shews how many of those equal parts are contained in the fraction. And it is evident that if the numerator and denominator be varied in the same ratio, the value of the fraction will remain unaltered : thus if the numerator and denominator of the fraction $\frac{1}{4}$ be multiplied by 2, 3 or 4, &c. the fractions arising will be $\frac{2}{8}$, $\frac{3}{12}$, $\frac{4}{16}$, &c. which are evidently equal to $\frac{1}{4}$.

Decimal Fraction is a fraction whose denominator is always an unit with some number of ciphers annexed, the numerators of which may be any numbers whatever ; as $\frac{2}{10}$, $\frac{3}{100}$, $\frac{15}{1000}$, &c. And as the denominator of a decimal is always one of the numbers 10, 100, 1000, &c. the inconvenience of writing these denominators may be avoided by placing a point between the integral and the fractional part of the number ; thus $\frac{3}{10}$ is written .3 ; and $\frac{14}{100}$ is written .14 ; the *mixed* number $3\frac{14}{100}$, consisting of whole numbers and fractional ones is written 3.14.

In setting down a decimal fraction, the numerator must consist of as many places as there are ciphers in the denominator ; and if it has not so many figures the defect must be supplied by placing ciphers before them : thus, $\frac{16}{100}$ = .16, $\frac{16}{1000}$ = .016, $\frac{16}{10000}$ = .0016, &c. So that as ciphers on the right hand side of integers increase their value in a tenfold proportion, as 2, 20, 200, &c. so when set on the left hand of decimal fractions, they decrease their value in a tenfold proportion, as .2, .02, .002, &c. but ciphers set on the right hand of these fractions make no alteration in their value, neither of increase or decrease ; thus .2 is the same as .20 or .200. The common arithmetical operations are performed the same way in decimals, as they are in integers ; regard being had only to the particular notation, to distinguish the integral from the fractional part of a sum.

ADDITION OF DECIMALS.

Addition of decimals is performed exactly like that of whole numbers, placing the numbers of the same denomination under each other, in which case the decimal separating points will range straight in one column.

EXAMPLES.

	Miles.	Feet.	Inches.
	26.7	1.26	272.3267
	32.15	2.31	.0134
	143.206	1.785	2.1576
	.003	2.0	31.4
Sum	202.059	7.355	305.8977

SUBTRACTION OF DECIMALS.

Subtraction of decimals is performed in the same manner as in whole numbers, by observing to set the figures of the same denomination and the separating points directly under each other.

EXAMPLES.

From	31.267	36.75	1.254	1364.2
Take	2.63	.026	.316	25.163
Diff.	28.637	36.724	.938	1339.037

MULTIPLICATION OF DECIMALS.

Multiply the numbers together the same as if they were whole numbers, and point off as many decimals from the right hand as there are decimals in both factors together; and when it happens that there are not so many figures in the product as there must be decimals, then prefix as many ciphers to the left hand as will supply the defect.

EXAMPLE I.

Multiply 3.25 by 4.5.

```
  3.25
  4.5
 -----
 1.625
13.00
 -----
Answer 14.625
```

In one of the factors is one decimal and in the other two, their sum 3 is the number of decimals of the product.

EXAMPLE II.

Multiply 0.5 by 0.7.

```
0.5
0.7
----
0.35 Answer.
```

EXAMPLE III.

Multiply 3.25 by .05

```
3.25
 .05
-----
.1625 Product.
```

EXAMPLE IV. Mult. .17 by .06.

```
 .17
 .06
-----
Answer .0102
```

In each of the factors are two decimals, the product ought therefore to contain 4, and there being only 3 figures in the product I prefix a cipher.

EXAMPLE 5. Multiply .18 by 24.

```
.18
 24
---
 72
36
---
Answer 4.32
```

EXAMPLE VI. Mult. 36.1 by 2.5

```
 36.1
  2.5
-----
 18.05
 72.2
-----
Answer 90.25
```

DIVISION OF DECIMALS.

Divifion of decimals is performed in the fame manner as in whole numbers; only obferving that the number of decimals in the quotient, muft be equal to the excefs of the number of decimals of the dividend above thofe of the divifor.

EXAMPLE I.

Divide 14.625 by 3.25.

```
3.25)14.625(4.5
     1300
     ----
      1625
      1625
      ----
```

In this example there are 2 decimals in the divifor and 3 in the dividend, hence there is one decimal in the quotient.

EXAMPLE II.

Divide 0.35 by 0.7

```
.7).35(.5
    .35
    ---
```

EXAMPLE III.

Divide 3.1 by .0062.

Previous to the divifion I affix a number of ciphers to the right hand of 3.1, which does not alter its value.

```
.0062)3.100000(500.00
       310
       ---
       0000
```

Therefore the anf. is 500.00 or 500.

EXAMPLE IV.

Divide 9.6 by .06

```
.06)9.60
    ----
    160. Anfwer.
```

Here by affixing a cipher to 9.6 it becomes 9.60, and has then 2 decimals in it, which is the fame number as is in the divifor, therefore the quotient is an integer number.

EXAMPLE V. Divide 17.256 by 1.16

```
1.16)17.25600(14.875
     116
     ---
      565
      464
      ----
      1016
       928
       ---
        880
        812
        ---
         680
         580
         ---
         100
```

REDUCTION OF DECIMALS.

If you wifh to reduce a vulgar fraction to a decimal, you may add any number of ciphers to the numerator, and divide it by the denominator, the quotient will be the decimal fraction; the decimal point muft be fo placed that there may be as many figures to the right hand of it as you added ciphers to the numerator; if there are not as many figures in the quotient, you muft place ciphers to the left hand to make up the number.

EXAMPLE I. Reduce $\frac{1}{5}$ to a decimal.

```
5)1.0
  ---
  .2 Anfwer.
```

EXAMPLE II. Reduce $\frac{3}{8}$ to a decimal.

```
8)3.000
  -----
  .375 Anfwer.
```

EXAMPLE III. Reduce 3 inches to the decimal of a foot.

Since 12 inches = 1 foot, this fraction is $\frac{3}{12}$;

```
12)3.00
   ----
   .25 Anfwer.
```

EXAMPLE IV. Reduce $3\frac{1}{2}$ inches to the decimal of a foot.

$3\frac{1}{2}=\frac{7}{2}$. this divided by 12 is $\frac{7}{24}$.

```
24)7.000(.291 Anſwer.
   48
   ---
   220
   216
   ---
    40
    24
   ---
    16
```

EXAMPLE V.

Reduce 1 foot and 6 inches to the decimal of a yard.

Here 1 foot 6 inches = 18 inches.

And 1 yard = 36 inches, therefore this fraction is $\frac{18}{36}$;

```
36)18.0(.5 Anſwer.
   180
   ---
```

If you have any decimal fraction, it is eaſy to find its value in the lower denominations of the ſame quantity; thus if the fraction was the decimal of a yard, by multiplying it by 3 we have its value in feet and parts, if we multiply this by 12, the product is its value in inches and parts; and in the ſame manner the values may be obtained in other caſes.

EXAMPLE VI.

Required the value of 3.25 yards.

```
3.25
   3
----
 .75
  12
----
9.00
```

Anſwer 3 yards 0 feet 9 inches.

EXAMPLE VII.

Required the value of 7.231 days?

```
 7.231
    24
------
  924
 462
------
 5.544
    60
------
32.640
    60
------
38.400
```

Anſwer 7 days 5 hours 32 minutes and 38 ſeconds.

GEOMETRY.

GEOMETRY is the Science which treats of the Defcription, Properties and Relations of Magnitudes in general, of which there are three Kinds or Species, viz. a Line which has only length without either breadth or thicknefs ; a Superficies, comprehended by length and breadth ; and a Solid, which has length, breadth, and thicknefs.

I.

A Point confidered mathematically, is incapable of being divided, and therefore hath no parts, or it is the fmalleft part of fpace that can be affigned, and may be conceived fo infinitely fmall, as to be void of length, breadth, or thicknefs, being always denoted by a dot, as at A.

A .

II.

A Right Line is the neareft diftance between two points which limits its length, without any fuppofed breadth, or thicknefs, as A C ; it may be fuppofed to be the fluxion of a point.

A———C

III.

A Plane Superficies is that which lies evenly between its extreme points, refembling a fmooth table, or polifhed glafs, bounded by lines ; having length and breadth but is conceived to have no depth or thicknefs, and may be conceived to be generated by the fluxion of a Right Line.

IV.

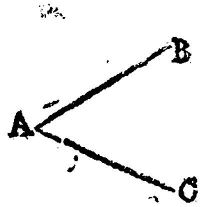
Parallel Lines are fuch as are equally diftant in all their parts, which extended infinitely on the fame plane would never meet, as the lines AB, BC.

A———B

B———C

V.

A Plane Angle is the inclination or meeting of two right lines in one point ; the point where they meet is called the angular point, and the lines AB and AC are called fides or legs ; it is generally expreffed by three letters, as BAC, the middle one always denotes the angular point, as A, and the two others the extremities of the legs, as B, C.

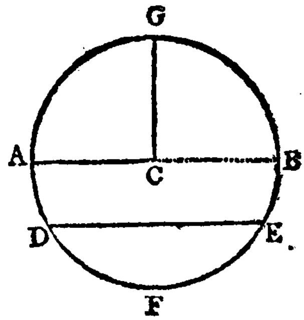


VI.

A Circle is a plane figure, bounded by an uniform curve line, it is ordinarily defcribed by a right line, taken with a pair of compaffes ; one point thereof being fixed, whilft the other is turned round to the place where the motion firft began ; the fixed point is called the centre, and the line defcribed by the other point is called the circumference.

VII.

The RADIUS of a circle, or SEMIDIAMETER, is a right line drawn from the centre to the circumference, as AC; or it is that line which is taken between the points of the compaſſes to deſcribe the circle.



A DIAMETER of a circle is a RIGHT LINE drawn through the centre and terminated at both ends by the circumference, as ACB, which is the double of the radius AC. A diameter divides the circle, and its circumference into two equal parts.

VIII.

An ARCH of a circle is any part or portion of the circumference; as DFE.

IX.

A CHORD of a circle is the ſubtenſe of an arch, or it is a right line joining the ends of an arch; it divides the circle into two unequal parts, called SEGMENTS, and is a chord to them both, as DE is the chord of the arches DFE and DGE.

X.

A SEMICIRCLE, or half a circle, is a figure contained under the diameter, as AGB or AFB. Any part of a circle contained between two radii and an arch, is called a SECTOR.

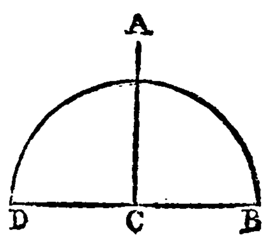
XI.

A QUADRANT is half a ſemicircle, or one fourth part of the whole circle, as the figure CAG.

NOTE. All circles whether great or ſmall, are ſuppoſed to have their circumference divided into 360 equal parts, called degrees, and each degree into 60 equal parts, called minutes, and each minute into 60 equal parts, called ſeconds, and ſo on into thirds, fourths, &c.

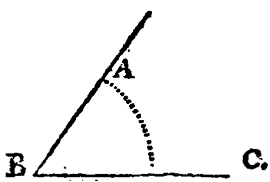
XII.

If a right line AC, fall upon another DB, ſo as to incline neither to the one ſide nor the other, but makes the angles ACD, ACB, on each ſide equal to each other; then the line AC is ſaid to be *perpendicular* to the line DC; and the two angles are called right angles.



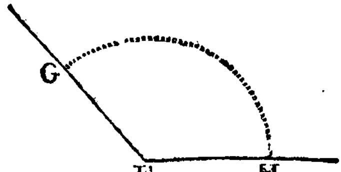
XIII.

An ACUTE ANGLE is leſs than a right angle, as ABC.



XIV.

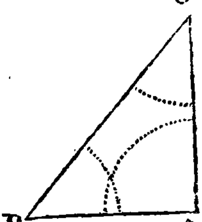
An OBTUSE ANGLE is greater than a right angle, as GEH.



The fewest number of right lines that can include a space, are three, which form a figure called a triangle, or three-cornered figure, which consists of six parts, viz. three sides and three angles: It is distinguished into three sorts, viz. a right-angled triangle, an obtuse-angled triangle, and an acute-angled triangle.

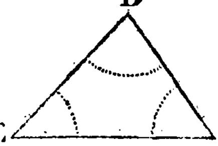
XV.

A RIGHT-ANGLED TRIANGLE has one of its angles right; the side opposite the right angle is called the hypotenuse; and the other two sides are called legs; that which stands upright, is called the perpendicular, and the other the base; thus BC is the hypotenuse, AC the perpendicular, and AB the base; the angles opposite the two legs are both acute.



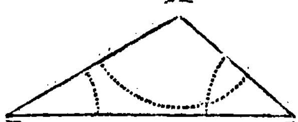
XVI.

An ACUTE-ANGLED TRIANGLE has all its angles acute, or none of them equal to a right angle, as DEG.



XVII.

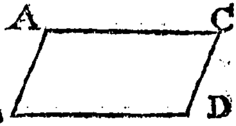
An OBTUSE-ANGLED TRIANGLE has one of its angles obtuse, or greater than a right angle, as RAF; the other two angles are acute.

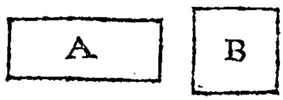


NOTE. All triangles, that are not right angled, whether they are acute or obtuse, are in general terms called oblique-angled triangles, without any other distinction.

XVIII.

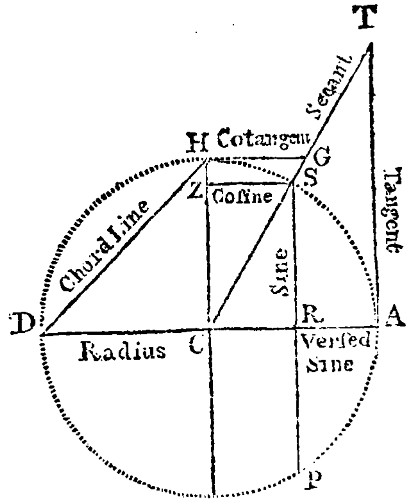
A QUADRILATERAL figure is one bounded by four sides as ACDB. If the opposite sides are parallel they are called PARALLELOGRAMS. Thus if AC be parallel to BD, and AB parallel to CD, the figure ACDB is a parallelogram. A parallelogram having all its sides equal and its angles right is called a SQUARE, as B. When the angles are right and the opposite sides only equal, it is called a RECTANGLE, as A.





XIX.

The SINE or RIGHT SINE of an arch is a line drawn from one end of the arch perpendicular to a diameter drawn through the other end of the same arch; thus R S is the right sine of the arch A S, it being a line drawn from one end of the arch S, perpendicular to D A which is the diameter passing through the other end of the arch A.



XX.

The CO-SINE of an arch is the sine of the *complement* of that *arch*, or of what that arch wants of a quadrant; thus A H being a quadrant, the arch S H is the complement of the arch A S; S Z is the sine of the arch S H, or the co-sine of the arch A S.

XXI.

The VERSED SINE of an arch is that part of the diameter contained between the right sine and the arch; thus R A is the versed sine of the arch A S, and D C R is the versed sine of the arch D H S.

XXII.

The TANGENT of an arch is a right line drawn perpendicular to the diameter passing through one end of the arch, and terminated by a line drawn from the centre through the other end of the arch; thus A T is the tangent of the arch A S.

XXIII.

The CO-TANGENT of an arch is the tangent of the complement of that arch to a quadrant; thus H G is the tangent of the arch H S, or the co-tangent of the arch A S.

XXIV.

The SECANT of an arch is a right line drawn from the centre through one end of the arch, to meet the tangent drawn from the other end; thus, C T is the secant of the arch A S.

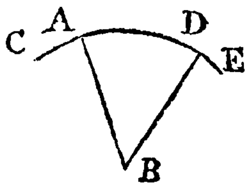
XXV.

The CO-SECANT of an arch is the secant of the complement of that arch to a quadrant, thus C G is the secant of the arch S H, or co-secant of the arch A S.

XXVI.

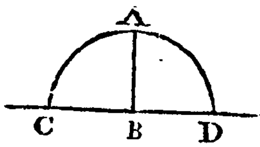
What an arch wants of a semicircle is called the SUPPLEMENT of that arch; thus, the arch D H S is the supplement of the arch A S. The sine, tangent, or secant of an arch, is the same as the sine, tangent, or secant of its supplement; thus, the sine of 80° = sine of 100°, and the sine of 70° = sine of 110°, &c.

XXVII.



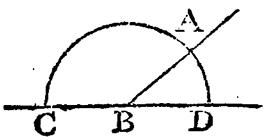
A right lined angle is measured by an arch of a circle comprehended between the two legs that form the angle; the centre of the circle being the angular point; thus, the angle ABD is measured by the arch AD of the circle CADE, described upon the point B as a centre, and the angle is said to be of as many degrees as the arch is; that is, if the arch AD be 45°, then the angle ABD is said to be an angle of 45 degrees. And the sine, tangent, &c. of any arch is called also the sine, tangent, &c. of the angle whose measure the arch is.

XXVIII.



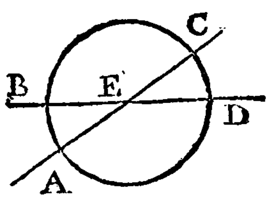
If the line AB be drawn perpendicular to the line CBD, and upon B as a centre, a semicircle CAD be described; the arches CA, AD will be, each equal to a quadrant, or 90 degrees. For *(by art.* 12*)* the angle ABD is equal to ABC; but these angles are measured by the arches AC, AD, therefore these arches must be equal; but the whole CAD is a semicircle, (since CD a line passing through the centre B is a diameter,) therefore each of the parts AC, AD is a quadrant or 90°.

XXIX.



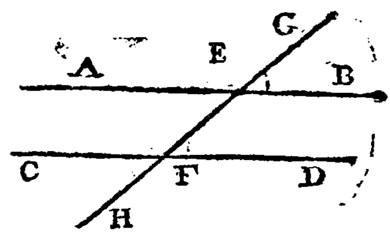
If one line AB fall any way upon another CD, the sum of the two angles ABD, ABC is always equal to two right angles. For on the point B as a centre, describe the circular arch CAB, cutting the line CD in C and D; then (*by Art.* 7) this arch is equal to a semicircle, but it is also equal to the sum of the arches CA, and AD, the measures of the two angles ABC, ABD; therefore the sum of the two angles is equal to a semicircle, or two right angles. Hence it is plain that all the angles which can be made from a point in any line, towards one side of the line, are equal to two right angles, and that all the angles which can be made about a point are equal to four right angles.

XXX.



If a line AC *cross another* BD *in the point* E, *the opposite angles shall be equal,* viz. BEA=CED, and BEC=AED. Upon the point E as a centre, describe the circle ABCD; then it is plain that ABC is a semicircle, as also BCD (*by the 7th.*) therefore the arch ABC= arch BCD, taking from both the common arch BC, there remains AB=CD, that is, the angle BEA equal to the angle CED *(by art.* 27.*)* After the same manner we may prove that the angle BEC is equal to the angle AED.

XXXI.



If a line GH *cross two parallel lines* AB, CD, *it makes the external opposite angles equal to each other*; viz. GEB=CFH, and AEG=HFD. For since AB and CD are parallel to each other, they may be considered as one broad line, and GH crossing it; then the vertical or opposite angles GEB, CFH are equal *(by art.* 30,*)* as also AEG=HFD.

XXXII.

If a line GH *cross two parallel lines* AB, CD, (see the preceding figure) *the alternate angles* AEF *and* EFD, *or* CFE *and* FEB *are equal.* For GEB=AEF *(art.* 30*)* as also CFH=EFD *(by the same art.)* but GEB=CFH by the last. Therefore AEF is equal to EFD; the same way we may prove FEB=CFE.

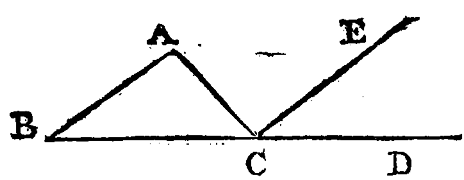
XXXIII.

If a line GH *cross two parallel lines* AB, CD, (see the preceding figure) *the external angle* GEB *is equal to the internal opposite one* EFD, *or* AEG *equal to* CFE. For the angle AEF is equal to the angle EFD by the last; but AEF=GEB *(by art.* 30,*)* therefore GEB=EFD; the same way we may prove AEG=CFE.

XXXIV.

If a line GH *cross two parallel lines* AB, CD, (see the preceding figure) *the sum of the two internal angles* BEF *and* DFE, *or* AEF *and* CFE *is equal to two right angles*; for since the angle GEB is equal to the angle EFD *(by the last)* to both add the angle BEF, and we have GEB+BEF =BEF+EFD, but GEB+BEF=two right angles *(art.* 29*)*. Hence BEF+EFD=two right angles; and in the same manner we may prove AEF+CFE= two right angles.

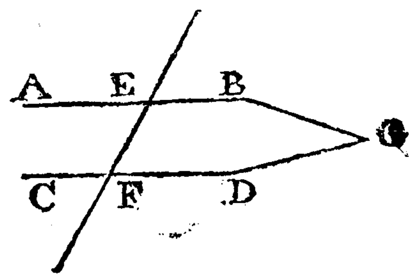
XXXV.



In any triangle ABC, *one of its legs, as* BC *being produced towards* D, *the external angle* ACD *is equal to both the internal and opposite angles* ABC, BAC *taken together.* To prove this, through C draw CE parallel to AB; then since CE is parallel to AB and the lines AC, BD cross them, the angle ECD=ABC *(by art.* 33,*)* and ACE=BAC *(by art.* 32,*)* adding these together we have ECD+ACE=ABC+BAC; but ECD+ACE=ACD therefore ACD=ABC+BAC.

XXXVI.

Hence it may be proved that if any two lines A B and C D, be crossed by a third line E F, and the alternate angles A E F and E F D be equal, the lines A B and C D will be parallel; for if they are not parallel, they must meet each other on one side of the line EF (suppose at G) and so form the triangle E G F, one of whose sides G E being produced to A, the exterior angle A E F must (by the preceding article) be equal to the sum of the two angles EFG and EGF; but by supposition it is equal to the angle E F G alone; therefore the angle A E F must be equal to the sum of the two angles E F G and E G F, and at the same time equal to E F G alone, which is absurd; therefore the lines A B, C D cannot meet and must be parallel.



XXXVII.

In any right lined triangle A B C, all three angles taken together are equal to two right angles. To prove this you must produce BC *(In the fig. art. 35,)* one of its legs to any distance, as to D, then *(by art. 35,)* the external angle ACD=ABC+BAC, to both add the angle ACB and we have ACD+ACB=ABC+BAC+ACB, but ACD+ACB=two right angles *(by art. 29).* Hence ABC+BAC+ACB=two right angles; that is, the sum of the three angles of any plane triangle ACB is equal to two right angles.

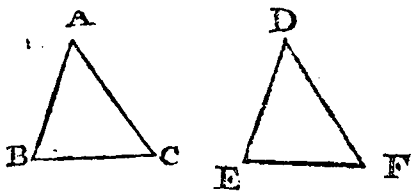
XXXVIII.

Hence in any plane triangle, if one of its angles be known the sum of the other two is also known; for by the last article the sum of all three angles is equal to two right angles or 180°, hence by subtracting the given angle from 180° the remainder is the sum of the other two.

In any right angled triangle, the two acute angles taken together are just equal to a right angle; for all three angles being equal to two right angles, and one angle being right by supposition, the sum of the other two must be equal to a right angle, consequently any one of the acute angles being given, the other one may be found by subtracting the given one from 90 degrees.

XXXIX.

If in any two triangles ABC, DEF, two legs of the one, AB, AC, be equal to two legs of the other DE, DF, each to each respectively, that is, AB=DE and AC=DF, and the angles BAC, EDF included between the equal legs be equal; then the remaining leg of the one shall be equal to the remaining leg of the other, and the angles opposite to the equal legs shall be equal; that is, BC=EF, ABC=DEF, and ACB=DFE; for if the triangle ABC be supposed to be lifted up and put upon the triangle DEF, with the point A on the point D; it is plain since AB=DE, that the point B will fall upon E, and since the angles BAC, EDF are equal, the line AC will fall upon DF, and these lines being of equal length, the point C will fall upon F, consequently the line BC will



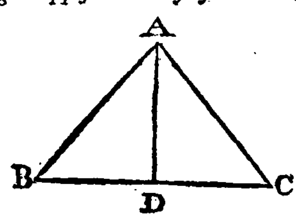
exactly agree with the line EF, and the triangle ABC will in all respects be exactly equal to the triangle DEF; and the angle ABC will be equal to the angle DEF, also the angle ACB will be equal to the angle DFE.

XL.

After the same manner it may be proved, that if in any two triangles ABC, DEF *(see the preceding figure)* two angles ABC and ACB of the one, be equal to two angles DEF, DFE of the other, and the included side BC be equal to EF; the remaining sides and included angles will also be equal to each other respectively, that is AB=DE, AC=DF, and the angle BAC=angle EDF. For if the triangle ABC be supposed to be lifted up and laid upon the triangle DEF, the point B being upon the point E, and the line BC upon the line EF; then since BC=EF, the point C will fall upon the point F, and since the angle ACB=the angle DFE, the line CA will fall upon the line FD, and by the same way of reasoning, the line BA will fall upon the line ED, therefore the point of intersection A of the two lines BA, CA, will fall upon D, the point of intersection of the lines ED, FD, consequently AB=DE, AC=DF, and the angle BAC=the angle EDF.

XLI.

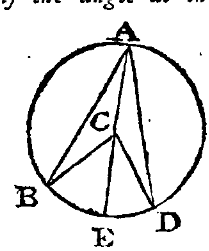
If two sides of a triangle are equal, the angles opposite to these sides will also be equal; that is if AB=AC, the angles ABC, ACB will also be equal; for suppose the line AD bisects the angle BAC, or divides it into two equal angles BAD, CAD, and meets the line BC in D, dividing the triangle BAC into two triangles ABD, ACD, in which the side AB=AC, the side AD is common to both triangles, and the included angle BAD=the angle DAC, therefore *(by art. 39,)* the angle ABD must be equal to the angle ACD.



The converse of this proposition is also true; that is, *if two angles of a triangle are equal, the opposite sides are also equal.* This is demonstrated in nearly the same manner by means of *art.* 40.

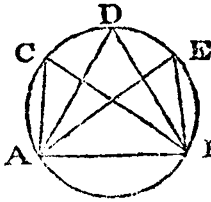
XLII.

Any angle at the circumference of a circle is but half the angle at the centre standing upon the same arch. Thus, the angle BAD is half the angle BCD standing upon the same arch BD of the circle BEDA, whose centre is C. To demonstrate this, draw through A and the centre C the right line ACE, then *(by art. 35,)* the angle CAD+angle CDA=angle ECD, but AC=CD (being two radii of the same circle) therefore *(by art. 41,)* the angle CAD=the angle CDA, and the sum of these two angles is the double of either of them, that is, CAD+CDA=twice CAD, therefore ECD=twice CAD; in the same manner we may prove that BCE=twice BAC, and therefore by adding these together we have ECD+BCE=twice CAD+twice BAC, that is, BCD=twice BAD, or BAD equal to half of BCD.



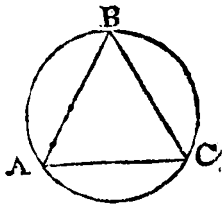
XLIII.

Hence an angle at the circumference is measured by half the arch it subtends; for an angle at the centre standing on the same arch is measured by the whole arch *(by Art. 27)*; but since an angle at the centre is double that at the circumference, it is plain that an angle at the circumference must be measured by only half the arch it stands upon. *Hence all angles* A C B, A D B, A E B, &c. *at the circumference of a circle standing on the same chord* A B *are equal to one another;* for they are all measured by the same arch, viz. half the arch A B which each of them subtends.

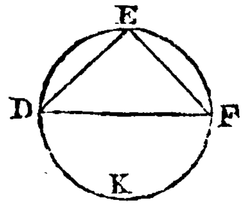


XLIV.

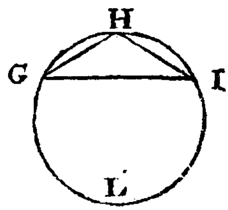
Hence an angle in a segment greater than a semicircle is less than a right angle; thus if A B C be a segment greater than a semicircle, the arch A C on which it stands must be less than a semicircle, and the half of it less than a quadrant or a right angle; but the angle A B C in the segment is measured by the half of the arch A C; therefore it is less than a right angle.



An angle in a semicircle is a right angle; for since D E F is a semicircle, the arch D K F must also be a semicircle; but the angle D E F is measured by half the arch D K F, that is by half a semicircle or by a quadrant; therefore the angle D E F is a right one.

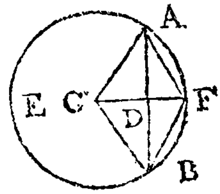


An angle in a segment less than a semicircle is greater than a right angle; thus if G H I be a segment less than a semicircle, the arch G L I on which it stands must be greater than a semicircle, and its half greater than a quadrant or right angle; therefore the angle G H I which is measured by half the arch G L I is greater than a right angle.



XLV.

If from the centre C of the circle A B E, there be let fall the perpendicular C D on the chord A B; it will bisect the chord in the point D. For to demonstrate this, draw from the centre to the extremities of the chord the lines C A, C B; then since C A = C B, the angles which they subtend C B A, C A B must be equal *(by Art. 41,)* but the perpendicular C D divides the triangle A C B into two right angled triangles A D C, C D B, in which the sum of the angles A C D, C A D, in the one is equal to the sum of the angles D C B and C B D in the other, each being equal to a right angle *(by Art. 38,)* but C A D is equal to C B D *(by Art. 41,)* therefore A C D is equal



to DCB; therefore in the two triangles ADC, CDB, the two legs CA, CD, in the one, are equal to the two legs CB and CD in the other, each to each respectively, and the included angles ACD, DCB are equal; therefore the remaining legs AD and BD are equal *(by Art. 39,)* consequently AB is bisected in D.

XLVI.

If from the centre of a circle there be drawn a perpendicular to a chord line, and it be continued to meet the circle, it will bisect the arch corresponding to that chord. Thus *(in the preceding figure)* if the line CD be drawn perpendicular to the chord AB, and continued to meet the circle in F, the arch AB will be bisected in the point F; for joining AF, FB, we have in the triangles ADF, BDF; AD equal to DB *(by the last art.)* and DF common to both, therefore AD, DF, two legs of the triangle ADF, are equal to BD, and DF, two legs of the triangle BDF, and the included angles ADF, BDF are equal being both right, therefore, *(by art. 39,)* the remaining legs AF and FB are equal, but in the same circle equal lines are chords of equal arches, therefore the arches AF and FB are equal, consequently the whole arch AFB is bisected in F.

XLVII.

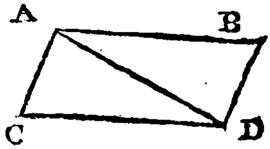
Any line bisecting a chord at right angles is a diameter; for since *(by art. 45,)* a line drawn from the centre perpendicular to a chord bisects that chord at right angles, therefore conversely a line bisecting a chord at right angles, must pass through the centre and consequently be a diameter.

XLVIII.

The sine of any arch is equal to half the chord of twice that arch; for *(in the last scheme)* AD is the sine of the arch AF, by the definition of a sine *(art. 19,)* and AF is half the arch AFB, and AD half the chord AB, *(by art. 45,)* whence the proposition is manifest.

XLIX.

If two equal and parallel lines AB, CD, *be joined by two others* AC, BD, *then these shall also be equal and parallel.*



To demonstrate this, join the two opposite angles A and D with the line AD; then it is plain that the line AD divides the quadrilateral ACDB into two triangles ABD, ACD, in which AB a leg of the one, is equal to CD a leg of the other by supposition, and AD is common to both triangles; and since AB is parallel to CD, the angle BAD will be equal to the angle ADC, *(by art. 32,)* therefore in the two triangles, the sides AB, AD and the angle BAD, are equal respectively to the sides CD, AD, and the angle ADC; that is, two legs and the included angle of the one, are equal to two legs and the included angle of the other; therefore *(by art. 39,)* BD is equal to AC, and the angle DAC is equal to the angle ADB; therefore *(by art. 36)* the lines BD, AC must be parallel.

Cor. Hence it is plain that the quadrilateral ABDC is a parallelogram, since the opposite sides are parallel. It is also evident that in any parallelogram, the line joining the opposite angles (called the *Diagonal*) as AD, divides the figure into two equal parts, since it has been proved that the triangles ABD, ACD, are equal to each other.

L.

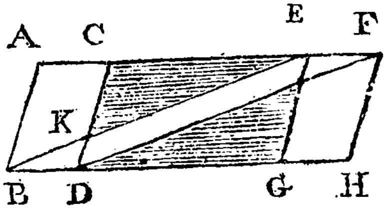
It follows alſo from the preceding article, that *a triangle* ACD (*ſee the preceding figure*) *on the ſame baſe, and between the ſame parallels with a parallelogram* ABDC, *is the half of that parallelogram.*

LI.

From the ſame article it alſo follows, that *the oppoſite ſides of a parallelogram are equal;* for it has been proved that ABDC being a parallelogram, AB will be equal to CD, and AC equal to BD.

LII.

All parallelograms on the ſame or equal baſes, and between the ſame parallels, are equal to each other; that is, if BD and GH be equal, and the lines BH, AF be parallel, the parallelograms ABDC, BDFE and EFHG are equal to each other. For AC is equal to EF each being equal to BD (*by art.* 51,) to both add CE and we have AE equal to CF; therefore in the two triangles ABE, CDF; AB, a leg of the one, is equal CD, a leg of the other,

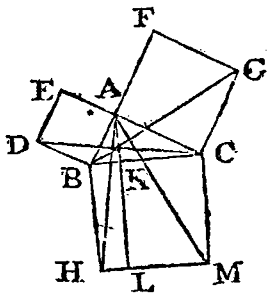


and AE is equal to CF, and the angle BAE is equal to DCF (*by art.* 33) therefore the two triangles ABE, CDF, are equal (*by art.* 39,) and taking the triangle CKE from both, the figure ABKC will be equal to the figure KDFE, to both which add the little triangle KBD, and we have the parallelogram ABDC equal to the parallelogram BDFE. In the ſame way it may be proved that the parallelogram EFHG is equal to the parallelogram BDFE; therefore the three parallelograms ABDC, BDFE, and EFHG are equal to each other.

Cor. Hence it follows, that *triangles on the ſame baſe and between the ſame parallels are equal,* ſince they are the half of the parallelograms on the ſame baſe and between the ſame parallels (*by Art.* 50).

LIII.

In any right angled triangle, the ſquare of the hypotenuſe is equal to the ſum of the ſquares of the two ſides. Thus if BAC be a right angled triangle, the ſquare of the hypotenuſe BC, viz. BCMH, is equal to the ſum of the ſquares, made on the two ſides AB and AC, viz. to ABDE and ACGF. To demonſtrate this, through the point A, draw AKL perpendicular to the hypotenuſe BC. Join AH, AM, DC, and BG; then it is evident, that DB is equal to BA (*by Art.* 18,) and BH equal to BC, therefore in the triangles DBC, ABH, the two legs DB, BC of the one are equal to the two legs AB, BH, of the other; and the included angles DBC and ABH are alſo equal, (becauſe DBA is equal to CBH being both right, to each add ABC and we have DBC equal to ABH) therefore the triangles DBC, ABH are equal (*by Art.* 39,) but the triangle DBC is half of the ſquare ABDE (*by Art.* 50) and the triangle ABH is half the parallelogram BKLH (*by the ſame Art.*) conſequently the ſquare ABDE is equal to the parallelogram



BKLH. In the ſame way it may be proved, that the ſquare ACGF is equal to the parallelogram KCML. Therefore the ſum of the ſquares ABDE and ACGF is equal to the ſum of the parallelograms BKLH and KCML; but the ſum of theſe parallelograms is equal to the ſquare

BCMH, therefore the sum of the squares on AB and AC is equal to the square on BC.

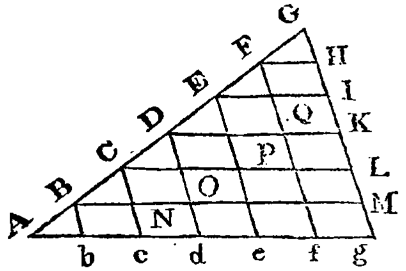
Cor. Hence in any right angled triangle, if we have the hypotenuse and one of the legs, we may easily find the other leg, by taking the square of the given leg from the square of the hypotenuse, the square root of the remainder will be the sought leg. Thus if the hypotenuse was 13, and one leg was 5, the other leg would be 12, for the square of 5 is 25, and the square of 13 is 169, subtracting 25 from 169 leaves 144, the square root of which is 12. If both legs are given, the hypotenuse may also be found by extracting the square root of the sum of the squares of the legs; thus if one leg was 6, and the other 8, the square of the first is 36, the square of the second is 64, adding 36 and 64 together gives 100, whose square root is 10, which is the sought hypotenuse.

LIV.

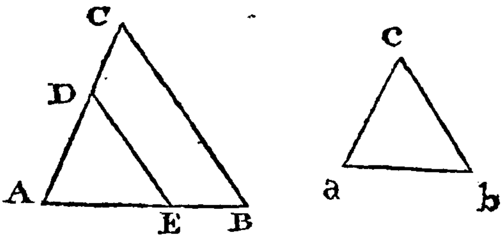
Four quantities are said to be proportional when the magnitude of the first compared with the second, is the same as the magnitude of the third compared with the fourth; thus 4, 8, 12 and 24, are proportional, because 4 is half of 8 and 12 is half of 24; and if we take like multiples A × a, A × b, of the quantities a and b, and other like multiples B × a, B × b, of the same quantities a and b, the four quantities A × a, A × b, B × a and B × b are proportional, for A × a compared with A × b is of the same magnitude as a compared with b, and B × a compared with B × b is also of the same magnitude as a compared with b.

LV.

In any triangle AGg, *if a line* Ee *be drawn parallel to either of the sides as* Gg, *the side* AG *will be to* AE, *as* Ag *to* Ae, *or as* Gg *to* Ee. To demonstrate this, upon the line AG take the line AB such that a certain multiple of it may be equal to AE, and another multiple of it may be equal to AG; this may be always done accurately when AE and AG are commensurable; if they are not accurately commensurable, the quantity AB may be taken so small, as that certain multiples of it may differ from AE and AG, only by quantities less than any assignable. On the line AG, take BC, CD, DE, EF, FG, &c. each equal to AB, and through these points draw the lines Bb, Cc, &c. parallel to Gg, cutting the line Ag in the points b, c, d, e, &c. draw also the lines BM, CL, DK, &c. parallel to Ag, cutting the former parallels in the points N, O, P, &c. and the line Gg in the points M, L, K, &c. Then the triangles ABb, BCN, CDO, &c. are similar and equal to each other; for the lines Bb, Cc are parallel, therefore the angle ABb=BCN (*by Art.* 33,) and by the same article the angle BAb is equal to CBN (because BN is parallel to Ab,) and by construction AB=BC, therefore (*by Art.* 39,) the triangles ABb and BCN are equal to each other; and in the same manner we may prove that the others CDO, DEP, EFQ, &c. are equal to ABb. Therefore Ab=BN=CO=DP, &c. and Bb=CN=DO=EP, &c. but (*by Art.* 51) BN=bc, CO=cd, DP=de; therefore the line Ab=bc=cd=de, &c. and since (*by construction*) AB=BC=CD, &c. any line AE will be the same multiple of AB as the corresponding line Ae is of Ab; and AG is the same multiple of AB as Ag is of Ab; therefore the lines AG, AE, Ag, Ae will be proportional (*by Art.* 54); that is, AG will be to AE as Ag is to Ae, and in a similar manner we may prove that AG is to AE as Gg is to Ee.

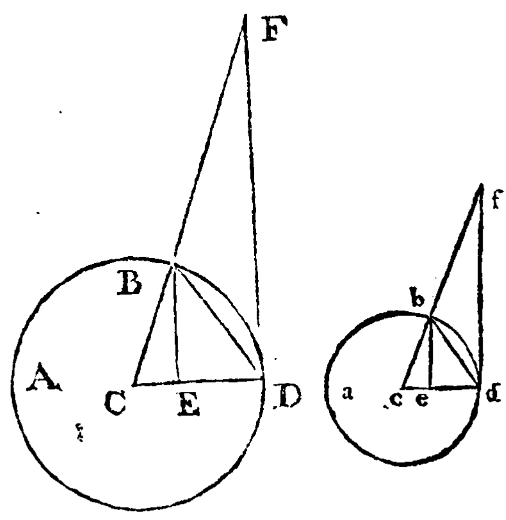


LVI.



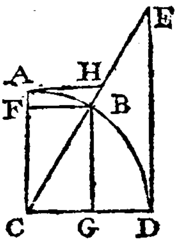
If any two triangles ABC, abc, are *ſimilar*, or have all the angles of the one, equal to all the angles of the other, each to each reſpectively, that is CAB=cab, ACB=acb, ABC=abc; the legs oppoſite to the equal angles will be proportional, viz. AB : ab :: AC : ac; and AB : ab :: BC : bc; and AC : ac :: BC : bc. To prove this, ſet off upon a ſide AB of the largeſt triangle AE=ab, and through E draw ED parallel to BC, meeting AC in D, then ſince DE, BC are parallel, the angle AED is equal to ABC (*by Art.* 33) and this (*by ſuppoſition*) is equal to the angle abc; alſo the angle DAE is (*by ſuppoſition*) equal to cab, therefore in the triangles ADE, abc, the two angles DAE, AED of the one, are equal to the two angles cab, abc of the other, each to each reſpectively, and the included ſide AE is (*by conſtruction*) equal to the included ſide ab; therefore (*by Art.* 40) AD is equal to ac, and DE equal to bc; but ſince in the triangle ABC there is drawn DE parallel to BC one of its ſides, to meet the other two ſides in the points D, E; therefore, (*by the preceding Art.*) AB : AE :: AC : AD, and AB : AE :: BC : DE, and AC : AD :: BC : DE; if in theſe three proportions for DE we put its equal bc, for AE put ab, and for AD put ac; they will become AB : ab :: AC : ac, and AB : ab :: BC : bc, and AC : ac :: BC : bc.

LVII.



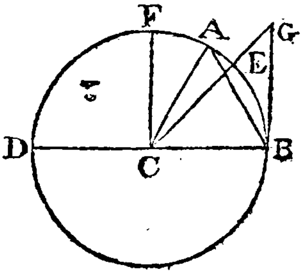
The chord, ſine, tangent, &c. of any arch in one circle, is to the chord, ſine, tangent, &c. of the ſame arch in another, as the radius of the one is to the radius of the other. Let ABD, abd, be two circles; BD, bd, two arches of theſe circles, equal to one another, or conſiſting of the ſame number of degrees; FD, fd, the tangents; BD, bd, the chords; BE, be, the ſines, &c. of theſe two arches BD, bd; and CD, cd, the radii of the circles; then CD will be to cd as FD to fd, and CD : cd :: BD : bd, and CD : cd :: BE : be, &c. For ſince the arches BD, bd, are equal, the angles BCD, bcd, are alſo equal, and FD, fd, being tangents to the points D and d, the angles CDF, cdf are each equal to a right angle (*by art.* 22); therefore, ſince in the two triangles CDF, cdf, the two angles FCD, CDF of the one, are equal to the two angles fcd, cdf, of the other, each to each, the remaining angle CFD is alſo equal to the remaining angle cfd (*by art.* 38); conſequently the triangles CFD, cfd, are ſimilar. The triangles BCD, bcd, are alſo ſimilar, for the angle CBD is equal to the angle CDB, being each ſubtended by the radius; therefore (*by art.* 38) each of theſe angles is equal to half the ſupplement of the angle BCD; and in the ſame manner the angle cbd or cdb is equal to half the ſupplement of the angle bcd, and ſince the angle BCD is equal to bcd, the angles of theſe two triangles muſt be equal, conſequently they are ſimilar. The triangles BCE, bce are alſo ſimilar, becauſe BE is parallel to FD, and be parallel to fd. Hence we obtain (*from art.* 56) the following analogies. CD : cd :: FD : fd; CD : cd :: BD : bd, CB : cb :: BE : be, &c.

LVIII.



Let ABD be a quadrant of a circle deſcribed by the radius CD; BD any arch of it, BA its complement, BG or CF the ſine, CG or BF the co-ſine, DE the tangent, AH the co-tangent, CE the ſecant, and CH the co-ſecant of that arch BD. Then ſince the triangles CDE, CGB are ſimilar or equi-angular we ſhall have (*by art.* 56) DE : CE :: BG : CB, that is, the tangent of an arch, is to the ſecant of the ſame, as the ſine of it is to radius. Alſo, CE : CD :: CB : CG; that is, the ſecant is to radius as the radius to the co-ſine of an arch. Alſo, CF : CA :: CB : CH, that is, the ſine is to radius as radius to the co-ſecant of an arch; and ſince the triangle CAH is ſimilar to the triangle CDE, we have AH : CA :: CD : DE, that is the co-tangent is to the radius as the radius to the tangent of an arch.

LIX.

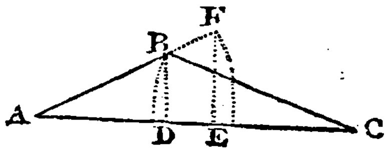


In all circles, the ſine of 90°, *the tangent of* 45°, *and the chord of* 60°, *are each equal to the radius.* For in the circle DFAEB, let the arch BE be 45°, the arch BA 60°, and BF 90°. Draw through the centre C the diameter DCB, and perpendicular thereto the tangent BG meeting CE produced in G; draw the chord BA, and join CF, CA. Then ſince the arch BF is 90° and the arch BFD is 180° (being a ſemicircle) the arch DF muſt be 90°, and therefore the angles DCF, BCF, are equal, hence (*by art.* 12) CF is perpendicular to DCB, and is therefore the ſine of the arch BF (*by Art.* 19,) hence the radius CF is equal to the ſine of the arch BF or ſine of 90°. Again in the triangle CBG, ſince the angle CBG is 90°, and BCG is 45° by ſuppoſition, the angle CGB is alſo 45° (*by Art.* 38.) therefore (*by Art.* 41,) BG is equal to CB, that is, the tangent of 45° is equal to the radius. Again, ſince the angle ACB is 60° (being meaſured by the arch BA,) the ſum of the angles CAB, CBA, muſt be equal to 120° (*by Art.* 38,) and ſince CA is equal to CB, (being both radii of the ſame circle) therefore (*by Art.* 41,) the angle CAB is equal to CBA: Hence either of theſe angles is equal to the half of 120°, or equal to 60°; conſequently, each angle of the triangle ABC is equal to 60°; therefore (*by Art.* 41.) the ſides are alſo equal; hence the chord of 60°, or BA, is equal to the radius CB.

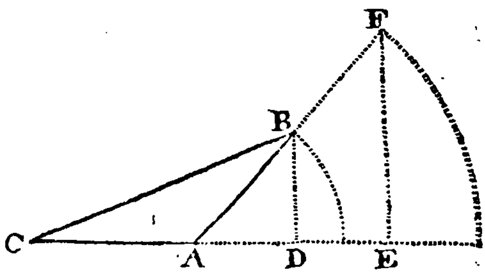
THE four following propoſitions contain the demonſtration of the rules by which all the calculations of trigonometry may be made: they were inſerted here, in order to prevent any embarraſſment to the young calculator, from the introduction of the demonſtrations among the precepts for calculation.

LX.

In any plane triangle, the ſides are proportional to the ſines of the oppoſite angles.



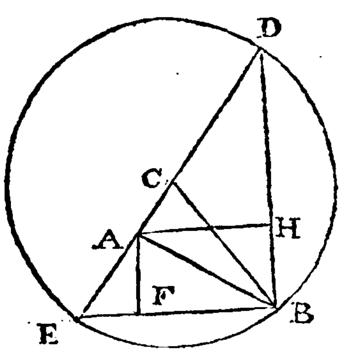
Let A B C be the triangle; produce the leſſer ſide A B to F, making A F equal to B C; from B and F let fall the perpendiculars BD, FE, upon AC (produced if neceſſary); then F E is the ſine of the angle A, and BD is the ſine of the angle C, the radius being BC equal to AF: now the triangles AB D, AFE, having the angle A common to both, and the angle D equal to the angle E (being each equal to a right angle) are ſimilar; hence (*by Art.* 56.) as AF (or its equal BC) is to AB, ſo is FE to BD; that is, BC is to AB as the ſine of the angle A is to the ſine of the angle C.



LXI.

In any triangle (ſuppoſing any ſide to be the baſe, and calling the other two the ſides) the ſum of the ſides will be to their difference, as the tangent of half the ſum of the angles at the baſe, is to the tangent of half the difference of the ſame angles.

Thus, in the triangle ABC, if we call AB the baſe, it will be as the ſum of AC and CB is to their difference, ſo is the tangent of half the ſum of the angles ABC, BAC, to the tangent of half their difference.



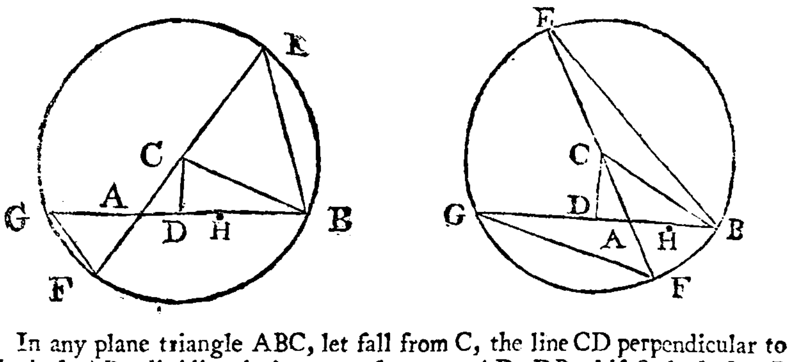
Dem. With the longeſt leg CB as radius, deſcribe a circle about the centre C, meeting the ſhorter ſide AC (produced on each ſide) in the points D and E, join EB, DB; draw AH perpendicular to DB, and AF perpendicular to EB; then (*by Art.* 44.) the angle EBD, being in a ſemicircle, is a right angle; and ſince AH is perpendicular to DB, the lines AH and EB are parallel (*by Art.* 36.); therefore (*by Art.* 33.) the angle DAH is equal to DEB, and (*by Art.* 32.) the angle ABE is equal to BAH, and ſince AF is perpendicular to EB, the triangles AHD, AFE, are ſimilar, and AF is equal to HB. Moreover ſince CB is equal to CD or CE; AD is the ſum and AE is the difference of the legs AC, CB : likewise (*by Art.* 35,) the angle BCD is equal to the sum of the angles BAC, ABC, and therefore (*by Art.* 42,) the angle DEB, or its equal DAH, is equal to half the sum of the angles at the base ABC, BAC. Again (*by Art.* 35,) the angle BAC is equal to the sum of the angles CEB (or CBE) and ABE, and therefore is equal to the sum of the angle ABC, and twice the angle ABE; hence the angle ABE or its equal BAH, is equal to half the difference of the angles at the base. But in the right angled triangles AHD, AHB, making AH radius, the legs DH, HB are the tangents of the angles DAH, BAH, or the tangents of half the sum and half the difference of the angles at the base; but by reason of the similar triangles AHD, AFE, we have AD:AE::DH:AF or HB; that is, AD, the sum of the legs AC and CB, is to AE their difference, as DH the tangent of half the sum of the angles at the base (the radius being AH) is to HB the tangent of half the difference of the same angles, (to the same radius,) and therefore (*by Art.* 57,) as the tabular tangent of half the sum of the angles at the base, is to the tabular tangent of half the difference of the same angles.

LXII.

If to half the difference of two quantities be added half their sum, the sum will be the greater of them; and if from half their sum be subtracted the half of their difference, the remainder will be the least of them.

Dem. Let the two quantities be represented by the lines AB and BC (making one continued line) whereof AB is the greater, and BC the lesser; bisect AC in E, and make AD equal to BC; then it is plain that AC is the sum and DB the difference of the two quantities, and AE or EC the half sum, and DE or EB their half difference: now if to AE we add EB, it is evident that the sum will be AB; that is, if to half the sum we add half the difference, the sum will be the greater quantity; also, if from EC we take EB, the remainder will be BC, that is, if from half the sum we take half the difference of two quantities, the remainder will be the least of them.

LXIII.

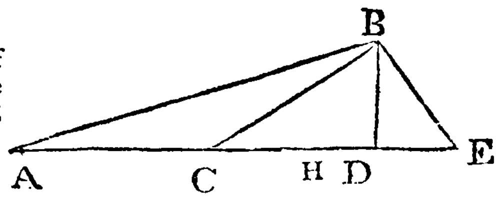


In any plane triangle ABC, let fall from C, the line CD perpendicular to the base AB, dividing it into two segments AD, DB; bisect the base AB in the point H; then, *As the base* AB *is to the sum of the sides,* AC, BC, *so is the difference of the sides to twice the distance* DH *of the perpendicular from the middle of the base.*

Dem. With the greater side CB as radius, describe about the centre C the circle BFGE, meeting the other side produced in the points E and F, and the base AB produced in G; join GF and BE. Then AE is the sum, and AF the difference of the sides AC, CB; and since CD is perpendicular to GB, the line GB is bisected in D (*by art.* 45) and as AB is bisected in H, the line AG is equal to twice DH. Now, in the triangles BAE, GAF, the angles ABE, GFA are equal (*by Art.* 43), and the angle BAE is equal to GAF (*by Art.* 30.) therefore the remaining angles AEB, AGF, must be equal; hence the triangles BAE, GAF, are similar; consequently (*by Art.* 56.) AB : AE : : AF : AG, or twice HD, which is the proposition to be demonstrated. Having thus obtained HD, we may find the segments AD, DB, by adding HD to the half base HA or HB, and by taking their difference.

LXIV.

In any plane triangle, the square of radius is to the square of the co-sine of either of the angles, as the rectangle contained by the two sides including that angle is to the rectangle contained by the half sum of the sides, and that half sum decreased by the side opposite to that angle.



Thus in the triangle CBE, the square of radius is to the square of the co-sine of half the angle C, as the rectangle CB×CE is to $\frac{CB+CE+BE}{2} \times \frac{CB+CE-BE}{2}$. For continue EC to A, making CA=CB, draw BD perpendicular to CE, bisect CE in H, and join AB. Then (supposing CB to be greater than EB) we have (*by Art.* 63.) CE : CB+BE : : CB—BE : $\frac{CB^2-BE^2}{CE} = 2 \cdot HD$; by adding half of this to CH half the base, we have the segment $CD = \frac{CB^2-BE^2+CE^2}{2 \cdot CE}$; to this, adding CA or CB, we have $AD = \frac{CB^2-BE^2+CE^2+2CE \cdot CB}{2 \cdot CE} = \frac{\overline{CB+CE}|^2-BE^2}{2\,CE} = \frac{\overline{CB+CE+BE} \times \overline{CB+CE-BE}}{2 \cdot CE}$. Again, $AD = AC+CD = CB+CD$; hence $\overline{AD}|^2 = CB^2+2\,CB \cdot CD+CD^2$; also, $BD^2 = CB^2-CD^2$; hence $AB^2 = AD^2+BD^2 = 2 \cdot CB^2+2\,CB \cdot CD = 2 \cdot CB, \overline{CB+CD} = 2\,CB \cdot AD$; hence $AB^2 : AD^2 :: 2\,CB : AD =$

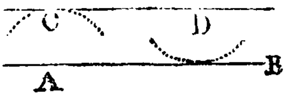
$\frac{\overline{CB+CE+BE} \cdot \overline{CB+CE-BE}}{2\,CE}$; but AB being radius, AD is the co-ſine of the angle A, which is equal to half the angle C (*by Art.* 42.); therefore the ſquare of radius is to the ſquare of the co-ſine of half the angle C, as the rectangle CE · CB is to the rectangle $\frac{CB+CE+BE}{2} \cdot \frac{CB+CE-BE}{2}$.

The other caſes of this propoſition are demonſtrated in the ſame manner.

GEOMETRICAL PROBLEMS.

PROBLEM I.

To draw a Right Line CD *parallel to a given Right Line* AB, *at any given distance, as at the point* D.

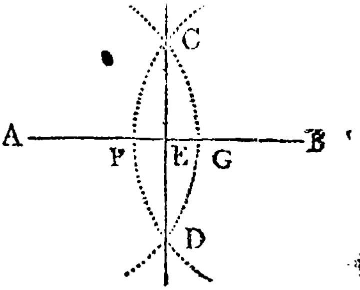


WITH a pair of compasses take the nearest distance between the point D and the given right line AB; with that distance set one foot of the compasses any where on the line AB, as at A, and draw the arch C; from the point D draw a line so as just to touch the arch C, and it is done; for the line CD will be parallel to the line AB, and at the distance of the point given D, as was required.

PROBLEM II.

To bisect or divide a given line AB *into two equal parts.*

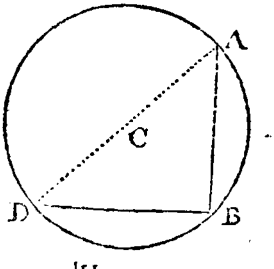
Take any distance in your compasses greater than half the line A B, then with one foot in B, describe the arch CFD; with the same distance, and one foot in A, describe the arch CGD; cutting the former arch in C and D; draw the line C D, and it will bisect A B in the point E.



PROBLEM III.

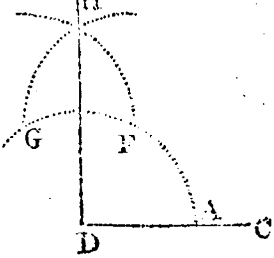
To erect a perpendicular BA *on the end of a given Right Line* DB.

Take any extent in your compasses, and with one foot in B fix the other in any point C without the given line; then with one point of the compasses in C, describe with the other the circle ABD; through D and C draw the diameter DCA meeting the circle in A; join B and A and it is done; for BA will be the required line *(by Art. 44, Geom.)*



Or thus,

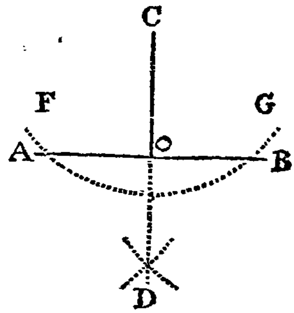
Take any convenient distance as DA in your compasses, and with one foot in D describe the arch AFG, upon which set off the same distance from A to F, and from F to G; upon F and G describe two arches intersecting one another in H; draw a line from H to D, and it is done; for HD will be the perpendicular required.



PROBLEM IV.

From a given Point, as C, *to let fall a Perpendicular* CO *on a given Right Line* AB.

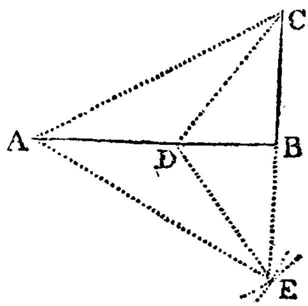
Take any extent in your compasses greater than the least distance between C and the given line AB; with one foot in C, describe an arch to cut the given line AB in F and G; with one foot in G describe an arch, and with the same distance, and one foot in F, describe another arch cutting the former in D; from C to D draw the line COD, cutting AB in O; then CO will be the perpendicular required.



PROBLEM V.

From a given Point C *to let fall a Perpendicular* CB *on a given Line* AB, *when the said Perpendicular is to fall so near the end of the given line that it cannot be done as above.*

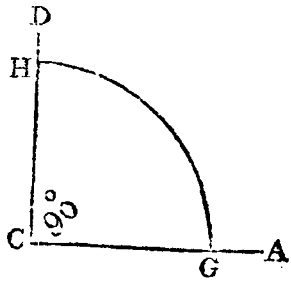
Upon any point A of the line AB as a centre, and with the distance AC describe an arch E; chuse any other point in the line AB, as D, and with the distance DC describe another arch intersecting the former in E, join CE cutting AB in B, and it is done; for CB will be the perpendicular required.



PROBLEM VI.

To make Plane Angles, and first a Right Angle, containing 90 *Degrees.*

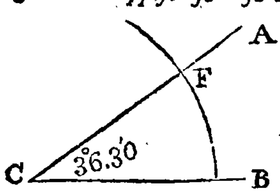
Draw the line CA; on C erect a perpendicular CD, and it is done; for the angle DCA is an angle of 90°. Or thus, on the point C, with the chord of 60°* describe an arch GH, and set off thereon from G to H the distance of the chord of 90° and from C through H draw CHD, which will form the angle DCA of 90° required.



PROBLEM VII.

To make an Acute Angle equal to any number of degrees. Suppose 36° 30′.

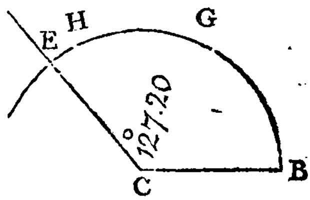
Draw the line BC; with the chord of 60° or radius, in your compasses, and one foot on C draw the arch FB, on which set off from B to F, the given angle $36\frac{1}{2}$° taken from the line of chords; through F and the centre C draw the right line AC, and it is done; for the angle ACB will be an angle of 36° 30′, as was required.



* For a description of the line of chords, see page 45.

PROBLEM VIII.

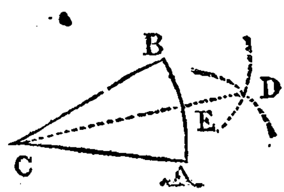
To make an Obtuse Angle that shall contain 127° 20′.



Draw CB; take the chord of 60° in your compasses, and with one foot on C describe an arch BGHE, upon which set off the chord of 60° (which you already have in your compasses) from B to G, and from G to H; then set off from G to E, the excess of the given angle above 60°, which is $67\frac{1}{3}$° taken from the line of chords; or you may set off from H to E, the excess of the given angle above 120°, which is $7\frac{1}{3}$°; draw the line CE, and it is done; for the angle ECB will be an angle of 127° 20′.

PROBLEM IX.

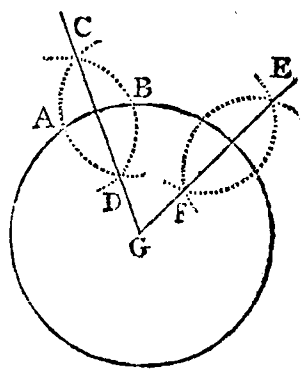
To bisect a given arch of a circle AB, whose centre is C.



Take in your compasses any extent greater than the half of AB, and with one foot in A, describe an arch; with the same extent and one foot in B, describe another arch cutting the former in D; join CD and it is done; for this line will bisect the arch AB in the point E. It is also evident that the line CD bisects the angle BCA, or divides it into two equal parts.

PROBLEM X.

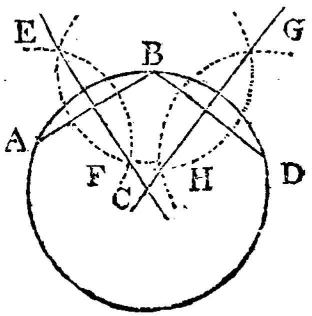
To find the centre of a given circle.



With any radius, and one foot in the circumference as at A, describe an arch of a circle, as CBD, cutting the given circle in B; with the same extent, and one foot in B, describe another arch CAD, cutting the former in C and D; through C and D draw the line CD, which will pass through the centre of the circle; in like manner may another right line be drawn, as EFG, which shall cross the first right line at the centre required. This construction depends upon Article 45 of Geometry.

PROBLEM XI.

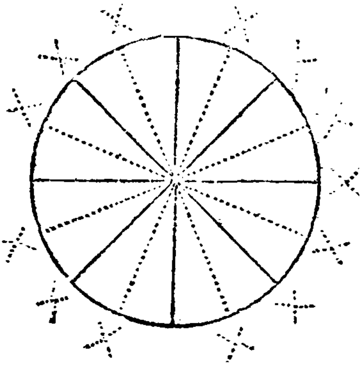
To draw a circle through any three given points not ſituated in a right line.



Let A, B, and D be the given points; take in your compaſſes any diſtance greater than half AB, and with one foot in A, ſweep an arch EF; with the ſame extent, and one foot in B, ſweep another arch cutting the former arch in E and in F, through which points draw the indefinite right line EFC; then take in your compaſſes any extent greater than half BD, and with one foot in B ſweep an arch GH; with the ſame extent, and one foot in D, ſweep an arch cutting the former in the points G, H, through which draw the right line GHC, cutting the former right line EFC, in the point C; upon the point C as a centre, with an extent equal to CA, CB, or CD, as radius, deſcribe the ſought circle.

PROBLEM XII.

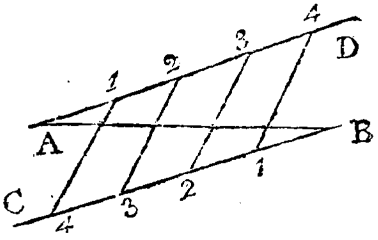
To divide a circle into 2, 4, 8, 16, or 32 equal parts.



Firſt draw the diameter through the centre, which will divide it into two equal parts; biſect the diameter with another right line perpendicular thereto, and the circle will be divided into four equal parts or quadrants: biſect each of theſe quadrants again by right lines drawn through the centre, and it will be divided into eight equal parts; and ſo you may continue on your biſections any number of times. This problem is uſeful in conſtructing the mariner's compaſs.

PROBLEM XIII.

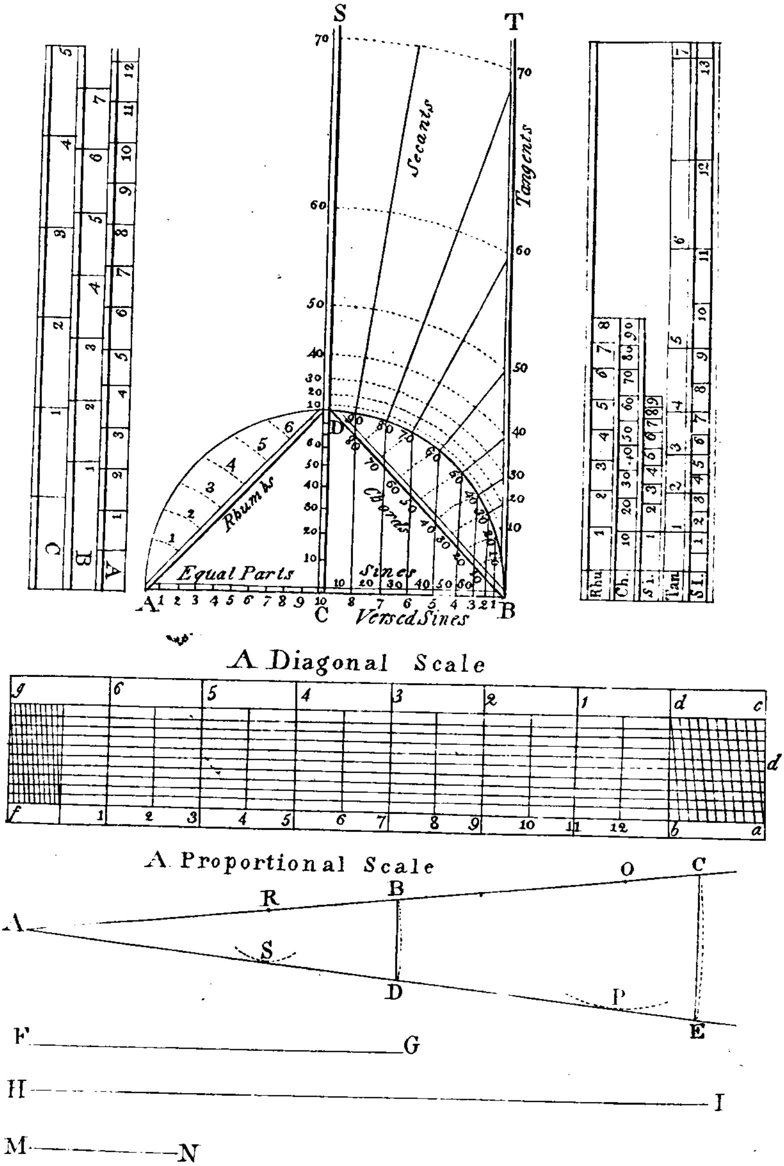
To divide a given line into any number of equal parts.



Let it be required to divide the line AB into five equal parts: From the point A draw any line AD, making an angle with the line AB: then through the point B draw a line BC parallel to AD; and from A, with any ſmall opening in your compaſſes, ſet off a number of equal parts on the line AD, leſs by one than the propoſed number (which in this example is 4); then from B ſet off the ſame number of the ſame parts on the line BC; then join 4 and 1, 3 and 2, 2 and 3, 1 and 4, and theſe lines will cut the given line as required.

CONSTRUCTION

PROJECTION OF THE PLANE SCALES. &c.



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CONSTRUCTION

OF THE

PLANE SCALE.

1ſt. WITH the radius you intend for your ſcale, deſcribe a ſemicircle ADB, and upon the centre C raiſe the perpendicular CD, (which will divide the ſemicircle into two quadrants, AD, BD) continue CD directly to S, and upon B raiſe the perpendicular BT, then draw the right lines BD and AD.

2dly. Divide the quadrant BD into 9 equal parts, then will each of theſe be 10 degrees. Again you may ſubdivide each of theſe parts into ſingle degrees; and theſe again, if your radius admits it, into minutes or ſome aliquot parts of a degree greater than minutes.

3dly. Set one foot of the compaſſes in B and transfer each of the diviſions in the quadrant BD to the right line BD, then is BD a line of Chords.

4thly. From the points 10, 20, 30, &c. in the quadrant BD draw right lines parallel to CD, till they cut the radius CB, then is the line CB divided into a line of ſines which muſt be numbered from C towards B.

5thly. If the ſame line of right ſines be numbered from B towards C, it will become a line of verſed ſines, which may be continued to 180°, if the ſame diviſions be transfered on the ſame line on the other ſide of the centre C.

6thly. From the centre C, through the ſeveral diviſions in the quadrant BD, draw right lines till they cut the tangent BT, ſo will the line BT become a line of tangents.

7thly. Setting one foot of the compaſſes in C, extend the other to the ſeveral diviſions 10, 20, 30, &c. in the tangent line BT, and transfer theſe extents ſeverally into the right line CS, then will the line CS be a line of ſecants.

8thly. Right lines drawn from A to the ſeveral diviſions 10, 20, 30, &c. in the quadrant BD, will divide the radius CD into a line of ſemitangents.

9thly. Divide the quadrant AD into eight equal parts, and from A transfer theſe diviſions ſeverally into the line AD, then is AD a line of Rhumbs, each diviſion anſwering to 11° 15′ upon the line of chords. The uſe of this line is for protracting and meaſuring angles, according to the common diviſion of the mariner's compaſs. If the radius AC be divided into 100 or 1000, &c. equal parts, and the lengths of the ſeveral ſines, tangents, and ſecants, correſponding to the ſeveral arches of the quadrant, be meaſured thereby, and theſe numbers be ſet down in a table,* each in its proper column, you will by theſe means have a triangular canon of numbers by which the ſeveral caſes in Trigonometry may be ſolved. Right lines graduated as above, being placed ſeverally upon a ruler, form the inſtrument called the Plane Scale, by which the lines and angles of all triangles may be meaſured. All right lines, as the ſides of plain triangles, &c. when they are conſidered ſimply as ſuch without having any relation to a circle, are meaſured by

* In Table XXII. is given the ſine and co-ſine to every minute of the quadrant, to five places of decimals.

scales of equal parts, one of which is subdivided equally into 10, and this serves as a common division to all the rest. In most scales an inch is taken for a common measure, to determine their largeness and number of parts: what an inch is divided into, is generally set at the end of the scale. By any scale of equal parts, divided as above, any number less than 100 may be readily taken; but if the number should consist of three places of figures, the value of the third figure can only be guessed at; wherefore in these scales it is better to use a diagonal scale, by which any number of three figures may be exactly found. The figure of this scale is given in the adjoined plate; its construction is as follows:

Having prepared a ruler of convenient breadth for your scale, (which may be an inch more or less) First, near the edges thereof, draw two right lines, *af*, *cg*, parallel to each other; then divide one of these lines as *af*, into equal parts, according to the largeness you intend your scale; and through each of these divisions draw perpendicular right lines as far as the line *cg*; next divide the breadth into 10 equal parts, and through each of these divisions draw right lines parallel to the former *af* and *cg*; again divide the lengths *ab*, *cd*, each into 10 equal parts, and from the point *a* to the first division in the line *cd*, draw a right line; then, parallel to that line, draw right lines through all the other divisions, and the scale is done.

Besides the lines already mentioned, there is another on the plane scale marked ML, which is joined to a line of chords; and shews how many miles easting or westing make a degree of longitude in every latitude; these several lines are generally put on one side of a ruler, two feet long; and on the other side is laid down a scale of the logarithms of the sines, tangents, and numbers, which is commonly called Gunter's Scale, and as it is of general use, it requires a particular description.

GUNTER's SCALE.

GUNTER's Scale hath set upon it these eight lines following :

1st. Sine Rhumbs marked (SR) is a line which contains the logarithms* of the natural sine of every point of the mariner's Compass figured from the left hand towards the right, with 1, 2, 3, 4, 5, 6, 7, to 8, where is a brass pin. This line is also divided, where it can be done, into halves and quarters.

2d. Tangent rhumbs marked (TR) also corresponds to the logarithm of the tangent of every point of the compass, and is figured 1, 2, 3, to 4, at the right hand where there is a pin, and from thence towards the left hand with 5, 6, 7 ; it is also divided, where it can be done, into halves and quarters.

3d. The Line of numbers marked (Num.) contains the logarithms of the numbers, and is figured thus ; near the left hand it begins at 1, and towards the right hand are 2, 3, 4, 5, 6, 7, 8, 9 ; and then 1 in the middle, at which is a brass centre pin, going still on 2, 3, 4, 5, 6, 7, 8, 9, and 10 at the end, where there is another centre pin. The values of these numbers and their intermediate divisions depend on the estimated values of the extreme numbers 1 and 10 ; and as this line is of great importance, I shall be more particular in the description of it and its uses. The first 1 may be counted for 1 or 10, or 100, or 1000, and then the next 2 is accordingly 2, or 20, or 200, or 2000, &c. Again, the first 1 may be reckoned 1 tenth, or 1 hundredth, or 1 thousandth part, &c. then the next is 2 tenth, or 2 hundredth, or 2 thousandth parts, &c. so that if the first 1 be esteemed 1, the middle 1 is then 10, and 2 to its right is 20, 3 is 30, 4 is 40, and ten at the end is 100 ; again if the first 1 is 10, the next 2 is 20, 3 is 30, so on, making the middle 1 now 100, the next 2 is 200, 3 is 300, 4 is 400, and 10 at the end is now 1000. In like manner if the first 1 be esteemed 1 tenth part, the next 2 is 2 tenth parts, and the middle 1 is 1, and the next 2 is 2, and 10 at the end is now 10. Again, if the first 1 be counted 1 hundredth part, the next is 2 hundredth parts, the middle one is now 10 hundredth parts or one tenth part, and the next 2 is two tenth parts, and 10 at the end is now but one whole number or integer.

As the figures are increased or diminished in their value, so in like manner must all the intermediate strokes or subdivisions be increased or diminished ; that is, if the first one at the left hand be counted 1, then 2 (next following it) is 2, and each subdivision between them now is 1 tenth part, and so all the way to the middle 1, which now is 10, the next two is 20, now the longer strokes between 1 and 2 are to be counted from 1 thus 11, 12 (where is a brass pin) then 13, 14, 15, sometimes a longer stroke than the rest, then 16, 17, 18, 19, 20, at the figure 2; and in the same manner the short strokes between the figures 2 and 3, 3 and 4, 4 and 5, &c. are to be reckoned as units. Again, if 1 at the left hand be 10, the figures between it and the middle 1 are common tens ; and the subdivisions between each figure are units ; from the middle 1 to 10 at the end, each figure is so many hundreds; and between these figures each longer division is 10. From this description it will be easy to find the divisions representing any given number, thus : Suppose the point representing the number 12, were required : Take the division at the figure 1, in the middle for the first figure of 12 ; then for the second figure count two tenths, or longer strokes to the right hand, and this last is the point representing 12, where the brass pin is.

* The description and uses of these logarithms will be given in page 54, et seq.

Again, ſuppoſe the number 22 were required; the firſt figure being 2, I take the diviſion to the figure 2, and for the ſecond figure 2, count 2 tenths onwards, and that is the point repreſenting 22.

Again, ſuppoſe 1728 were required; for the firſt figure 1, I take the middle 1, for the ſecond figure 7, count onwards as before, and that is 1700. And as the remaining figures are 28 or nearly 30, I note the point which is nearly $\frac{3}{10}$ of the diſtance between the marks 7 and 8, and this will be the point repreſenting 1728.

If the point, repreſenting 435, was required; from the four in the ſecond interval count towards 5 on the right, three of the larger diviſions and one of the ſmaller (this ſmaller diviſion being midway between the marks 3 and 4) and that will be the diviſion expreſſing 435, and the like of other numbers, which by a little practice is readily done.

All fractions found in this line muſt be decimals; and if they are not, they muſt be reduced into decimals, which is eaſily done by extending the compaſſes from the denominator to the numerator; that extent laid the ſame way, from 1 in the middle or right hand, will reach to the decimal required.

Example. Required the decimal fraction equal to $\frac{3}{4}$: Extend from 4 to 3; that extent will reach from 1 on the middle to ,75 towards the left hand; the like may be obſerved of any other vulgar fraction.

Multiplication is performed on this line, by extending from one to the multiplier; that extent will reach from the multiplicand to the product.

Suppoſe, for example, it were required to find the product of 16 multiplied by 4, extend from 1 to 4, that extent will reach from 16 to 64, the product required.

Diviſion being the reverſe of multiplication, therefore extend from the diviſor to unity, that extent will reach from the dividend to the quotient.

Suppoſe 64 to be divided by 4; extend from 4 to 1, that extent will reach from 64 to 16, the quotient.

N. B. This extent in diviſion is to be taken backwards, or to the left hand, from the dividend to the quotient; but in multiplication it is taken forward, or to the right hand, from the multiplicand to the product, they being contrary to one another.

Proportion, or the Rule of Three, being performed by multiplication and diviſion, therefore extend from the firſt term to the ſecond, that extent will reach from the third term to the fourth. And it ought to be particularly noted, that if you extend to the left, from the firſt number to the ſecond, you muſt alſo extend to the left, from the third number to the fourth; and the contrary.

Example. If the diameter of a circle be 7 inches, and the circumference 22, what is the circumference of another circle, the diameter of which is 14 inches?—Extend from 7 to 22, that extent will reach from 14 to 44 the ſame way.

In like manner may any other proportion of any denomination be worked, which makes this line of general uſe, particularly in meaſuring ſuperfices and ſolids, which is done by extending from one to the breadth, that extent will reach from the length to the ſuperficial content.

Example. Suppoſe a plank or board, 15 inches broad, and 27 feet long, the content of which is required.—Extend from 1 to 1 foot 3 inches (or 1,25); that extent will reach from 27 feet to 33,75 feet, the ſuperficial content. Or extend from 12 inches to 15, &c.

The ſolid content of any bale, box, cheſt, &c. is found by extending from 1 to the breadth; that extent will reach from the depth to a fourth number, and the extent from 1 to that fourth number will reach from the length to the ſolid content.

Example 1ſt. What is the content of a ſquare pillar, whoſe length is 21 feet 9 inches, and breadth 1 foot 3 inches?—The extent from 1 to 1,25 will reach from 1,25 to 1,56, the content of one foot in length; again, the extent from 1 to 1,56 will reach from the length 21,75 to 33,98 or 34, the ſolid content in feet.

Example 2d. Suppoſe a ſquare piece of timber, 1,25 feet broad, ,56 deep, and 36 long, be given to find the content.—Extend from 1 to 1,25; that extent will reach from ,56 to ,7; then extend from 1 to ,7; that extent will reach from 36 to 25,2, the ſolid content. In like manner may the contents of any bales, &c. be found, which divided by 40 will give the tonnage.

4thly. The line of ſines marked (Sin.) begins at the left hand, and is figured to the right thus, 1, 2, 3, 4, 5, &c. to 10; then 20, 30, 40, &c. ending at 90 degrees, where is a braſs centre pin, as there is at the right end of all the lines.

5thly. The line of verſed ſines, marked (V. S.) begins at the right hand againſt 90° on the ſines, and from thence figured towards the left hand thus, 10, 20, 30, 40, &c. ending at the left hand at about 169°; each of the ſubdiviſions, from 10 to 30, is in general two degrees, and from thence to 90, is ſingle degrees, and from thence to the end, each degree is divided into 15 minutes.

6thly. The line of tangents, marked (Tang.) begins at the left hand, as do the ſines; from thence it is figured to the right hand, thus: 1, 2, 3, &c. to 10, and ſo on 20, 30, 40, and 45, at the right hand, where is a little braſs pin, juſt under and even with 90° in the ſines; from thence back again it is figured 50, 60, 70, 80, &c. to 89, ending at the left hand where it began at 1 degree. The ſubdiviſions are nearly the ſame as thoſe of the ſines. When you have any extent in your compaſſes, to be ſet off from any number leſs than 45° on the line of tangents, towards the right, and it is found to reach beyond the mark of 45°, you muſt ſee how much it extends beyond that mark, and ſet it off from 45° towards the left, and ſee what degree it falls upon, which will be the number ſought, which muſt exceed 45°; if, on the contrary, you are to ſet off ſuch a diſtance to the right, from a number greater than 45°, you muſt proceed as before, only remembering that the anſwer muſt be leſs than 45°.

7thly. The line of the meridional parts, marked (Mer.) begins at the right hand, and is numbered thus: 10, 20, 30, to the left hand, where it ends at 87 degrees. This line, with the line of equal parts marked (EP) under it, are uſed together, and only in Mercator's ſailing. The uppermoſt line contains the degrees of the meridian, or latitude in a Mercator's chart; and the lower is the equator and contains the degrees of longitude.

DESCRIPTION AND USE
OF THE
SECTOR.

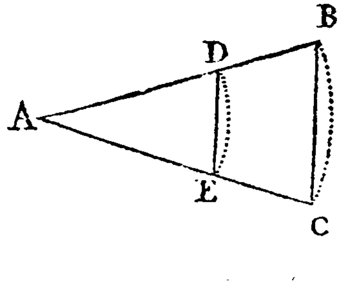
THIS inſtrument conſiſts of two rules or legs, repreſenting the radii, moveable round an axis or joint, the middle of which repreſents the centre; from whence ſeveral ſcales are drawn on the faces; ſome of theſe ſcales are ſingle, others double; the ſingle ſcales are like thoſe upon a common Gunter's ſcale, the double ſcales are thoſe which proceed from the centre; each of theſe being laid twice on the ſame face of the inſtrument, viz. once on each leg. From theſe ſcales dimenſions or diſtances are to be taken, when the legs of the inſtrument are ſet in an angular poſition.

The ſingle ſcales being uſed exactly like thoſe on the common gunter's ſcale it is unneceſſary to notice them particularly; we ſhall therefore only enumerate a few of the uſes of the double ſcales; the number of which is ſeven, viz. the ſcale of Lines marked Lin. or L. the ſcale of Chords marked Cho. or C. the ſcale of Sines marked Sin. or S. the ſcale of Tangents to 45°, and another ſcale of tangents from 45° to about 76°, both of which are marked Tan. or T. the ſcale of Secants marked Sec. or S. and the ſcale of Polygons marked Pol.

The ſcales of lines, chords, ſines and tangents under 45°, are all of the ſame radius, beginning at the centre of the inſtrument, and terminating near the other extremity of each leg, viz. the lines at the diviſion 10, the chords at 60°, the ſines at 90°, and the tangents at 45°; the remainder of the tangents or thoſe above 45°, are on other ſcales beginning at $\frac{1}{4}$ of the length of the former, counted from the centre, where they are marked with 45°, and run to about 76 degrees. The ſecants alſo begin at the ſame diſtance from the centre, where they are marked with 0, and are from thence continued to 75°. The ſcales of polygons are ſet near the inner edge of the legs, and where theſe ſcales begin, they are marked with 4, and from thence are figured backward or towards the centre, to 12.

In deſcribing the uſe of the ſector, the terms *lateral diſtance* and *tranſverſe diſtance* often occur. By the former is meant the diſtance taken with the compaſſes on one of the ſcales only, beginning at the centre of the ſector; and by the latter, the diſtance taken between any two correſponding diviſions of the ſcales of the ſame name, the legs of the ſector being in an angular poſition.

The uſe of the Sector depends upon the proportionability of the correſponding ſides of ſimilar triangles, demonſtrated in art. 55, Geometry; for if in the triangle ABC we take AB=AC and AD=AE, and draw DE, BC, it is evident that DE and BC will be parallel, therefore by the above-mentioned propoſition AB : BC :: AD : DE; ſo that whatever part AD is of AB, the ſame part is DE of BC; hence if DE be the chord, ſine or tangent, of any arch to the radius AD, then BC will be the ſame to the radius AB.



Use of the Line of Lines.

The line of lines is useful, to divide a given line into any number of equal parts, or in any proportion, or to find 3d and 4th proportionals, or mean proportionals, or to increase a given line in any proportion.

EXAMPLE 1. To divide a given line into any number of equal parts, as suppose 9 : make the length of the given line a transverse distance to 9 and 9, the number of parts proposed ; then will the transverse distance of 1 and 1 be one of the parts, or the ninth part of the whole ; and the transverse distance of 2 and 2 will be 2 of the equal parts, or $\frac{2}{9}$ of the whole line, &c.

EXAMPLE 2. If a ship sails 52 miles in 8 hours, how much would she sail in 3 hours at the same rate ?

Take 52 in your compasses as a transverse distance and set it off from 8 to 8, then the transverse distance 3 and 3 being measured laterally, will be found equal to 19½, which is the number of miles required.

EXAMPLE 3. Having a chart constructed upon a scale of 6 miles to an inch, it is required to open the sector, so that a corresponding scale may be taken from the line of lines ?

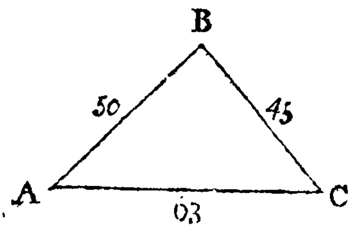
Make the transverse distance 6 and 6, equal to 1 inch, and this position of the sector will produce the given scale.

EXAMPLE 4. It is required to reduce a scale of 6 inches to a degree, to another of 3 inches to a degree ?

Make the transverse distance 6 and 6, equal to the lateral distance 3 and 3 ; then set off any distance from the chart laterally, and the corresponding transverse distance will be the reduced distance required.

EXAMPLE 5. One side of any triangle being given, of any length, to measure the other two sides on the same scale.

Suppose the side A B of the triangle ABC measures 50, what are the measures of the other two sides ?

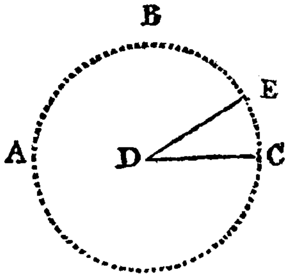


Take A B in your compasses, and apply it transversely to 50 and 50 ; to this opening of the sector apply the distance A C in your compasses to the same number on both sides of the rule transversely ; and where the two points fall will be the measure on the line of lines of the distance required ; the distance A C will fall against 63, 63, and B C against 45, 45 on the line of lines.

Use of the line of Chords on the Sector.

The line of chords upon the sector is very useful for protracting any angle, when the paper is so small that an arch cannot be drawn upon it with the radius of a common line of chords.

Suppose it was required to set off an arch of 30°, from the point C of the small circle A B C ?



Take the radius DC in your compaſſes, and ſet it off tranſverſely from 60° to 60° on the chords; then take the tranſverſe extent from 30° to 30° on the chords; and place one foot of the compaſſes in C, the other will reach to E, and CE will be the arch required. And by the converſe operation any angle or arch may be meaſured, viz. with any radius deſcribe an arch about the angular point; ſet that radius tranſverſely from 60° to 60°; then take the diſtance of the arch intercepted between the two legs and apply it tranſverſely to the chords, which will ſhew the degrees of the given angle.

NOTE. When the angle to be protracted exceeds 60°, you muſt lay off 60° and then the remaining part; or if it be above 120°, lay off 60° twice, and then the remaining part. And in a ſimilar manner any arch above 60° may be meaſured.

Uſes of the lines of Sines, Tangents and Secants.

By the ſeveral lines diſpoſed on the ſector, we have ſcales of ſeveral radii. So that,

1ſt. Having a length or radius given not exceeding the length of the ſector when opened, we can find the chord, ſine, &c. of the ſame: thus, ſuppoſe the chord, ſine, or tangent of 20 degrees to a radius of 2 inches be required. Make 2 inches the tranſverſe opening to 60° and 60° on the chords; then will the ſame extent reach from 45° to 45° on the tangents, and from 90° to 90° on the ſines: ſo that to whatever radius the line of chords is ſet, to the ſame are all the others ſet alſo. In this diſpoſition therefore, if the tranſverſe diſtance between 20° and 20° on the chords be taken with the compaſſes, it will give the chord of 20 degrees; and if the tranſverſe of 20° and 20° be in like manner taken on the ſines, it will be the ſine of 20 degrees; and laſtly, if the tranſverſe diſtance of 20° and 20° be taken on the tangents, it will be the tangent of 20 degrees to the ſame radius of 2 inches.

2dly. If the chord or tangent of 70° were required. For the chord, you muſt firſt ſet off the chord of 60° (or the radius) upon the arch, and then ſet off the chord of 10°. To find the tangent of 70 degrees, to the ſame radius, the ſcale of upper tangents muſt be uſed, the under one only reaching to 45°; making therefore 2 inches the tranſverſe diſtance to 45° and 45° at the beginning of that ſcale, the extent between 70° and 70° on the ſame will be the tangent of 70 degrees to 2 inches radius.

3dly. To find the ſecant of any arch; make the given radius the tranſverſe diſtance between 0 and 0 on the ſecants; then will the tranſverſe diſtance of 20° and 20°, or 70° and 70°, give the ſecant of 20° or 70°.

4thly. If the radius and any line repreſenting a ſine, tangent or ſecant, be given, the degrees correſponding to that line may be found by ſetting the ſector to the given radius, according as a ſine, tangent or ſecant is concerned; then taking the given line between the compaſſes, and applying the two feet tranſverſely to the proper ſcale, and ſliding the feet along till they both reſt on like diviſions on both legs; then the diviſions will ſhew the degrees and parts correſponding to the given line.

Uſe of the line of Polygons.

The uſe of this line is to inſcribe a regular polygon in a circle. For example let it be required to inſcribe an octagon in a circle. Open the ſector till the tranverſe diſtance 6 and 6 be equal to the radius of the circle ; then will the tranſverſe diſtance of 8 and 8 be the ſide of the inſcribed polygon.

Uſe of the Sector in Trigonometry.

All proportions in trigonometry are eaſily worked by the double lines on the ſector ; obſerving that the ſides of triangles are taken off the line of lines, and the angles are taken off the ſines, tangents or ſecants, according to the nature of the proportion. Thus, if in the triangle ABC we have given AB = 56, AC = 64, and the angle ABC = 46° $30'$, to find the reſt. In this caſe we have (by art. 60, Geometry) the following proportions, as AC (64) : ſine ∠B ($46^\circ 30'$) :: AB (56) : ſine ∠C, and as ſine B : AC :: ſine A : BC. Therefore to work theſe proportions by the ſector, take the lateral diſtance 64 = AC from the line of lines, and open the ſector to make this a tranſverſe diſtance of $46^\circ 30'$ = ∠B on the ſines ; then take the lateral diſtance 56 = AB on the lines, and apply it tranſverſely on the ſines, which will give $39^\circ 24'$ = ∠C. Hence the ſum of the angles B and C is $85^\circ 54'$, which taken from 180°, leaves the angle A = $94^\circ 6'$. Then to work this ſecond proportion, the ſector being ſet at the ſame opening as before, take the tranſverſe diſtance of $94^\circ 6'$ = the angle A, on the ſines, or which is the ſame thing, the tranſverſe diſtance of its ſupplement $85^\circ 54'$; then this applied laterally to the lines, gives the ſought ſide BC = 88. In the ſame manner we might ſolve any problem in trigonometry, where the tangents and ſecants occur; by only meaſuring the tranſverſe diſtances on the tangents or ſecants, inſtead of meaſuring them on the ſines as in the preceding example.

LOGARITHMS.

IN order to abbreviate the tedious operations of multiplication and division with large numbers, a series of numbers, called logarithms, were invented by Lord Napier, Baron of Marchinston in Scotland, and published in Edinburgh in 1614; by means of which the operation of multiplication was performed by addition, and division by subtraction; numbers were involved to any power by simple multiplication, and the root of any power was extracted by simple division.

In Table XXIV, is given the logarithm of every number from 1 to 9999; to each one ought to be prefixed an index, with a period or dot to seperate it from the other part, as in decimal fractions; the numbers from 1 to 100, are published in that table with their indices; but from 100 to 9999 the index is left out for the sake of brevity, but it may be supplied by this general rule, viz. *the index of the logarithm of any integer, or mixed number, is always one less than the number of integer places in the natural number.* Thus the index of the logarithm of any number (integer or mixed) between 10 and 100 is 1, from 100 to 1000 it is 2, from 1000 to 10000 is 3, &c. the method of finding the logarithms from this table will be evident from the following examples.

To find the logarithm of any number less than 100.

RULE. Enter the first page of the table, and opposite the given number will be found the logarithm, with its index prefixed.

Thus, opposite 71 is 1.85126, which is its logarithm.

To find the logarithm of any number between 100 *and* 1000.

RULE. Find the given number in the left hand column of any table of logarithms and immediately under 0 in the next column is a number, to which must be prefixed the number 2 as an index (because the number consists of three places of figures,) and you will have the sought logarithm.

Thus, if the logarithm of 649 was required; this number being found in the left hand column, against it in the column marked 0 at the top (or bottom) is found 81224, to which prefixing the index 2, we have the logarithm of 649=2.81224.

To find the logarithm of any number between 1000 *and* 10000.

RULE. Find the three left hand figures of the given number, in the left hand column of the table of logarithms, opposite to which in the column that is marked at the top (or bottom) with the fourth figure, is to be found the sought logarithm; to which must be prefixed the index 3, because the number contains 4 places of figures.

Thus, if the logarithm of 6495 was required; opposite to 649, and in the column marked 5 at the top (or bottom) is 81258, to which prefix the index 3 and we have the sought logarithm 3.81258.

To find the logarithm of any number above 10000.

Rule. Find the three first figures of the given number in the left hand column of the table, and the fourth figure at the top or bottom, and take out the corresponding number as in the preceding rule; take also the difference between this logarithm and the next greater, and multiply it by the given number exclusive of the four first figures, cross off at the right hand of the product as many figures as you had figures of the given number to multiply by; then add the remaining left hand figures of this product to the logarithm taken from the table, and to the sum prefix an index equal to one less than the number of integer figures in the given number, and you will have the sought logarithm.

Thus, if the logarithm of 64957 was required; opposite to 649 and under 5 is 81258, the difference between this and the next greater number 81265 is 7, this multiplied by 7 (the last figure of the given number) gives 49, crossing off the right hand figure leaves 4,9 or 5 to be added to 81258, which makes 81263, to this prefixing the index 4, we have the sought logarithm 4.81263.

Again, if the logarithm of 6495738 was required; the logarithm corresponding to 649 at the left, and 5 at the top, is as in the last example 81258, the difference between this and the next greater is 7, which multiplied by 738 (which is equal to the given number excluding the four first figures) gives 5166, crossing off the three right hand figures of this product (because the number 738 consists of three figures) we have the correction 5 to be added to 81258; and the index to be prefixed is 6 because the given number consists of 7 places of figures, therefore the sought logarithm is 6.81263.

To find the logarithm of any mixed decimal number.

Rule. Find the logarithm of the number as if it was an integer by the last rule, to which prefix the index of the integer part of the given number.

Thus, if the logarithm of the mixed decimal 649,5738 was required; find the logarithm of 6495738 without noticing the decimal point; this in the last example was found to be 81263, to this we must prefix the index 2 corresponding to the integer part 649; the logarithm sought will therefore be 2.81263.

To find the logarithm of any decimal fraction less than unity.

The index of the logarithm of any number less than unity is negative, but to avoid the mixture of positive and negative quantities, it is common to borrow 10 or 100 in the index, which must afterwards be neglected in summing them with other indices; thus instead of writing the index —1, it is generally written +9 or +99; but in general it is sufficient to borrow 10 in the index, and it is what we shall do in the rest of the work. In this way we may find the logarithm of any decimal fraction by the following rules.

Rule. Find the logarithm of a fraction as if it was a whole number; see how many ciphers precede the first figure of the decimal fraction, subtract it from 9 and the remainder will be the index of the given fraction.

Thus the log. of 0,0391 is 8.59218; the log. of 0,25 is 9.39794; the log. of 0,0000025 is 4.39794, &c.

To find the logarithm of a vulgar fraction.

RULE. Subtract the logarithm of the denominator from the logarithm of the numerator, (borrowing 10 in the index when the denominator is the greatest) the remainder will be the logarithm of the fraction sought.

EXAMPLE I.		EXAMPLE II.	
Required the log. of $\frac{3}{8}$?		Required the log. of $3\frac{1}{4}$ or $\frac{13}{4}$?	
From log. of 3	0.47712	From log. of 13	1.11394
Take log. of 8	0.90309	Take log. of 4	0.60206
Rem. log. $\frac{3}{8}$ or ,375	9.57403	Rem. log. of $3\frac{1}{4}$ or 3,25	0.51188

To find the number corresponding to any logarithm.

RULE. In the column marked 0 at the top (and bottom) of the table, seek for the next less logarithm, neglecting the index; note the number against it, and carry your eye along that line until you find the nearest less logarithm to the given one, and you will have the fourth figure of the given number at the top, which is to be placed to the right of the three other figures; if you wish for greater accuracy, you must take the difference between this tabular logarithm and the next greater, also the difference between that least tabular logarithm and the given one; to the latter difference annex 2 or more ciphers at the right hand, and divide it by the former difference, and place the quotient to the right hand of the four figures already found, and you will have the number sought expressed in a mixed decimal, the integer part of which will consist of a number of figures (at the left hand) equal to the index of the logarithm increased by unity.*

Thus, if the number corresponding to the logarithm 1.52634 was required; I look for 52634 in the column marked 0 at the top or bottom, and find it standing opposite to 336; now the index being 1, the sought number must consist of two integer places, therefore it is 33,6.

If the given logarithm was 2.32838; I find that 32838 stands in the column marked 0 at the top or bottom, directly opposite to 213 which is the number sought, because the index being 2, the number must consist of 3 places of figures.

If the number corresponding to the logarithm 2.57345 was required; I look in the column 0, and find in it, against the number 374, the logarithm 57287, and guiding my eye along that line, I find the given logarithm 57345 in the column marked 5; therefore the mixed number sought is 3745, and since the index is 2, the integer part must consist of 3 places, therefore the number sought is 374,5. If the index had been 1, the number would have been 37,45; and if the index had been 0, the number would have been 3,745. If the index had been 8 corresponding to a number less than unity, the answer would have been 0,03745, &c.

Again, if the number corresponding to the logarithm 5.57811 was required; I look in the column 0, and find in it against 378, and under 5, the logarithm 57807, the difference between this and the next greater logarithm 57818 being 11, and the difference between 57807 and the given number 57811 being 4, to this 4 I affix two ciphers, which make 400, and divide it by 11 the quotient is 36 nearly; this number connected with the former four figures make 378436, which is the number required, since the index being 5 the number must consist of six places of figures.

* If the index corresponds to a fraction less than unity, you must place as many ciphers to the left of that number as are equal to the index subtracted from 9, the decimal point being placed to the left of these ciphers; in this manner you will obtain the sought number.

MULTIPLICATION BY LOGARITHMS.

RULE. Add the logarithms of the two numbers to be multiplied and the sum will be the logarithm of their product.

EXAMPLE I.
Multiply 25 by 35.

25 log.	1.39794
35 log.	1.54407
Product 875 log.	2.94201

EXAMPLE II.
Multiply 22,4 by 1,8.

22,4 log.	1.35025
1,8 log.	0.25527
Product 40,32 log.	1.60552

EXAMPLE III.
Multipy 3,26 by 0,0025.

3,26 log.	0.51322
0,0025 log.	7.39794
Product 0,00815 log.	7.91116

EXAMPLE IV.
Multiply 0,25 by 0,003.

0,25 log.	9.39794
0,003 log.	7.47712
Product 0,00075 log.	6.87506

In the last example the sum of the two indices is 16, but since 10 was borrowed in each number, I have neglected 10 in the sum, and the remainder 6 being less than the other 10, is evidently the index of the logarithm of a fraction less than unity.

DIVISION BY LOGARITHMS.

RULE. From the logarithm of the dividend subtract the logarithm of the divisor, the remainder will be the logarithm of the quotient.

EXAMPLE I.
Divide 875 by 25.

875 log.	2.94201
25 log.	1.39794
Quotient 35 log.	1.54407

EXAMPLE II.
Divide 40,32 by 22,4.

40,32 log.	1.60552
22,4 log.	1.35025
Quotient 1,8 log.	0,25527

EXAMPLE III.
Divide 0,00815 by 0,0025.

0,00815 log.	7.91116
0,0025 log.	7.39794
Quotient 3,26 log.	0.51322

EXAMPLE IV.
Divide 0,00075 by 0,025.

0,00075 log.	6.87506
0,025 log.	8.39794
Quotient 0,03 log.	8.47712

In Example III. both the divisor and dividend are fractions less than unity, and the divisor is the least, consequently the quotient is greater than unity. In Example IV. both fractions are less than unity, and since the divisor is the greatest, its logarithm is greater than that of the dividend; for that reason it was necessary to borrow 10 in the index previous to making the subtraction, hence the quotient is less than unity.

INVOLUTION BY LOGARITHMS.

RULE. Multiply the logarithm of the number given, by the index of the power to which the quantity is to be raised, the product will be the logarithm of the power sought. But in raising the powers of any decimal fraction it must be observed, that the first significant figure of the power be put as many places below the place of units as the index of its logarithm wants of 10 multiplied by the index of the power.

Example I.

Required the square of 18?

18 log.	1.25527
	2
Answer 324 log.	2.51054

Example II.

Required the cube of 13?

13 log.	1.11394
	3
Answer 2197 log.	3.34182

Example III.

Required the square of 6,4?

6,4 log.	0.80618
	2
Answer 40,96 log.	1.61236

Example IV.

Required the cube of 0,25?

0,25 log.	9.39794
	3
Answer 0,015625	28.19382

In the last example the index 28 wants 2 of 30 (the product of 10 by the power 3) therefore the first significant figure of the answer, viz. 1, is placed two figures distant from the place of units.

EVOLUTION BY LOGARITHMS.

Rule. Divide the logarithm of the number by the index of the power, the quotient is the logarithm of the root sought. But if the power whose root is to be extracted is a decimal fraction less than unity, prefix to the index of its logarithm a figure less by one than the index of the power, and divide the whole by the index of the power, the quotient will be the logarithm of the root sought.

Example I.

What is the square root of 324?

324 log.	2)2.51055
Answer 18 log.	1.25527

Example II.

Required the cube root of 2197?

2197 log.	3)3.34183
Answer 13 log.	1.11394

Example III.

Required the square root of 40,96?

40,96 log.	2)1.61236
Answer 6,4 log.	0.80618

Example IV.

Required the cube root of 0,015625?

0,015625 log.	8.19382
Prefix 2 to the index	3)28.19382
Answer 0,25 log.	9.39794

To work the RULE of THREE by LOGARITHMS.

When three numbers are given to find a fourth proportional in arithmetic we make a statement and say, as the first number is to the second so is the third to the fourth; and by multiplying the second and third together, and dividing the product by the first, we obtain the fourth number sought. To obtain the same result by logarithms, we must *add the logarithms of the second and third numbers together, and from the sum subtract the logarithm of the first number, the remainder will be the logarithm of the sought fourth number.*

EXAMPLE I.

If 6 yards of cloth coft 5 dollars, what will 20 yards coft?

As 6	log.	0.77815
Is to 5	log.	0.69897
So is 20	log.	1.30103
Sum of 2d. and 3d.		2.00000
Subtract firft		0.77815
To 16,67	log.	1.22185

The anfwer therefore is 16 dollars and $\frac{67}{100}$, or 16 dollars and 67 cents.

EXAMPLE II.

If a fhip fails 20 miles in 7 hours, how much will fhe fail in 21 hours at the fame rate?

As 7	log.	0.84510
Is to 20	log.	1.30103
So is 21	log.	1.32222
Sum of 2d. and 3d.		2.62325
Subtract the firft		0.84510
To 60	log.	1.77815

The anfwer is 60 miles.

To calculate COMPOUND INTEREST by LOGARITHMS.

To 100 dollars add its intereft for 1 year; find the logarithm of this fum and reject 2 in the index, then multiply it by the number of years or parts of a year for which the intereft is to be calculated; to the product add the logarithm of the fum put at intereft; the fum of thefe two logarithms will be the logarithm of the amount of the given fum for the given time.

EXAMPLE.

Required the amount of the principal and intereft of 355 dollars, let at 6 per cent. compound intereft for 7 years.

Adding 6 to 100 gives 106, whofe logarithm, rejecting 2 in the index, is - - 0.02531

Multiplied by		7
Product		0.17717
Principal 355 dollars.	log.	2.55023
Sum gives the log of 533,83.	log.	2.72740

Therefore the amount of principal and intereft is 533 dollars and 83 cents.

To find the Logarithm of the Sines, Tangents, and Secants, &c. belonging to any number of Degrees and Minutes, by Table XXV.

If the required degrees be lefs than 45, or more than 135, the degrees are marked on the top, but between 45° and 135° are marked on the bottom, the minutes being found in the column marked M, which ftands on the fame fide of the page on which the degrees are marked; thus if the degrees are lefs than 45, the minutes are found in the left hand column, &c. and it muft be noted that if the degrees are found at the top, the names of hour, fine, co-fine, tangent, &c. muft alfo be found at the top: And if the degrees are found at the bottom, the names fine, co-fine, &c. muft alfo be found at the bottom.

EXAMPLE I.—Required the log. fine of 28° 37′?

Find 28° at the top of the page, directly below which in the left hand column find 37′; againſt which in the column marked ſine is 9.68029, the ſine of the given number of degrees: and in the ſame manner the tangents, &c. are found.

EXAMPLE II.—Required the log. ſecant of 126° 20′?

Find 126° at the bottom of the page, directly above which in the left hand column find 20′; againſt which in the column marked ſecants, is 10.22732 required.

To find the Logarithm-Sine, Co-ſine, &c. for Degrees, Minutes and Seconds, by Table XXV.

Find the logarithms correſponding to the even minutes next above and below the given degrees and minutes, and take their difference; then ſay, as 60″ is to the odd number of ſeconds, ſo is that difference to a correction to be applied to the logarithm of the leaſt number of degrees and minutes additive, if it is the leaſt of the two logarithms taken from the table, otherwiſe ſubtractive.

EXAMPLE I.—Required the log. ſine of 24° 16′ 48″?

Sine of 24° 16′	9.61382
Sine of 24 17	9.61411
Diff.	29

Then, as 60″ : 48″ :: 29 : 23, which added to the log. of 24° 16′, gives 9.61405 the log. of 24° 16′ 48″.

EXAMPLE II.—Required the log. ſecant of 105° 20′ 16″?

Secant of 105.20 log.	10.57768
105.21	10.57722
Diff.	46

Then 60″ : 16″ :: 46 : 12, which ſubtracted from the log. of 105° 20′, gives 10.57756, the log. ſec. of 105° 20′ 16″.

If the given ſeconds be $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ or $\frac{1}{6}$, or any other even parts of a minute, the like parts may be taken of the difference of the logarithms, and added or ſubtracted as above, which may be frequently done by inſpection.

To find the Degrees, Minutes and Seconds correſponding to any given Logarithm-Sine, Co-ſine, &c. by Table XXV.

Find the two neareſt numbers to the given logarithm, one greater and the other leſs, and take their difference; take alſo the difference between the given logarithm and the logarithm correſponding to the leaſt number of degrees and minutes: then ſay, as the firſt found difference is to the ſecond found difference, ſo is 60″ to a number of ſeconds to be annexed to the ſmalleſt number of degrees and minutes before found.

EXAMPLE I.—Find the degrees, minutes, and ſeconds (leſs than 90°) correſponding to the log. ſine 9.61405.

Next leſs log.	24° 16′	9.61382	Log. of leaſt numb. 24° 16′ is	9.61382
Greater	24 17	9.61411	Given log. -	9.61405
		29		23

Then ſay, as 29 : 23 :: 60″ : 48″ which annexed to 24° 16′ give 24° 16′ 48″, anſwering to log. ſine 9.61405. Subtracting 24° 16′ 48″ from 180°, and there remains 155° 43′ 12″, the log. ſine of which is alſo 9.61405.

EXAMPLE II.—Find the degrees, minutes and ſeconds (above 90°) correſponding to the log. ſecant 10.56703?

Secant 105° 43′	log. 10.56722	Log. of leaſt numb.	105° 43′		10.56722
Secant 105 44	10.56677	Given log.		-	10.56703
	45				19

Then as 45 is to 19, ſo is 60″ to 25″, which annexed to 105° 43′ gives 105° 43′ 25″, the degrees, minutes, and ſeconds required.

To find the Arithmetical Complement of any Logarithm.

The arithmetical complement of any logarithm, is what it wants of 10,00000 or 20.00000, and is uſed to avoid ſubtraction; for when working any proportion by logarithms, you may add the arithmetical complement of the logarithm of the firſt term, inſtead of ſubtracting the logarithm itſelf; only obſerving that 10 or 20 muſt be neglected in the index of the ſum of the logarithms. The arithmetical complement of any logarithm is thus found. Beginning at the index, *write down what each figure wants of 9, except the laſt ſignificant figure, which take from 10.**

EXAMPLE. Required the arithmetical complement of 9.62595?

For the firſt figure 9, write 0; for 6, 3; for 2, 7; for 5, 4; for 9, 0; and for the laſt figure 5 write 5; thus the arithmetical complement is 0.37405.

In the ſame manner the arithmetical complement of 1.86563 is 8.13437, the ar. co. of 10.33133 is 9.66867, and the ar. co. of 1.22800 is 8.77200. To illuſtrate the method of uſing the arithmetical complement of any logarithm, I ſhall here calculate the examples given in page 59.

EXAMPLE I.

As 6	log. ar. co.	9.22185
Is to 5	log.	0.69897
So is 20	log.	1.30103
To 16,67	log.	1.22185

EXAMPLE II.

As 7	log. ar. co.	9.15490
Is to 20	log.	1.30103
So is 21	log.	1.32222
To 60	log.	1.77815

* When the index of the given logarithm is greater than 10, the left hand figure of it may be neglected; and when there are any ciphers to the right hand of the laſt ſignificant figure, you may place the ſame number of ciphers to the right hand of the other figures of the arithmetical complement.

PLANE TRIGONOMETRY.

PLANE TRIGONOMETRY is the art which ſhews how to find the meaſures of the ſides and angles of plane triangles, ſome of them being already known. It is divided into two parts, right-angled and oblique-angled: in the former caſe, one of the angles is a right angle, or 90°; in the latter, they are all oblique.

In every plane triangle there are ſix parts, viz. three ſides and three angles; any three of which being given (except the three angles) the other three may be found by various methods, viz. by Gunter's ſcale, by the ſector, by geometrical conſtruction, or by arithmetical calculation. We ſhall explain each of theſe methods; but the latter is by far the moſt accurate; it is performed by the help of a few theorems, and a trigonometrical canon, exhibiting the natural or the logarithmic ſine, tangent, and ſecant, to every degree and minute of the quadrant.* The theorems alluded to are the following.

THEOREM I.

In any right-angled triangle, if the hypotenuſe be made radius, one ſide will be the ſine of the oppoſite angle, and the other its co-ſine; but if either of the legs be made radius, the other leg will be the tangent of the oppoſite angle, and the hypotenuſe will be the ſecant of the ſame angle.

Fig. 1.

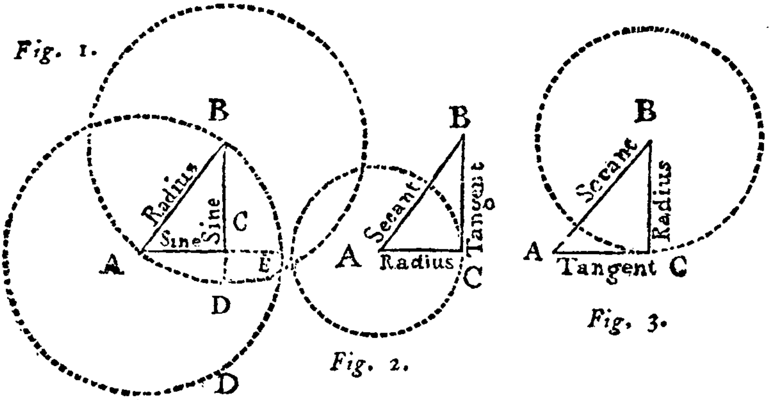


Fig. 2. *Fig.* 3.

For, 1ſt. If in the right-angled plane triangle ACB (fig. 1.) we make the hypotenuſe AB radius, and upon the centre A deſcribe the arch BE, to meet AC produced in E; then it is evident, that BC is the ſine of the arch BE (or the ſine of the angle BAC) and that AC is the co-ſine of the ſame angle: and if the arch AD be deſcribed about the centre B; AC will be the ſine of the angle ABC, and BC its co-ſine.

2dly. If the leg AC (fig. 2.) be made radius, and the arch CD be deſcribed about the centre A; CB will be the tangent of that arch, or the tangent of the angle CAB; and AB will be its ſecant.

3dly. If the leg BC (fig. 3.) be made radius, and the arch CD be deſcribed about the centre B; CA will be the tangent of that arch, or the tangent of the angle B; and AB will be its ſecant.

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* See Tables XXII. and XXV.

Now it has been already demonſtrated (in Art. 57, Geom.) that the ſine, tang. ſec. &c. of any arch in one circle, is to the ſine, tang. ſec. &c. of a ſimilar arch in another circle as the radius of the former circle to the radius of the latter. And ſince in any right-angled triangle there are given either two ſides, or the angles and one ſide, to find the reſt; we may, if we wiſh to find a ſide, make any ſide radius; then ſay, as the tabular number of the ſame name as the given ſide is to the given ſide of the triangle, ſo is the tabular number of the ſame name as the required ſide, to the required ſide of the triangle. If we wiſh to find an angle, one of the given ſides muſt be made radius; then ſay, as the ſide of the triangle made radius, is to the tabular radius, ſo is the other given ſide to the tabular ſine, tangent, ſecant, &c. by it repreſented; which being ſought for in the table of ſines, &c. will correſpond to the degrees and minutes of the required angle.

THEOREM II.

In all plane triangles, the ſides are in direct proportion to the ſines of their oppoſite angles (by Art. 60, Geom.)

Hence, to find a ſide, we muſt ſay, as the ſine of an angle is to its oppoſite ſide, ſo is the ſine of either of the other angles to the ſide oppoſite thereto. But if we wiſh to find an angle, we muſt ſay, as any given ſide is to the ſine of its oppoſite angle, ſo is the ſine of either of the other ſides to the ſine of its oppoſite angle.

THEOREM III.

In every plane triangle, it will be, as the ſum of any two ſides is to their difference, ſo is the tangent of half the ſum of the two oppoſite angles to the tangent of half their difference (by Art. 61, Geom.)

THEOREM IV.

As the baſe of any plane triangle is to the ſum of the two ſides, ſo is the difference of the two ſides to twice the diſtance of a perpendicular (let fall upon the baſe from the oppoſite angle) from the middle of the baſe (by Art. 63, Geom.)

THEOREM V.

In any plane triangle, as the rectangle contained by any two ſides including a ſought angle, is to the rectangle contained by the half ſum of the ſides and the half ſum decreaſed by the other ſide, ſo is the ſquare of radius to the ſquare of the co-ſine of half the ſought angle (by Art. 64, Geom.)

IN addition to theſe Theorems, it will not be amiſs for the learner to recall to mind the following articles, moſt of which have been already demonſtrated.

1. In every triangle, the greateſt ſide is oppoſite to the greateſt angle; and the greateſt angle oppoſite to the greateſt ſide.

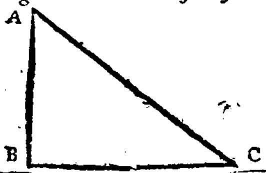
2. In every triangle, equal ſides ſubtend equal angles. (*Art.* 41, *Geom.*)

3. The three angles of any plane triangle are equal to 180°. (*Art.* 37, *Geom.*)

4. If one angle of a triangle be obtuſe, the reſt are acute; and if one angle be right, the other two together make a right angle, or 90°; wherefore, if one of the acute angles of a right-angled triangle be known, the other is found by ſubtracting the known angle from 90°. If one angle of any triangle be known, the ſum of the other two is found by ſubtracting the given angle from 180°; and if two of the angles be known, the third is found by ſubtracting their ſum from 180°.

5. The complement of an angle is what it wants of 90°, and the ſupplement of an angle is what it wants of 180°.

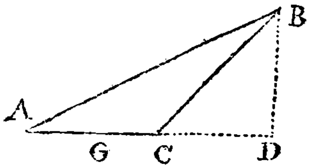
In the two following Tables we have collected all the rules necessary for solving the various cases of Right-Angled and Oblique-Angled Trigonometry.

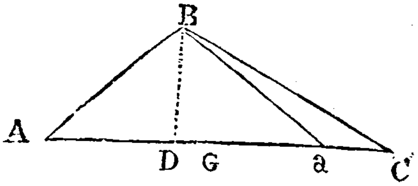


RIGHT-ANGLED TRIGONOMETRY.

Case	Given.	Sought.	Solutions.
1	Hyp. AC. Angles.	Leg BC. Leg AB.	Rad. : hyp. AC :: sine A : leg. BC. Rad. : hyp. AC :: sine C : leg. AB.
2 & 3	Leg. BC. Angles.	Leg AB. Hyp. AC.	Rad. : leg. BC :: tang. C : leg. AB. Rad. : leg. BC :: sec. C : hyp AC. Or sine A : leg. BC :: rad. : hyp. AC.
4 & 5	Hyp. AC. Leg AB.	Angles. Leg. BC.	Hyp. AC : rad. :: leg AB : sine C, whose comp. is A. Rad. : hyp. AC :: sine A : leg. BC.
6	Both legs AB & BC.	Angles. Hyp. AC.	Leg. BC : rad. :: leg AB : tang. C, whose comp. is A. Sine C : leg AB :: rad. : hyp. AC. Or Rad. : leg BC :: sec. C : hyp. AC.

OBLIQUE-ANGLED TRIGONOMETRY.





Case	Given.	Sought.	Solutions.
1	The Angles and side AB.	Side BC. Side AC.	Sine C : side AB :: sine A : side BC. Sine C : side AB :: sine B : side AC.
2 & 3	Two sides AB, BC, and angle C opposite to one of them.	Angle A. Angle B. Side AC.	Side AB : Sine C :: side BC : sine A, which added to C, and the sum subtracted from 180°, gives B. Sine C : side AB :: sine B : side AC.
4 & 5	Two sides AC, AB, and the included angle A.	Angles C and B.	Subtract half the given angle A from 90°, the remainder is half the sum of the other angles. Then say, as the sum of the sides AC, AB is to their difference, so is tangent of the half sum of the other angles to the tangent of half their difference; which added to, and subtracted from the half sum, will give the two angles B and C, the greatest angle being opposite to the greatest side.
		Side BC.	Sine B : side AC :: sine A : side BC.
6	All three sides.	All the angles.	Let fall a perpendicular BD opposite to the required angle; then as AC : sum of AB, BC :: their difference : twice DG, the distance of the perpendicular from the middle of the base; hence, AD, CD are known, and the triangle ABC is divided into two right angled triangles BCD, BAD; hence, by cases 4 and 5 of right-angled trigonometry, we may find the angle A or C.
		Either angle, as A.	Either of the angles, as A, may also be found by the following rule. From half the sum of the three sides subtract the side BC opposite to the sought angle; take the logarithms of the half sum and remainder, to which add the arithmetical complements of the logarithms of the sides AB, AC (including the sought angle); half the sum of these four logarithms will be the logarithmic co-sine of half the sought angle.

In working by logarithms with any of the preceding rules, you muſt remember, that the logarithm of the firſt term of the analogy is to be ſubtracted from the ſum of the logarithms of the ſecond and third terms, the remainder will be the logarithm of the ſought fourth term.

When the firſt term is radius (whoſe logarithm is 10.00000) you need only reject an unit in the ſecond left hand figure of the index of the ſum of the ſecond and third terms. But when the radius occurs in the ſecond or third term, you muſt ſuppoſe an unit to be added to the ſecond left hand figure of the index of the other term, and ſubtract therefrom the logarithm of the firſt term.

RIGHT-ANGLED TRIGONOMETRY.

Solution of the ſix caſes in right-angled trigonometry.

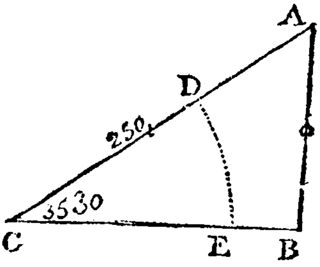
CASE I.

The angles and hypotenuſe given, to find the legs.

Given the hypotenuſe AC 250 leagues, and the angle C oppoſite to the ſide AB=35° 30′, to find the baſe CB and perpendicular AB.

By PROJECTION.

Draw the baſe CB of any length; on C as a centre, deſcribe the arch DE; from E to D lay off 35° 30′; through C and D draw the line AC, which make equal to 250; from A let fall the perpendicular AB, to cut CB in B, and it is done; for CB will be 203.5, and AB=145.2.



By LOGARITHMS.

By making the hypotenuſe CA radius, it will be,

To find the baſe BC.		To find the perpendicular AB.	
As radius	10.00000	As radius	10.00000
Is to the hypot. AC 250	2.39794	Is to the hypot. AC 250	2.39794
So is ſine ang. A 54° 30′	9.91069	So is ſine ang. C 35° 30′	9.76395
To the baſe BC 203,5	2.30863	To the per. AB 145,2	2.16189

By GUNTER's SCALE.

In all proportions wrought by gunter's ſcale, when the firſt and ſecond terms are of the ſame kind, the extent from the firſt term to the ſecond, will reach from the third to the fourth;

Or when the firſt and third terms are of the ſame kind,

The extent from the firſt term to the third will reach from the ſecond to the fourth; that is, ſet one point of the compaſſes on the diviſion expreſſing the firſt term, and extend the other point to the diviſion expreſſing the third term; then, without altering the opening of the compaſſes, ſet one point on the diviſion repreſenting the ſecond term, and the other point will fall on the diviſion ſhewing the fourth term or anſwer.

In the preſent example the work will be as follows:

Extend from radius, or 90°, to 54° 30′ on the line of ſines; that extent will reach from 250, the hypotenuſe, to 203.5, the baſe, on the line of numbers; and the extent from radius, or 90°, to 35° 30′ on the line of ſines, will reach from 250 to 145,2 on the line of numbers.

Obſerve the like in all that follows, except in thoſe proportions where the word ſecant is mentioned, which caſes muſt be wrought by conſidering the hypotenuſe radius, there being no line of ſecants on the common Gunter's ſcale, although it might eaſily be marked on the line of ſines.

NOTE. The radius, according to the nature of the proportion, may be any of theſe:

8 points on the line of rhumbs.	90° on the line of ſines.
4 points on the line of tan. rhbs.	45° on the line of tangents.

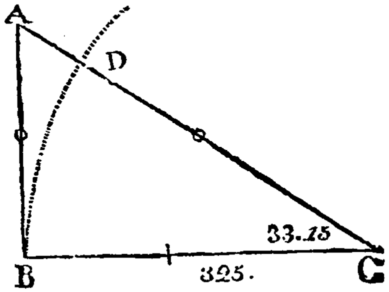
CASES II. and III.

The angles and one leg given, to find the hypotenuſe and other leg.

The angle ACB 33° 15′, the leg BC 325 miles, given, to find the hypotenuſe and the other leg.

By PROJECTION.

Draw the line BC, which make equal to 325 miles; on B erect the perpendicular BA; on C, as a centre, with the chord of 60° ſweep the arch BD, which make equal to 33° 15′; draw CD, and continue it to cut AB in A, and it is done; for AB being meaſured on the ſame ſcale that BC was, will be 213.1, and AC 388.6 miles.



By LOGARITHMS.

By making the baſe BC radius, it will be,

To find the perpendicular AB.		To find the hypotenuſe AC.	
As radius 45°	10.00000	As radius 90°	10.00000
Is to the baſe BC 325	2.51188	Is to the baſe BC 325	2.51188
So is tang. ang. C 33° 15′	9.81666	So is ſec. ang. C 33° 15′	10.07765
To the perpen. AB 213,1	2.32854	To the hypot. AC 388,6	2.58953

By GUNTER.

Extend from 45° to 33° 15′ on the line of tangents; that extent will reach from the baſe 325 to the perpendicular 213,1 on the line of numbers.

2dly. Extend from 56° 45′ to radius on the line of ſines; that extent will reach from the baſe 325 to the hypotenuſe 388,6 on the line of numbers.

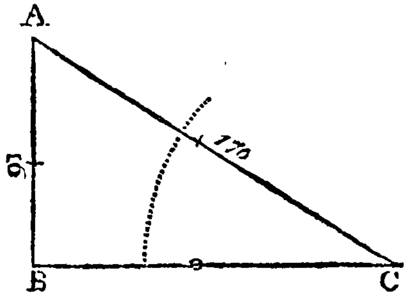
CASES IV. and V.

The hypotenuſe and one leg given, to find the angles and other leg.

The leg AB 91, the hypotenuſe AC 170, given, to find the angle ACB, or BAC, and the leg BC.

By PROJECTION.

Draw BC at pleaſure; on B erect the perpendicular BA, which make equal to 91; take 170 in your compaſſes, and with one foot on A, ſweep an arch to cut BC in C; join A and C, and it is done: for the angle C will be 32° 22′, the angle A 57° 38′ and BC 143,6.



By LOGARITHMS.

By making the hypotenuſe radius, it will be,

To find the angle C.		To find the baſe BC.*	
As the hypotenuſe 170	2.23045	As radius	10.00000
Is to the radius	10.00000	Is to the hypotenuſe 170	2.23045
So is the perpendicular 91	1.95904	So is ſine ang. A 57° 38′	9.92667
To ſine angle C 32° 22′	9.72859	To the baſe BC 143,6	2.15712

By GUNTER.

Extend from the hypotenuſe 170 to the perpendicular 91 on the line of numbers; that extent will reach from radius to the angle C, or the complement of angle A = 32° 22′ on the line of ſines.

2dly. Extend from radius to the angle A 57° 38′ on the line of ſines; that extent will reach from the hypotenuſe 170 to the baſe 143,6 on the line of numbers.

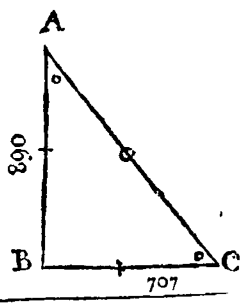
CASE VI.

The legs given, to find the angles and hypotenuſe.

The legs AB 890, BC 707, given, to find the angle BAC, or ACB, and the hypotenuſe AC.

By PROJECTION.

Make BC = 707, and on B erect the perpendicular BA, which make equal to 890; join AC, and it is done; for the angle C will be 51° 32′; conſequently, the angle A 38° 28′, and the hypotenuſe 1137.



* When you take the log. ſines or tangents to the neareſt minute only, it is beſt to uſe this canon for finding BC, which is more correct than the one found by making the perpendicular radius; becauſe the variation of the log. ſine of an arch is leſs than the correſponding variation of the log. tangent.

By LOGARITHMS.

By making the base radius, it will be,

To find the angle C.		To find the hypoth. AC.*	
As the base 707	2.84942	As radius	10.00000
Is to radius	10.00000	Is to the base 707	2.84942
So is the perpend. 890	2.94939	So is sec. ang. C 51° 32′	10.20617
To tan. ang. C = 51° 32′	10.09997	To the hyp. AC = 1137	3.05559

By GUNTER.

The extent from 707 to 890 on the line of numbers will reach from radius (or 45 degrees) to the angle C 51° 32′ on the line of tangents.

2dly. The extent from the angle C 51° 32′ to radius, or 90°, on the line of sines, will reach from the base 890 to the hypotenuse 1137, on the line of numbers.

QUESTIONS

To exercise the Learner in Right-Angled Plane Trigonometry.

Quest. 1. The hypotenuse 496 miles, and the angle opposite to the base 56° 15′, given, to find the base and perpendicular.

Ans. Base 412.4, and the perpendicular 275.6 miles.

Quest. 2. The perpendicular 275 leagues, and the angle opposite to the base 56° 15′, given, to find the hypotenuse and base.

Ans. The hypotenuse 495, and base 411.6 leagues.

Quest. 3. The base 33 yards, and the angle opposite to the perpendicular 53° 26′, given, to find the hypotenuse and perpendicular.

Ans. Hypotenuse 55.39, and the perpendicular 44.49 yards.

Quest. 4. The hypotenuse 575, and perpendicular 50 miles, given, to find the base.

Ans. Base 572.8 miles.

Quest. 5. The hypotenuse 59, and the base 33 miles, given, to find the perpendicular.

Ans. Perpendicular 48.9 miles.

Quest. 6. The base 33, and perpendicular 52 leagues, given, to find the hypotenuse.

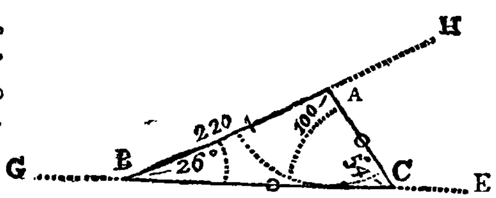
Ans. Hypotenuse 61.59 leagues.

OBLIQUE TRIGONOMETRY.

CASE I.

Two angles and one side given, to find either of the legs.

The angle BAC = 100° and angle ACB = 54° and the leg AB = 220 are given to find the sides.



*When you are finding AC it is best to make the greatest side radius, for the reason mentioned in the last note.

By PROJECTION.

Subtract the sum of the angles A and C from 180°, the remainder will be the angle B=26°. Draw the indefinite line GE; and from any point of it as B, draw the line BH making the angle EBH=26°, on BH set off BA 220. On A make the angle BAC 100°; then AC will intersect the line GE in the point C, which completes the triangle, and BC will measure on the same scale from which BA was laid down 268 nearly, and AC 119 also on the same scale.

By LOGARITHMS, by Theorem II.

To find BC.		To find DC.	
As the sine of the angle C 54°	9.90796	As sine ang. C 54°	9.90796
Is to the side AB 220	2.34242	Is to the side AB 220	2.34242
So is the sine of the ang. A 100°	9.99335	So is sine ang. B 26°	9.64184
	12.33577		11.98426
	9.90796		9.90796
To the side BC 267.8	2.42781	To side AC 119.2	2.07630

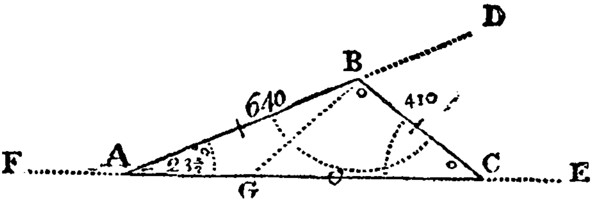
By GUNTER.

The extent from the angle C=54° to the angle A or its supplement 80°, on the sines, will reach from AB=220 to BC=268 on the line of numbers.

2dly. The extent from the angle C=54° to the angle B=26°, on the sines, will reach from AB=220 to AC=119 on the line of numbers.

CASES II. and III.

Two sides and an angle opposite to one of them being given, to find the other angles and the third side.



NOTE. It may be proper to observe, that if the given angle be obtuse, the angle sought will be acute; but when the given angle is acute and opposite to a lesser given side, then it is doubtful whether the required angle is acute or obtuse, it ought therefore to be given by the conditions of the problem.

EXAMPLE. Let there be given the side BC 410, the side AB 640, and the angle A 23½°, to find the other side AC, and the angles ABC, BCA?

By PROJECTION.

Draw the indefinite line FE, and on any point therein, as at A, make the angle DAE=23½°, on AD set off AB=640, then on B, with 410 in your compasses taken from the same scale, describe an arch cutting FE in the points C and G, join BC, BG, and it is done; for the triangle may be either ACB, or AGB, according as the angle C, or G, is acute or obtuse; if that angle be acute, the triangle will be ABC; the side AC will measure 908, the angle ACB will measure 38½°, and the angle ABC will measure 118° nearly; but if the angle at the base be obtuse, the triangle will be AGB; the side AG will measure 266, the angle AGB will measure 141½°, and the angle ABG 15°.

If the ſide BC had been given greater than AB, there could have been only one anſwer to this problem; for in that caſe, the point G would have fallen on the continuation of the line CA towards F, in which caſe the angle A of the triangle would become equal to FAB, inſtead of being equal to its ſupplement, as is required by the conditions of the problem.

By LOGARITHMS, by Theorem II.

To find the angle C or G.

As the ſide BC 410		2.61278
Is to the ſine of angle A $23\frac{1}{2}°$		9.60070
So is the ſide AB 640		2.80618
		12.40688
		2.61278
To ſi. an. C 38 30 or G 141 30		9.79410
Ang. A add 23 30	23 30	
Subtract 62 0 or	165 0	
From 180 00	180 00	
Ang. ABC 118 0	ABG 15 0	

To find AC.

As ſine angle C 38° 30′	9.79410
Is to AB 640	2.80618
So is ſine angle ABC 118°	9.94593
	12.75211
	9.79410
To the ſide AC 907,8	2.95801

To find AG.

As ſine angle G 141° 30′	9.79410
Is to AB 640	2.80618
So is ſine angle ABG 15°	9.41300
	12.21918
	9.79410
To the ſide AG 266,1	2.42508

By GUNTER.

1ſt. The extent from BC=410 to AB=640, on the line of numbers, will reach from A=$23\frac{1}{2}°$ to $38\frac{1}{2}°$, on the line of ſines, which is equal to the angle C; its ſupplement 141° 30′ being equal to the angle G.

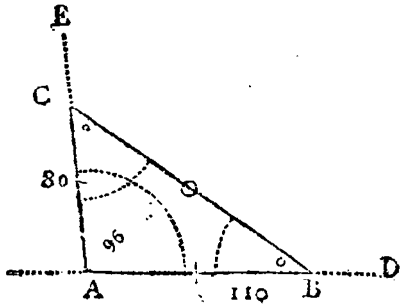
2dly. The extent from the angle C=38° 30′ to 62° 0′ (the ſupplement of the angle ABC, 118° 0′) on the ſines, will reach from AB=640 to 908, on the line of numbers; therefore the ſide AC=908.

Or, the extent from 38° 30′ (the ſupplement of the angle G) to the angle ABG=15° 0′ on the ſines, will reach from AB=640 to 266, on the line of numbers; hence AG=266.

CASES IV. and V.

Two ſides and their contained angle being given, to find either of the other angles and the third ſide.

Given the ſide AB 110 m. AC 80 m. and angle BAC 96° 0′, to find the angle BCA and CBA.



By PROJECTION.

Draw the indefinite right line AD, on which set off AB=110; make the angle EAB=96°; and on AE set off AC=80: join BC, and it is done; for BC will measure on the former scale 143, and the angles B and C will measure 33° 55′ and 50° 5′ respectively on the line of chords.

By LOGARITHMS.

To find the angles B & A, by Th. III.

As sum of sides AC & AB	190	2.27875
Is to their difference	30	1.47712
So is tan. ½ sum op. ∠s or comp. ½ ang. A	42°	9.95444
		11.43156
		2.27875
To tang. half diff.	8° 5′	=9.15281
Sum is angle C	50 5	
Diff. is angle B	33 55	

To find the side AB, by Theor. II.

As sine ang. B	33°55′	9.74662
Is to AC	80	1.90309
So is sine ang. A or its sup.	96° 0′ / 84 0	9.99761
		11.90070
		9.74662
To side BC	142.6	2.15408

By GUNTER.

1st. The extent from the half sum of the sides 190 to their half difference 30, on the line of numbers, will reach from the half sum of the angles B and C 42° to their half difference 8° 5′ on the line of tangents. The sum of which half sum and half difference gives the angle C 50° 5′ and their difference the angle B 33° 55′; the greatest angle being opposite to the greatest side.

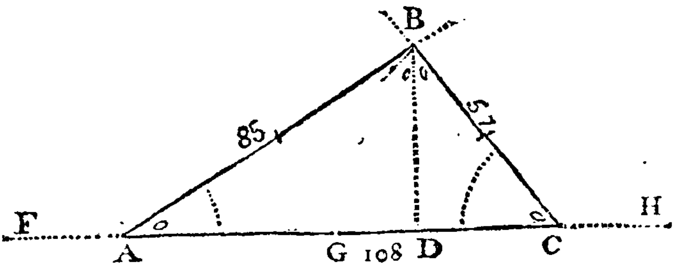
2dly. The extent from the angle B 33° 55, to the angle A 96° (or its supplement 84°) on the line of sines, will reach from the side AC 80 to the side BC 142,6 on the line of numbers.

CASE VI.

The three sides of a plane triangle given, to find the angles.

The side AB 85, BC 57, AC 108, given, to find the angles ABC, BAC, BCA.

By PROJECTION.



Draw the indefinite right line FH, on which set off AC=108; take 85 in your compasses, and with one foot on the point A, sweep an arch; then take the distance 57 in your compasses, and with one foot on C, sweep another arch intersecting the former arch in the point B; join AB, CB and it is done. For the angle A being measured will be found=31½°, B=97° and the angle C=51½° nearly.

By LOGARITHMS, by Theorem IV.

Suppose BD to be drawn perpendicular to AC, and that AG=GC.

Side A B =	85	As the base A C	108	2.03342
Side B C =	57	Is to the sum of the sides A B and B C	142	2.15229
		So is diff. of the sides A B and B C	28	1.44716
Sum of the sides	142			
Diff. of the sides	28			3.59945
				2.03342
Half base A C	54			
DG	18,4	To twice DG	36,8	1.56603
		Its half=DG	18,4	
Sum is greater seg. A D	72,4			
Diff. is least seg. D C	35,6			

Having divided the triangle into two right angled triangles, the hypotenuses and bases of which are given, we may find the angles by Theor. I.

To find the angle B A D.		To find the angle B C D.	
		As the hypotenuse B C 57	1.75587
As the hypotenuse A B 85	1.92942	Is to radius 90°	10.00000
Is to radius 90°	10.00000	So is the lesser seg. D C 35,6	1.55145
So is the greater seg. A D 72,4	1.85974		
		To co-sine of BCD=51° 21'	9.79558
To co-sine B A D = 31° 36'	9.93032	B A D=31 36	
		Sum 82 57	
		Subtract from 180	
		Remains Angle ABC 97 3	

By GUNTER.

1st. The extent from the base AC=108, to the sum of the sides 142, on the line of numbers, will reach from the difference of the sides 28, to twice DG 36.8 on the same line of numbers.

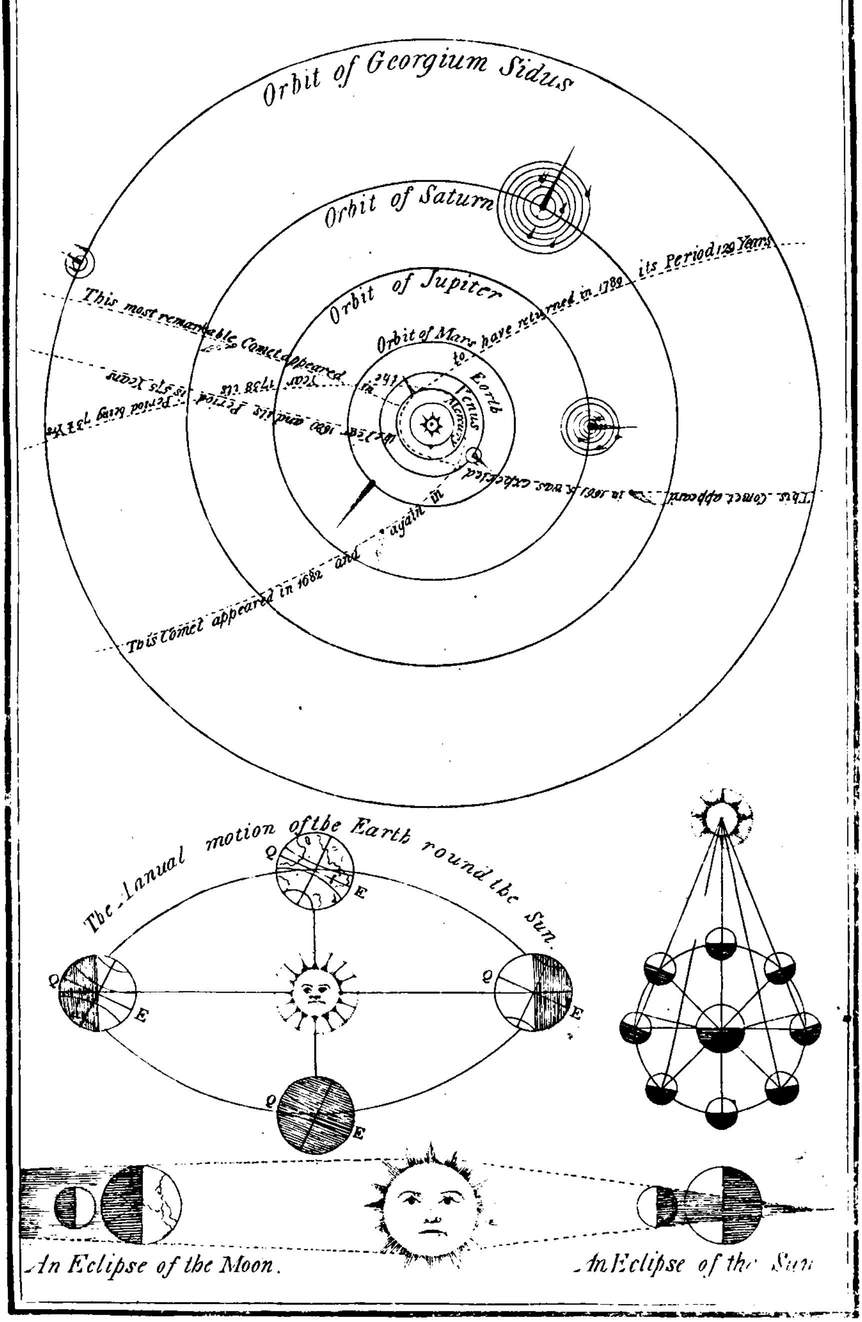
2dly. The extent from the hypotenuse AB=85 to the greater segment AD 72.4, on the line of numbers, will reach on the sines from the radius 90° to 58°24', which is the complement of the angle BAD.

3dly. The extent from the hypotenuse CB 57 to the lesser segment DC 35.6, on the line of numbers, will reach on the sines from the radius 90° to 38° 39', which is the complement of the angle BCA.

This case may be solved without dividing the triangle into two right angled triangles by Theorem V.

To find the angle A.			Having the angle A, we may find the angle C by Theorem II.	
BC= 57				
AB= 85	log. co. ar.	8.07058	As BC 57	1.75587
AC=108	log. co. ar.	7.96658	Is to sine angle A 31° 36'	9.71932
			So is AB 85	1.92942
Sum 250				
Half sum 125	log.	2.09691		11.64874
Half sum less BC 68	log.	1.83251		1.75587
	Sum)	19 96658	To the sine of angle C 51° 23'	9.89287
Half sum 15° 48'	Co-sine	9.98329		
2				
Doubled is 31° 36'=angle A.				

THE SOLAR SYSTEM.



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A SHORT INTRODUCTION TO

ASTRONOMY AND GEOGRAPHY.

ASTRONOMY is a ſcience which treats of the motions and diſtances of the heavenly bodies, and of the appearances thence ariſing.

The common opinion of aſtronomers of the preſent day is, that the univerſe is compoſed of an infinite number of ſyſtems, or worlds; in every ſyſtem there are certain bodies moving in free ſpace, and revolving at different diſtances round a ſun, placed in, or near, the centre of the ſyſtem; and that theſe ſuns and other bodies are the ſtars which are ſeen in the heavens.

The SOLAR SYSTEM, ſo called, is that in which our earth is placed, and in which the ſun is ſuppoſed to be fixed near the centre, with ſeveral bodies ſimilar to our earth revolving round him at different diſtances. This hypotheſis, which is fully confirmed by obſervation, is called the Copernican Syſtem, from Nicholas Copernicus, a Poliſh philoſopher, who revived it about the year 1500, after it had been buried in oblivion many ages.

Stars are diſtinguiſhed into two kinds, *fixed* and *wandering*. The former are ſuppoſed to be ſuns in the centres of their ſyſtems, ſhining with their own light, and preſerving always the ſame ſituation with reſpect to each other. They are uſually diſtinguiſhed by their brightneſs, the largeſt being called of the firſt magnitude, and the ſmalleſt viſible to the naked eye being of the ſixth or ſeventh magnitude. A *Conſtellation* is a number of ſtars lying in the neighbourhood of one another on the ſurface of the celeſtial ſphere, which aſtronomers, for the ſake of remembering with greater eaſe, ſuppoſe to be circumſcribed by the outlines of ſome animal, or other figure. The wandering ſtars are thoſe bodies within our ſyſtem, or celeſtial ſphere, which revolve round the ſun: they appear luminous by reflecting the light of the ſun, and are of three kinds, namely, primary planets, ſecondary planets, and comets.

The *Primary Planets* are thoſe bodies, which, in revolving round the ſun, reſpect him only as the centre of their courſes; the motions of which are regularly performed in tracks or paths (called *orbits*) that are nearly circular and concentric with each other. A *Secondary Planet, Satellite*, or *Moon*, is a body, which, while it is carried round the ſun, does alſo revolve round a primary planet, which it reſpects as its centre. *Comets* are a ſort of planets moving round the ſun in very eccentric orbits, with vaſt atmoſpheres about them, and tails derived from the ſame, eſpecially when they come near the ſun.

There are ſeven primary planets, which, reckoned in order from the ſun, are as follows: Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and Herſchel.

Mercury and Venus are called inferior planets, becauſe their orbits are within the earth's; the others are called ſuperior planets, as their orbits include that of the earth.

The SUN is the first and greatest object of astronomical knowledge; it is placed near the centre of the orbits of all the planets, and turns round its axis in 25¼ days; its diameter is 883,000 English miles, and its mean distance from the earth is 95 millions of miles.

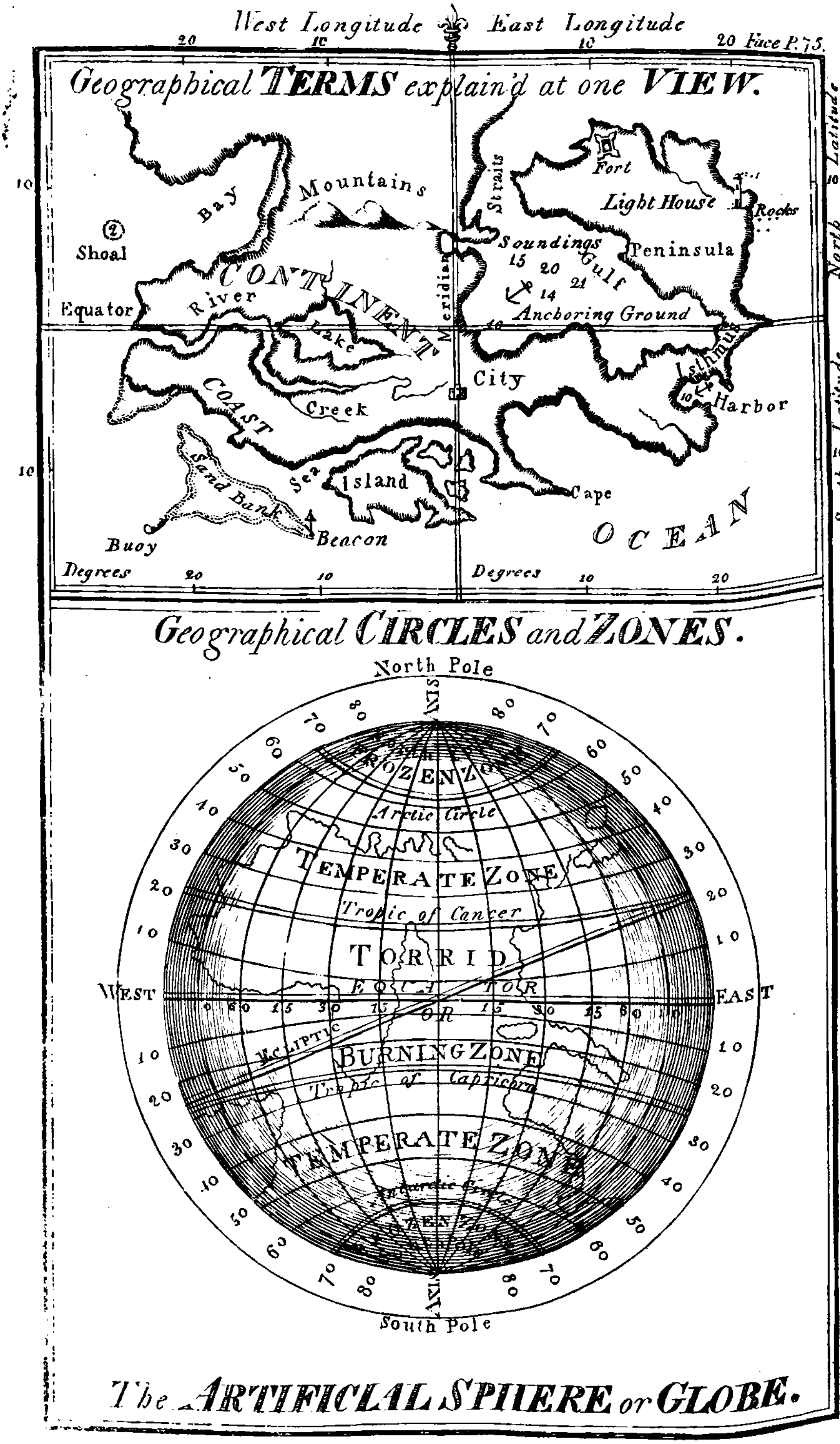
MERCURY is the least of all the planets, and is nearest to the sun, his mean distance from that luminary being 37 millions of miles. His periodic revolution in his orbit round the sun is performed in 87 days 23 hours. The diameter of Mercury is about 3200 miles.

VENUS is the brightest of all the planets. Her diameter is 7687 miles; her mean distance from the sun is 68 millions of miles; and her periodic revolution is performed in 224 days 17 hours. When this planet is in that part of her orbit which is west of the sun, she rises before him in the morning, and is called the *morning-star;* when she is in the eastern part of her orbit, she shines in the evening after he sets, and is called the *evening-star.*

The EARTH is next to Venus; its diameter is 7964 miles, its distance from the sun 96 millions of miles, and goes round him in a year, or 365 days, 6 hours. It turns round its axis from west to east in 23 h. 56 m. which occasions the apparent diurnal motion of the sun and all the heavenly bodies round it, from east to west, in the same time; it is, of course, the cause of their rising and setting, of day and night. The axis of the earth is inclined 23° 28′ to the plane of its orbit, and keeps in a direction parallel to itself, throughout its annual course, which causes the return of spring and summer, autumn and winter. Thus the diurnal motion gives us the grateful vicissitude of night and day, and the annual motion the regular succession of the seasons. The earth is attended by a satellite called the MOON, whose diameter is 2161 miles; her distance from the centre of the earth is 240,000 miles: she goes round her orbit in 27 days 8 hours; but reckoning from change to change, in 29½ days. Her orbit is inclined to the ecliptic in an angle of 5° 18′, cutting it in two points diametrically opposite to each other, called her *nodes.* As the moon shines only by the reflected light of the sun, she must appear different when in different situations with respect to that luminary. When she is in conjunction with the sun, her dark side is turned towards the earth, which renders her invisible; this is called *new moon:* when she is in opposition, her light side is wholly visible from the earth; this is called *full moon.*

If at the time of new moon she is near to either of her nodes, she may intercept a part of the sun's light, and thus cause an *eclipse of the sun;* and if she is near either of her nodes at the time of full moon, she may pass into the shadow of the earth, and cause an *eclipse of the moon.* These eclipses are of immense importance in ascertaining the longitudes of places on the earth. They also furnish a convincing proof of the rotundity of the earth, since the shadow of the earth seen upon the moon when eclipsed, is always circular. This is farther confirmed by the appearance of objects at sea; for when a ship is making towards the land, the mariners first descry the tops of steeples, trees, &c. pointing above the water; the lower parts being hid, by reason of the curvature of the earth.

The earth is not a perfect globe or sphere, but is a little flatted at the poles, being nearly of the figure of an oblate spheriod, the equatorial diameter being about 34 miles longer than the polar; but since this difference bears but a small comparison to the whole diameter, we may, for all the practical purposes of navigation, consider the earth as a perfect sphere. The natural divisions of the earth will be given hereafter.



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MARS is the next planet to the earth; his diameter is 4189 miles, his distance from the sun 144 millions of miles, and his periodic revolution is performed in about 687 days. He revolves round his axis in 24 hours 40 minutes, appearing of a dusky reddish hue, and is supposed to be encompassed with a very great atmosphere.

JUPITER is situated still higher in the system. He is the largest of all the planets, and easily distinguished from them by his peculiar magnitude and light. His diameter is 89,170 miles, his distance from the sun 490 millions of miles, and performs his periodic revolution in 4332½ days. Though Jupiter is the largest of all the planets, yet his diurnal revolution is the swiftest, being only 9 hours and 56 minutes.

Jupiter is attended by four satellites, invisible to the naked eye; but through a telescope they make a beautiful appearance. In speaking of them, we distinguish them, according to their places, into the first, the second, and so on; by the first we mean that which is nearest to the planet. The appearance of these satellites is marked in the XIIth. page of the Nautical Almanac, for some particular hour of the night; the times when they are eclipsed by passing into the shadow of Jupiter, are also given in the Nautical Almanac; these eclipses are of considerable use in determining the longitudes of places on the earth.

SATURN was reckoned the most remote planet of our system, before the discovery of the planet Herschel. He shines but with a pale and feeble light. His diameter is 79,042 miles, his distance from the sun 900 millions of miles, and his periodic revolution in his orbit is performed in about 29 years 167 days. This planet is surrounded with a broad flat ring, suspended round the body of the planet, and is quite different from all other planetary phenomena with which we are acquainted. This planet has a diurnal revolution round its axis, and is attended by seven satellites.

HERSCHEL, which is also called GEORGIUM SIDUS, and URANUS, is the most remote planet of our system. It was discovered in the year 1781, by Dr. Herschel; though there are many reasons to suppose it had been seen before, but had been considered as a fixed star. Its diameter is 35,109 miles, its distance from the sun 1800 millions of miles, and its periodic revolution in its orbit is performed in 83½ years. Dr. Herschel has also discovered six satellites attending this planet.

The astronomy of comets is yet in its infancy: the return of one of them in the year 1758, was foretold by Dr. Halley, and it happened nearly as he predicted. He also foretold the return of another in the year 1790, but it never appeared. Probably this mistake of Dr. Halley was owing to the inaccuracy of the observations of the comet at its former appearance; for Mr. Mechain having collected all the observations, and calculated the orbit again, found it to differ essentially from that determined by Dr. Halley.

Comets move round the sun in all directions; but the planets all move from west to east, when seen from the sun; but if viewed from any other of the planets, as the earth, they would appear to revolve round it as a centre; but the sun would be the only one that moved uniformly the same way: for the other planets would sometimes appear to move from west to east, and then to stand still; then they would seem to move from east to west; and after standing some time, they would again move from west to east, and so on continually. The motion of a planet from west to east is called the *direct* motion, or *according to the order of the signs*. The contrary motion, from east to west, is called *retrograde*. When the planet appears to stand still, it is said to be *stationary*.

In noting the situations of the stars and planets, astronomers have been under the necessity of imagining various lines and circles on the sphere; and geographers have done the same for fixing the situation of places on the earth. The most remarkable of these are the following.

1. A *great circle* is that whose plane passes through the centre of the sphere; and a *small circle* is that whose plane does not pass through its centre.

2. A diameter of a sphere, perpendicular to any great circle, is called the *axis* of that circle; and the extremities of the diameter are called its *poles*. Hence the pole of a great circle is 90° from every point of it upon the surface of the sphere; but as the axis is perpendicular to the circle when it is perpendicular to any two radii, a point on the surface of a sphere, 90° distant from any two points of a great circle, will be the pole.

3. All angular distances on the surface of a sphere, to an eye at the centre, are measured by arcs of *great* circles. Hence all triangles formed upon the surface of a sphere, for the solution of spherical problems, must be formed by the arcs of *great* circles.

4. *Secondaries* to a great circle are great circles which pass through its poles; and consequently must be perpendicular to their great circles.

5. The *axis* of the earth is that diameter about which it performs its diurnal motion; and the extremities of this diameter are called the poles.

6. The *terrestrial equator* is a great circle of the earth perpendicular to its axis. Hence the axis and poles of the earth are the axis and poles of its equator. That half of the earth which lies on the side of the equator we inhabit, is called the *northern hemisphere*, and the other the *southern*; and the poles are respectively called the *north* and *south* poles.

7. The *latitude* of a place upon the earth's surface is its angular distance from the equator, measured upon a secondary to it. These secondaries to the equator are called meridians.

8. The *longitude* of a place on the earth's surface is an arc of the equator intercepted between the meridian passing through the place, and another, called the *first meridian*, passing through that place from which you begin to measure. The Americans and English generally place the first meridian at London or Greenwich, the French place it at Paris, the Spaniards at Cadiz; some Geographers place it at Teneriffe, and others at other places. The longitude is counted from the first meridian, both eastward and westward, till it meets at the same meridian on the opposite point; therefore the longitude (and also the difference of longitude between any two places) can never exceed 180°.

9. If the plane of the *terrestrial* equator be produced to the sphere of the fixed stars, it marks out a circle called the *celestial* equator; and if the axis of the earth be produced in like manner, the points of the heavens to which it is produced are called poles, being the *poles* of the celestial equator. The star nearest to each pole is called the *pole* star.

10. Secondaries to the celestial equator are called *circles of declination*; of these, 24 which divide the equator into equal parts, each containing 15°, are called *hour* circles.

11. Small circles parallel to the celestial equator are called *parallels of declination*.

12. The *sensible* horizon is that circle in the heavens whose plane touches the earth at the spectator. The *rational* horizon is a great circle in the heavens, passing through the earth's centre, parallel to the sensible horizon.

13. If the radius of the earth to the place where the ſpectator ſtands be produced both ways to the heavens, the point vertical to him is called the *zenith*, and the point oppoſite, the *nadir*. Hence the *zenith* and *nadir* are the poles of the rational horizon.

14. Secondaries to the horizon are called *vertical* circles, becauſe they are perpendicular to the horizon; on theſe circles, therefore, the altitude of an heavenly body is meaſured.

15. The ſecondary common to the celeſtial equator, and the horizon of any place, is the *celeſtial meridian* of that place. This meridian correſponds with the *terreſtrial meridian* of the ſame place, which paſſes through the poles of the earth, the zenith and nadir croſſing the equator at right angles, and cutting the horizon in the north and ſouth points; that point being called *north* which paſſes through the north pole, and the oppoſite direction is called *ſouth*. Hence the meridian of any place divides the heavens into two hemiſpheres lying to the eaſt and weſt; that lying to the eaſt is called the *eaſtern* hemiſphere, and the other lying to the weſt is called the *weſtern* hemiſphere. When the ſun is upon the meridian of any place, it is noon or mid-day.

16. The vertical circle which cuts the meridian of any place at right angles, is called the *prime* vertical; and the points where it cuts the horizon are called the *eaſt* and *weſt* points. Hence the eaſt and weſt points are 90° diſtant from the north and ſouth. Theſe four are called the *cardinal* points.

17. The *azimuth* of an heavenly body is its diſtance on the horizon, when referred to it by a ſecondary, from the north or ſouth points. The *amplitude* is its diſtance from the eaſt or weſt points, at the time of riſing or ſetting.

18. The *ecliptic* is that great circle in the heavens which the ſun appears to deſcribe in the courſe of a year. The ecliptic and equator, being great circles, muſt biſect each other, and their angle of inclination is called the *obliquity of the ecliptic*; and the points where they interſect are called the *equinoctial points*. The times when the ſun comes to theſe points are called the equinoxes. The ecliptic is divided into 12 equal parts, called *ſigns*; viz. Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, Piſces ♓. The order of theſe is according to the apparent motion of the ſun. The firſt point of Aries coincides with one of the equinoctial points, and the firſt point of Libra with the other. The firſt ſix ſigns are called *northern*, lying on the north ſide of the equator; and the laſt ſix are called *ſouthern*, lying on the ſouth ſide.

19. The *zodiac* is a ſpace extending 8 degrees on each ſide of the ecliptic, within which the motion of all the planets is contained.

20. The *right aſcenſion* of a body is an arc of the equator intercepted between the firſt point of Aries and a declination circle paſſing through the body, meaſured according to the order of the ſigns.

21. The *aſcenſional difference* of any object is the difference between the right aſcenſion of that object and that point of the equator which riſes or ſets with it.

22. The *declination* of a body is its angular diſtance from the equator, meaſured upon a ſecondary to it through the body.

23. The *longitude* of a ſtar is an arc of the ecliptic intercepted between the firſt point of Aries and a ſecondary to the ecliptic paſſing through the body, meaſured according to the order of the ſigns. If the body be in

our syſtem, and ſeen from the earth, it is called the *geocentric* longitude; but if ſeen from the ſun it is called the *heliocentric* longitude; the body in each caſe being referred perpendicularly to the ecliptic in a plane paſſing through the eye.

24. The *latitude* of a ſtar is its angular diſtance from the ecliptic, meaſured upon a ſecondary to it drawn through the body. If the body be in our ſyſtem, its angular diſtance from the ecliptic ſeen from the earth is called the *geocentric* latitude; but if ſeen from the ſun it is called the *heliocentric* latitude. The ſecondary circle drawn perpendicular to the ecliptic is called a *circle of latitude*.

25. The *tropics* are two parallels of declination touching the ecliptic. One, touching it at the beginning of Cancer, is called the *tropic of Cancer;* and the other touching it at the beginning of Capricorn, is called the *tropic of Capricorn*. The two points where the tropics cut the ecliptic are called the *ſolſtitial* points.

26. *Colures* are two ſecondaries to the celeſtial equator, one paſſing through the equinoctial points, called the *equinoctial* colure; and the other paſſing through the ſolſtitial points, called the *ſolſtitial* colure. The times when the ſun comes to the ſolſtitial points are called the ſolſtices.

27. The *artic* and *antarctic* circles are two parallels of declination, the former about the north, and the latter about the ſouth pole, the diſtance of which from the two poles is equal to the diſtance of the tropics from the equator, which is about 23° 28′. Theſe are alſo called polar circles. The two tropics and two polar circles, when referred to the earth, divide it into five parts, called *zones*; the two parts within the polar circles are called the *frigid* zones; the two parts between the polar circles and tropics are called the *temperate* zones; and the part between the tropics is called the *torrid* zone.

Beſides theſe imaginary diviſions of the earth, there are various natural diviſions of its ſurface, formed by nature; ſuch as continents, oceans, iſlands, ſeas, rivers, &c.

A Continent is a great quantity of land, wherein are ſeveral empires, kingdoms, and countries conjoined; as Europe, Aſia, Africa, and America.

An Iſland is a part of the earth that is environed or encompaſſed round by the ſea, as Long Iſland, Block Iſland, &c.

A Peninſula is a part of land almoſt ſurrounded with water, ſave one narrow neck which joins it to the continent.

An Iſthmus is a narrow neck of land joining the peninſula to the adjacent land, by which the people may paſs from one to the other.

A Promontory is a high part of land, ſtretching itſelf into the ſea, the extremity of which is called a Cape or Headland.

A Mountain is a riſing part of dry land over-topping the adjacent country, and appearing firſt at a diſtance.

An Ocean is a vaſt collection of ſalt water, ſeparating continents from one another, and waſhing their borders or ſhores.

A Sea is part of the Ocean, to which we muſt ſail through ſome Strait, as the Mediterranean and Baltic ſeas.

A Strait is a narrow part of the Ocean lying between two ſhores, and opening a way into ſome ſea, as the Straits of Gibraltar that lead into the Mediterranean Sea, and the Sound which leads into the Baltic Sea.

A Creek is a ſmall narrow part of the ſea or river, that goes up but a little way into the land.

A Bay is a great inlet of the land, as the Bay of Bifcay, and the Bay of Mexico ; otherwife a bay is a ftation or road for fhips to anchor in.

A river is a confiderable ftream of water iffuing out of one or various fprings, and continually gliding along in one or more channels, till it difcharges itfelf into the ocean: The leffer ftreams are called rivulets.

A Lake is a large collection of waters in an inland place, as the lakes Superior and Huron in America.

A Gulf is a part of the ocean or fea, contained between two fhores, and is every where environed by land, except its entrance, where it communicates with other bays, feas, or oceans.

There are five Oceans, namely, the Northern, the Atlantic, the Pacific, the Indian, and the Southern.

The Atlantic Ocean is ufually divided into two parts, one called the North Atlantic Ocean, and the other South Atlantic or Ethiopic Ocean.

The Northern Ocean ftretches to the northward of Europe, Afia, and America, towards the north pole.

The Atlantic Ocean lies between the continents of Europe and Africa, on the eaft, and America on the weft. That part of the North Atlantic Ocean lying between Europe and America, is frequently called the Weftern Ocean.

The Pacific Ocean, or, as it is fometimes called, the South Sea, is bounded by the weftern and north-weft fhores of America, and by the eaftern and north-eaft fhores of Afia.

The Indian Ocean wafhes the fhores of the eaftern coafts of Africa, and the fouth of Afia, and is bounded on the eaft by the Indian iflands, New-Holland and New-Zealand.

The fouthern Ocean extends to the fouthward of Africa and America towards the fouth pole.

Thus we have given the moft ufeful definitions of Aftronomy and Geography ; in addition to which, it may be obferved, that as the latitude of any place upon the earth is counted from the equator upon an arch of the meridian north and fouth, the difference of latitude between two places, both north, or both fouth, is found by fubtracting the lefs latitude from the greater ; but if one latitude be north, and the other fouth, the difference is found by adding both latitudes together.

Confequently, if a fhip in north latitude fails northerly, or in fouth latitude foutherly, fhe increafes her latitude ; but in north latitude failing foutherly, or in fouth latitude failing northerly, fhe decreafes her latitude, becaufe fhe fails nearer to the equator, from whence the latitude is reckoned.

Wherefore, in north latitude failing northerly, or in fouth latitude failtude failing foutherly, the difference of latitude added to the latitude left, gives the latitude in.

In north latitude failing foutherly, or in fouth latitude failing northerly, th difference of latitude fubtracted from the latitude left, gives the latitude in.

When the latitude decreafes, and the difference of latitude is greater than the latitude failed from, fubtract the latitude left from the difference, and the remainder will be the latitude in, and of a different name : for it is plain, in this cafe, that the fhip has croffed the equator.

The difference of longitude between two places, being both eaft or weft, is found by fubtracting the lefs longitude from the greater : but if one be in eaſt longitude and the other in weſt, their ſum is the difference of longitude, when it does not exceed 180°; but if it exceeds 180°, that ſum muſt be ſubtracted from 360°, and the remainder will be the difference of longitude.

Therefore, in eaſt longitude ſailing eaſterly, or in weſt longitude ſailing weſterly, the difference of longitude added to the longitude left, gives the longitude in, when that ſum does not exceed 180°; but if it exceeds 180°, the ſum ſubtracted from 360° leaves the longitude in, of a different name from that left.

In eaſt longitude ſailing weſterly, or in weſt longitude ſailing eaſterly, the difference of longitude ſubtracted from the longitude left, gives the longitude in; but when the difference of longitude is greateſt, the longitude left muſt be ſubtracted from that difference, and the remainder will be the longitude in, of a different name from the longitude left.

What has been ſaid will be rendered familiar to the learner by the following examples:

EXAM. I. What is the difference of latitude between Boſton in the latitude of 42° 23′ N. and Richmond (Virginia) in the lat. of 37° 30′ North?

From Boſton's lat.	42°	23′	N.
Subtract Richmond's lat.	37	30	N.
Remains the diff. of lat.	4	53	
	60		
In miles	293		

EXAM. II. A ſhip from latitude 59° 27′ S. ſails ſouthward until her difference of latitude be 374 miles, what latitude is ſhe come to?

Latitude ſailed from	59°	27′	S.
Diff. of lat. 374 ÷ 60 =	6	14	S.
Lat. in	65	41	S.

EXAM. III. Required the difference of latitude between Georgetown and Cape Frio in South America.

Georgetown's lat.	33°	14′	N.
Cape Frio's lat.	22	35	S.
Diff. of latitude	55	49	
	60		
In miles	3349		

EXAM. IV. A ſhip from latitude 28° 25′ N. ſails ſouth 1800 miles, what latitude is ſhe in?

From diff. of lat. 1800 miles, or	30°	00′	S.
Sub. lat. left	28	25	N.
Diff. = lat. in	1	35	S.

In the laſt example it is plain, that as the difference of latitude is more than the latitude left, the ſhip muſt have croſſed the equator, and conſequently come into ſouth latitude.

NOTE. When one of the places has no latitude, or is on the equator, the latitude of the other place is their difference of latitude.

EXAM. V. What is the difference of longitude between Cape Ann light-house and Lisbon?

C. Ann light-house's long.	70°	33′	W.
Lisbon's long.	9	7	W.
Diff. of long.	61	26	
	60		
In miles	3686		

EXAM. VI. A ship from Cape Charles in Virginia sails eastward, till her difference of longitude be 400 miles, what longitude is she in?

Cape Charles' long.	76°	10′	W.
Diff. of long. 400 miles =	6	40	E.
Long. in	69	30	W.

EXAM. VII. What is the difference of longitude between Barcelona and Salem?

Barcelona's long.	2°	18′	E.
Salem's long.	70	50	W.
Diff. of long.	73	8	W.

EXAM. VIII. A ship from 15° 40′ E. long. sails westward till her diff. of long. be 27° 15′, what long. is she in?

Long. left	15°	40′	E.
Diff. of long.	27	15	W.
Long. in	11	35	W.

EXAM. IX. What is the difference of longitude between Manilla and New-York light-house?

Manilla's long.	120°	59′	E.
New-York light-house	74	07	W.
Sum exceeds 180°	195	06	
Subtract it from	360	00	
Diff. of long.	164	54	

EXAM. X. A ship from longitude 160° 20′ W. sails westward until she differs her longitude 41° 20′; what longitude is she in?

Long. left	160°	20′	W.
Diff. of long.	41	20	W.
	201	40	
	360	00	
Long. in	158	20	E.

In the last example the ship has crossed the opposite meridian, and therefore has come into a longitude of a different name.

PLANE SAILING.

PLANE SAILING is the art of navigating a ſhip upon the principles deduced from the ſuppoſition of the earth's being an extended plane, on which the meridians are all parallel to each other, and the length of a degree of latitude and longitude is every where equal. A map of the ſeveral parts of the earth conſtructed upon theſe principles is called a PLANE CHART. When the parts of the earth are thus delineated on a plane, it is eaſy to ſee the track by which a ſhip may go from one place to another; and alſo what angle this track makes with the meridian: Ships at ſea are kept in this track by means of an inſtrument called the mariner's compaſs.

The MARINER'S COMPASS is an artificial repreſentation of the horizon of any place. It conſiſts of a circular piece of paper, called a card, divided (like the horizon) into 360 degrees or 32 points. This is fixed to a piece of ſteel called a needle, to which a magnetic virtue has been communicated by means of a loadſtone, which has the property of pointing ſteadily towards the north, and carrying the card with it, when turning freely on a pivot or any thing to ſupport it. Thus will every point of the card correſpond with the ſame points of the horizon; conſequently by help of the compaſs a ſhip may be kept in any propoſed track or courſe.

A RHUMB LINE is a right line drawn from the centre of the compaſs to the horizon, repreſented by the circumference of the card. It has different names according to the point of the horizon it is drawn to.

The COURSE is the angle which any rhumb line makes with the meridian; ſometimes it is reckoned in points, half points, &c. and ſometimes in degrees. A table of the ſeveral angles which every point, and quarter point, makes with the meridian will be given in the next page.

DISTANCE is the number of miles, leagues, &c. intercepted between two places reckoned on a rhumb; or it is the way or length a ſhip has gone on a direct courſe in a given time. The method of meaſuring this diſtance by the log will be explained hereafter.

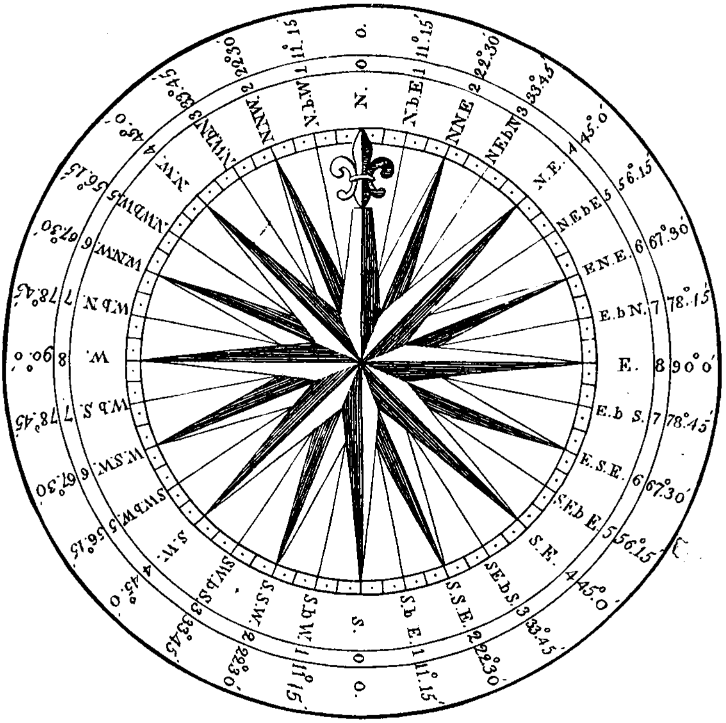
DIFFERENCE OF LATITUDE is the diſtance which the ſhip has made north or ſouth of the place ſailed from; and is generally reckoned in miles and parts of a mile on a meridian.

DEPARTURE is the eaſt or weſt diſtance a ſhip has made from the meridian of the place ſhe departed from, and in the plane chart is the ſame as the difference of longitude.

If a ſhip ſails due north or ſouth, ſhe ſails on a meridian, makes no departure, aud her diſtance and difference of latitude are the ſame. If ſhe ſails due eaſt or weſt, ſhe goes on a parallel of latitude, makes no difference of latitude, and her departure and diſtance are the ſame.

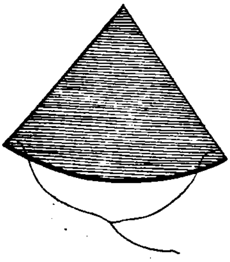
The difference of latitude and departure make the legs of a right-angled triangle, the hypotenuſe of which is the diſtance the ſhip has ſailed; the perpendicular is the difference of latitude counted on the meridian; the baſe is the departure, which is eaſting or weſting counted from the meridian; the angle oppoſite to the baſe is the courſe, or angle, that the ſhip makes with the meridian; and the angle oppoſite the perpendicular is the comple-

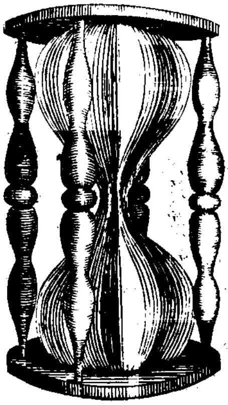
THE MARINERS COMPASS.



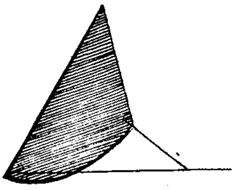
THE MINUTE GLASS.

The Log.





The Log, *in the Act of heaving.*



N.B. There are many kinds of Logs, but the above is the most Common.

Newburyport Published by Edmund M.Blunt.

In the following Table, the rules for solving the various cases of Plane Sailing are collected.

PLANE SAILING.

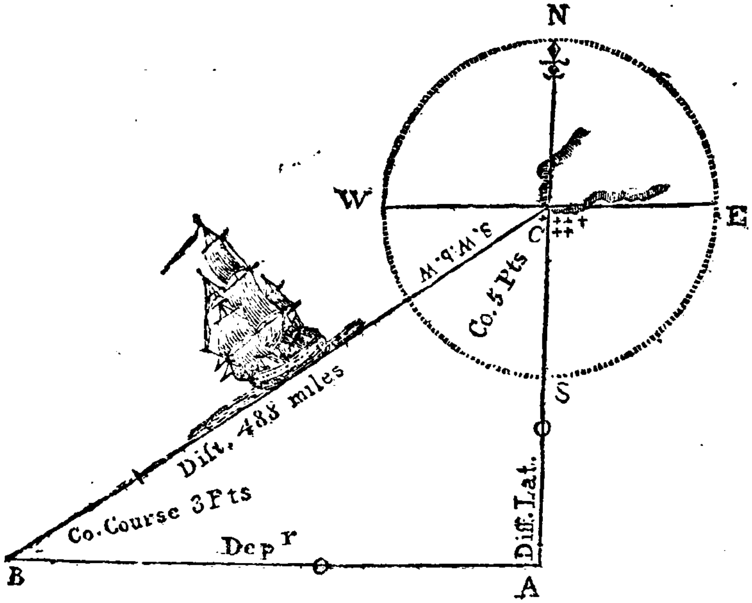
Case.	Given.	Required.	Solutions.
1	Courfe and Diftance.	Diff. Lat. Departure.	Rad. : Dift. : : Cof. Courfe : Diff. Lat. Rad. : Dift. : : Sine Courfe : Departure.
2	Courfe and Diff. of Lat.	Diftance Departure.	Co-fine Courfe : Diff. Lat. : : Rad. : Diftance. Radius : Diff. Lat. : : Tang. Courfe : Departure.
3	Courfe and Departure.	Diftance Diff. Lat.	Sine Courfe : Departure : : Rad. : Diftance. Radius : Departure : : Co-tang. Courfe : Dif. Lat.
4	Diftance and Diff. Lat.	Courfe Departure.	Diftance : Radius : : Diff. Lat. : Cof. Courfe. Radius : Diftance : : Sine Courfe : Departure.
5	Diftance and Departure.	Courfe Diff. Lat.	Diftance : Radius : : Departure : : Sine Courfe. Radius : Diftance : : Cof. Courfe : Diff. Lat.
6	Diff. Lat. & Departure.	Courfe Diftance.	Diff. Lat. : Radius : : Dep. : Tang. Courfe. Sine Courfe : Departure : : Rad. : Diftance. Radius : Diff. Lat. : : Secant Courfe : Diftance.

CASE I.

Courfe and diftance failed given, to find the difference of latitude and departure from the meridian.

A fhip from the latitude 49° 57′ N. fails S. W. by W. 488 miles ; required the latitude fhe is in, and her departure from the meridian fhe failed from.

By PROJECTION.



Draw the line CA to reprefent the meridian of the place C, from whence the fhip failed.

With the chord of 60° in your compaffes, and one foot in C, defcribe the compafs NWSE.

Take 5 points in your compaffes from the line of rhumbs on the plane fcale, and fet it off on the arch from S. towards W. for the courfe; through this point and C draw the line CB, which make equal to the diftance 488: draw BA parallel to the E. and W. points WE to cut the meridian in A.

Then will CA be the difference of latitude 271.1, and AB the departure 405.8.

By LOGARITHMS.

By making the diftance radius,

To find the departure.		To find the diff. of latitude.	
As radius 8 points	10.00000	As radius 8 pts.	10.00000
Is to the diftance 488	2.68842	Is to the diftance 488	2.68842
So is the fine courfe 5 pts.	9.91985	So is co-fine courfe 5 pts.	9.74474
To the departure 405.8	2.60827	To the diff. of lat. 271.1	2.43316

Now as the fhip is in north latitude failing foutherly; from the latitude left — — 49° 57′ N.

Take the difference of latitude 271.1 = 4 31 S.

Gives the latitude in 45 26 N.

And the departure from the meridian is 405.8 miles.

Though this method of working by logarithms is certain, yet the fame may be wrought by Gunter's fcale and compaffes, much more expeditioufly, and exact enough in the practice of navigation.

By GUNTER.

Extend from radius or 8 points* to 5 points on the line marked S R; that extent will reach from the diftance 488 to the departure 405.8 on the line of numbers.

2dly. Extend from radius or 8 points to 3 points, the complement of the courfe, on the line S R; that extent will reach from the diftance 488 to the difference of latitude 271 on the line of numbers.

Thus may all the operations be performed in the feveral cafes of Navigation.

By this cafe are calculated the tables of latitude and departure (TABLES I. and II.) for every degree, point and quarter-point of the mariner's compafs, to the diftance of 300 miles, which are of excellent ufe in working day's works at fea, and may be applied both to Middle Latitude and Mercator's Sailing, as fhall be fhewn hereafter: the prefent cafe is worked by thefe tables in the following manner.

By INSPECTION.

Find the given courfe at the top or bottom of the tables, either among the points or degrees, and in that page, and right againft the diftance taken in its column, ftand the difference of latitude and departure in their columns.†

* When the courfe is given in points, make ufe of the lines marked fine rhumbs, and tangent rhumbs, on the upper fide of the fcale; when in degrees, make ufe of the lines marked fine and tangent.

† When the diftance is too great to be found in the tables, you muft divide it by 2, 3, 4, or any convenient number, the numbers correfponding to the quotient being multiplied by the divifor will give the fought numbers.

It muſt be obſerved, that in uſing theſe tables, the names Diſt. Lat. Dep. muſt be found at the top if the courſe is found there, but if the courſe is found at the bottom, thoſe names muſt be found at the bottom.

Thus, the courſe S. W. by W. or 5 points, is found at the bottom of the table of difference of latitude and departure for points: and as the diſtance 488 is too great to be found in the tables, divide it by 2 (or any other convenient number) and that gives 244, which look for in the diſtance column, and right againſt it ſtand 135.5 for the difference of latitude, and 202.9 for the departure, which being doubled (becauſe divided by 2) give 271 for the difference of latitude, and 405.8 for the departure, the ſame as before.

Any of theſe methods will do, but the laſt is chiefly practiſed at ſea.

CASE II.

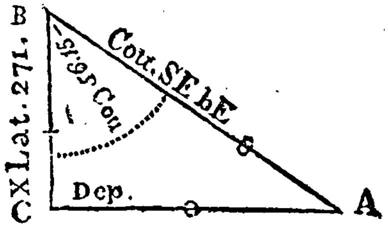
Courſe and difference of latitude given, to find the diſtance run, and departure from the meridian.

If a ſhip runs S. E. b. E. from 1° 45′ north latitude, and then by obſervation is in 2° 46′ ſouth latitude, what is her diſtance and departure?

In this caſe, as the ſhip has croſſed the equator, the ſum of the two latitudes 1° 45′ and 2° 46′ is the difference of latitude 4° 31′=271 miles.

By PROJECTION.

Draw BC=271, and BA making an angle with BC=the courſe 5 points, or 56° 15′; upon C erect the perpendicular CA cutting BA in A, and it is done; for CA will be the departure=406, and AB the diſtance=488.



By LOGARITHMS.

By making diff. of lat. BC radius. To find the departure.		By making the Dep. AB radius. To find the diſtance.	
As radius 4 points	10.00000	As co-ſine courſe 5 points	9.74474
Is to diff. of lat. 271	2.43297	Is to the diff. of lat. 271	2.43297
So is tang. courſe 5 pts.	10.17511	So is radius	10.00000
To the departure 405.6	2.60808	To the diſtance 487.8	2.68823

Hence the ſhip's diſtance run is 487.8 miles, and her departure from the meridian is 405.6 eaſterly.

By GUNTER.

Extend from radius or 4 points to the courſe 5 points on the line marked TR; that extent will reach from the difference of latitude 271 to the departure 405.6 on the line of numbers.

2dly. Extend from the complement of the courſe 3 points to the radius 8 points on the line SR, that extent will reach from the difference of latitude 271 to thediſtance 488 on the line of numbers.

By INSPECTION.

Find the courſe among the points or degrees, and the difference of latitude in its column, right againſt which ſtand the diſtance and departure in their columns.

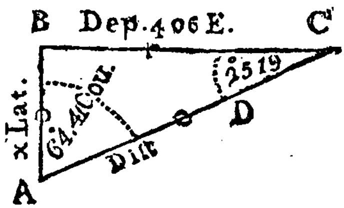
Now, as the difference of latitude 271 is too great to be found in the tables, I divide it by 2, and that gives 135.5 which I find over 5 points in the latitude column; against that stand 244, for the distance, and 202.9 for the departure, which multiplied by 2 give the distance 488, and the departure 405.8.

CASE III.

Course and departure from the meridian given, to find the distance and difference of latitude.

If a ship sails N. E. b. E. ¼ E. from a port in 3° 15′ south latitude, until she depart from her first meridian 406 miles, I demand her distance, and what latitude she is in?

By PROJECTION.



Draw the meridian AB, upon which erect the perpendicular BC, and set off thereon from B her departure 406 easterly from B to C; with the chord of 60°, on C describe an arch, and set off thereon the complement of the course, as DE; through D and C draw the line CDA, cutting the meridian in the point A; then AC measured on the same scale before used, gives the distance 449; and AB 192, the difference of latitude.

By LOGARITHMS.

By making the departure BC radius.		By making the distance AC radius.	
As radius 4 points	10.00000	As sine course 5¼ pts.	9.95616
Is to the departure 406	2.60853	Is to departure 406	2.60853
So is co-tang. course 5¼ pts.	9.67483	So is radius	10.00000
To the diff. of lat. 192	2.28336	To the distance 449.1	2.65237

From the latitude left	3° 15′ S.
Subtract the difference of latitude 192 miles, or	3 12 N.
The remainder being 3, shews the ship is in the latitude of	0 03 S.

By GUNTER.

Extend from radius or 4 points to the co-course 2¾ points on the line marked T R; that extent will reach from the departure 406 to the difference of latitude 192 on the line of numbers.

2dly. Extend from the course 5¼ points to radius on the sines, that extent will reach from the departure 406 to the distance 449 miles on the line of numbers.

By INSPECTION.

Find the course either among the points or degrees, and the departure in its column, right against which stand the distance and difference of latitude in their respective columns.

Thus, with the course $5\frac{1}{4}$ points, and half the departure 203,* I find 224.5 for the distance, and 96.0 for the difference of latitude, which being doubled, give the distance 449, and the difference of latitude 192.0, as before.

CASE IV.

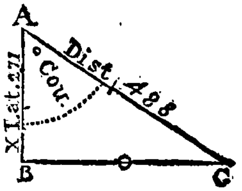
Distance and difference of latitude given, to find the course and departure.

Suppose a ship sails 488 miles, between the south and the east, from a port in 2° 52′ south latitude, and then by observation is in 7° 23′ south latitude; what course has she steered, and what departure has she made?

From the latitude by observation 7° 23′ take 2° 52′ the latitude left, the remainder 4° 31′=271 miles is the difference of latitude.

By PROJECTION.

Draw the meridian AB=271; upon B erect the perpendicular BC; take 488 in your compasses, and with one foot on A, lay the other on the line BC; join A and C; then will BC be the departure 406, and the angle BAC the course=56° 16′ or five points nearly.



By LOGARITHMS.

To find the course.		To find the departure.	
As the distance 488	2.68842	As radius	10.00000
Is to radius	10.00000	Is to the distance 488	2.68842
So is the diff. of lat. 271	2.43297	So is sine course 56° 16′	9.91993
To co-sine course 56° 16′	9.74455	To the departure 405.8	2.60835

Hence the course is S. E. b. E. and the departure 405.8.

By GUNTER.

The extent, from the distance 488, to the difference of latitude 271, on the line of numbers, will reach from radius, or 90° to 33° 44′ the co-course on the line of sines.

And the extent, from radius to 56° 16′ on the line of sines, will reach from the distance 488 to the departure 405,8 on the line of numbers.

By INSPECTION.

Seek in the tables till against the distance, taken in its column, be found the given difference of latitude in one of the following columns; and adjoining to it stands the departure; which, if less than the difference of latitude, the course is found at the top;† but if greater, the course is found at the bottom.

Now with half the distance 244, and half the difference of latitude 135,5, look in the tables till they are found to agree in their respective columns, which they do over 5 points; against them stand 202,9 for the departure, which being doubled, give 405,8, as before.

* The nearest numbers in the table are 202.5 and 203.4, and as the number 203 is nearly a mean of these two values, I take the mean 224.5 of the corresponding distances 224, 225, and the mean 96 of the corresponding departures 95.8 and 96.2; these doubled give the true distance 449, and departure 192.

† It may also be known whether the course be marked at the top or bottom of the table, by observing whether the difference of latitude or departure corresponds with the marks at the top or bottom. Thus the half distance 244, and half diff. of lat. 135,5 correspond to the course 5 points, because the column in which 135,5 is found, is marked lat. at the bottom; the same may be observed in the following cases.

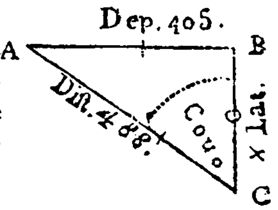
CASE V.

Distance and Departure given, to find the Course and difference of Latitude.

Admit a ship sails 488 miles between the north and west from the lat. of 32° 25′ north, until her departure is 405 miles; what course has she steered, and what latitude is she in?

By PROJECTION.

Draw the line AB equal to the departure 405, and perpendicular thereto the line BC to represent the meridian, then take the distance 488 in your compasses, and fixing one foot in A lay the other on the line BC, join AC and it is done; for the angle ACB will be the course, and BC the difference of latitude.



By LOGARITHMS.

To find the Course.		To find the diff. of Lat.	
As the distance 488	2.68842	As radius	10.00000
Is to radius	10.00000	Is to the distance 488	2.68842
So is the departure 405	2.60746	So is co-sine course 56° 6′	9.74644
To the sine of cou. 56° 6′	9.91904	To the diff. of lat. 272,2	2.43486

Hence the Course is N. 56° 6′ W. or N. W. by W. nearly.

To the latitude sailed from 32° 25′ add the difference of latitude 272, or 4° 32′, the sum 36° 57′ is the latitude the ship is in.

By GUNTER.

Extend from the distance 488 to the departure 405 on the line of numbers, that extent will reach from radius to the course 56° 6′ on the line of sines.

2dly. Extend from radius to the complement of the course 33° 54′ on the line of sines, that extent will reach from the distance 488 to the diff. of lat. 272 on the line of numbers.

By INSPECTION.

Seek in the tables till against the distance, taken in its column, be found the given departure in one of the following columns; and adjoining to it stands the difference of latitude; which, if greater than the departure, the course is found at the top; but if less, the course is found at the bottom.

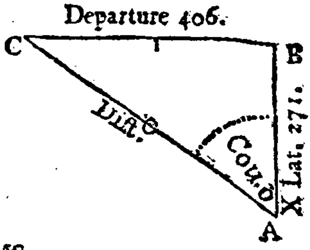
Now, with half the distance 244, and half the departure 202,5, I look in the tables; and find them to agree in their columns, nearly over 5 points, against which is latitude 135,5, which being doubled, is 271, the difference of latitude nearly, as before.

CASE VI.

Difference of Latitude and Departure given, to find the Course and Distance.

A ship sails between the north and west till her difference of latitude is 271 miles, and her departure is 406 miles; I demand her course and distance?

By PROJECTION.



Draw AB=271, and perpendicular to it BC=406; join C and A; then will the angle CAB be the course=56° 17′, and AC the distance=488 miles.

By LOGARITHMS.

To find the course.		To find the distance.	
As the diff. of lat. 271	2.43297	As radius	10.00000
Is to radius	10.00000	Is to the diff. of lat. 271	2.43297
So is departure 406	2.60853	So is sec. of course 56° 17′	10.25564
To tang. of course 56° 17′	10.17556	To the distance 488.2	2.68861

Hence her course is N. 56° 17′ W. or N. W. b. W. and the distance sailed is 488.2 miles.

By GUNTER.

Extend from the difference of latitude 271 to the departure 406 on the line of numbers, that extent will reach from radius to 56° 17′ the course on the line of tangents.

2dly. For the distance we must consider it as radius, (unless there is a line of secants on the scale) and extend from the course 56° 17′ to the radius or 90° on the line of sines, that extent will reach from the departure 406, to the distance 488 on the line of numbers.

By INSPECTION.

Seek in the tables till the given difference of latitude and departure are found together in their respective columns, then right against them will be the distance in its column, and the course will be found at the top of that table if the departure be less than the difference of latitude, otherwise at the bottom.

Thus with half the difference of latitude 135.5, and half the departure 203, enter the tables and these numbers will be found to correspond nearly to a 5 point course, and a distance equal to 244 miles, which being doubled gives the sought distance, 488.

The six foregoing Problems are common cases of Plane Sailing, which the learner ought to be well acquainted with; and for that end I here add ten more for practice, whose answers may be found by the foregoing rules.

Question I. A ship in 2° 10′ south latitude, sails N. by E. 89 leagues; what latitude is she in, and what is her departure?

Answer. Latitude in 2° 12′ N. and departure 17,36 leagues.

Question II. A ship sails S. S. W. from a port in 41° 30′ north latitude, and then by observation is in 36° 57′ north latitude, I demand the distance run and departure?

Answer. Distance run 98,5 leagues, departure 37,7 leagues.

Question III. A ship sails S. S. W. half W. from a port in 2° 30′ south latitude, until her departure be 59 leagues; I demand her distance run and latitude in?

Answer. Distance run 125,2 leagues, latitude in 8° 1′ south.

Question IV. If a ship sails 360 miles south westward from 21° 59′ south latitude, until by observation she be in 24° 49′ south latitude, what is her course and departure?

Answer. The course is S. W. by W. half W. or S. 61° 49′ W. and her departure from the meridian is 317,3 miles.

Question V. Suppose a ship sails 354 miles north eastward from 2° 9′ south latitude, until her departure be 150 miles; what is her course and latitude in?

Answer. Her course is N. 25° 4′ E. or N. N. E. $\frac{1}{4}$ E. nearly, and she is in latitude 3° 12′ north.

Question VI. Sailing between the north and the west, from a port in 1° 59′ south latitude, and then arriving at another port in 4° 8′ north latitude, which is 209 miles to the westward of the first port; I demand the course and distance from the first port to the second?

Answer. The course is N. 29° 40′ W. or N. N. W. $\frac{1}{4}$ W. nearly, and the distance of the ports is 422,4 miles, or 140,8 leagues.

Question VII. Four days ago we were in lat. 3° 25′ S. and have since that time sailed in a direct course N. W. by N. at the rate of 8 miles an hour; required our present latitude and departure?

Answer. Latitude in 7° 14′ N. Departure 426.7 miles.

Question VIII. A ship in the latitude 3° 52′ S. is bound to a port bearing N. W. by W. $\frac{1}{2}$ W. in the latitude of 4° 30′ N. how far does that port lay to the westward; and what is the ship's distance from it?

Answer. The port lies 939.2 miles to the westward, and the direct distance 1065 miles.

Question IX. A ship from the latitude of 48° 17′ N. sails S. W. by S. until she has depressed the north pole two degrees; what direct distance has she sailed, and how many miles has she got to the westward?

Answer. Distance run 144,3 miles, and has got to the westward 80,2 miles.

Question X. Two ports lie under the same meridian, one in the latitude of 52° 30′ N. and the other in the latitude 47° 10′ N. A ship from the southernmost sails due east 9 knots an hour, and two days after meets a sloop that had sailed from the northernmost port: required the sloop's direct course and distance run?

Answer. The sloop sailed S. 53° 28′ E. and distance run 537,6 miles.

TRAVERSE SAILING.

A TRAVERSE is an irregular track which a ſhip makes by ſailing on ſeveral different courſes; theſe are reduced to a ſingle courſe by means of two or more caſes of plane ſailing, either by geometrical conſtruction, or by arithmetical calculation.

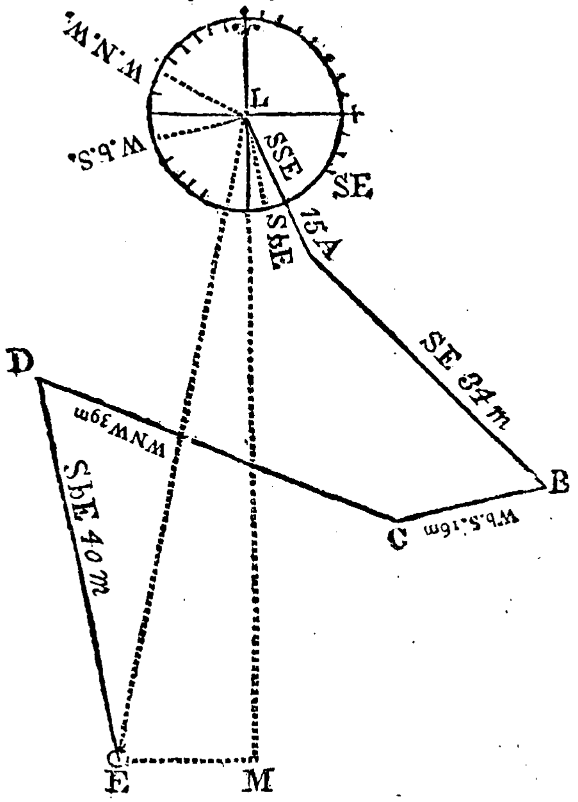
The geometrical conſtruction is performed as follows: Deſcribe a circle with the chord of 60°, to repreſent the compaſs, and lay off on its circumference the various courſes ſailed. From the centre, upon the firſt courſe ſet off the firſt diſtance, and mark its extremity; through this extremity, and parallel to the ſecond courſe, draw the ſecond diſtance of its proper length; through the extremity of the ſecond diſtance, and parallel to the third courſe, draw the third diſtance of its proper length; and thus proceed till all the diſtances are drawn. A line drawn from the extremity of the laſt diſtance, to the centre of the circle, will repreſent the diſtance made good; a line drawn from the ſame point, perpendicular to the meridian, will repreſent the departure; and the part of the meridian intercepted between this and the centre, will repreſent the difference of latitude.

The arithmetical calculation to work a traverſe is as follows: Make a traverſe table conſiſting of ſix columns; title them, Courſe, Diſt. N. S. E. W.; begin at the left ſide, and write the given courſes and diſtances in their reſpective columns. Find the difference of latitude and departure for each of theſe courſes, by Table I. or II. (as in Caſe I. Plane Sailing) and write them in their proper columns; that is, when the courſe is ſoutherly, the difference of latitude muſt be ſet in the column S.; but if northerly, in the column N.; when weſterly in the column W.; and when eaſterly in the column E. Add up the columns of northing, ſouthing, eaſting and weſting; take the difference between the northing and ſouthing, and the eaſting and weſting; the former difference will be the difference of latitude, of the ſame name as the greater; and the latter will be the departure, which is alſo of the ſame name as the greater. With this difference of latitude and departure, the courſe and diſtance made good are found as in Caſe VI. Plane Sailing.

EXAMPLE I.

Suppoſe a ſhip takes her departure from Block Iſland in the latitude of 41° 10′ N. the middle of it bearing N. N. W. diſtance by eſtimation 5 leagues, and ſails S. E. 34, W. by S. 16, W. N. W. 39, and S. by E. 40 miles; required the latitude ſhe is in, and her bearing and diſtance from Block Iſland?

By PROJECTION.



Let L represent the middle of Block-Island; draw the meridian LM, and on L as a centre, with the chord of 60°, sweep a circle to represent the compass, on which mark the various courses sailed, and the bearing of the land at the time of taking the departure; opposite to this bearing draw the S. S. E. line LA, which make equal to 15 miles, the estimated distance of the land; then will A represent the place of the ship at the time of taking the departure: through A draw AB = 34 miles parallel to the S. E. line; then will B be the place of the ship after sailing her first course: in like manner, draw BC=16 miles parallel to the W. by S. line; CD=39 miles parallel to the W. N. W. line, and DE=40 miles parallel to the S. by E. line; then will E represent the place of the ship after sailing her several courses. Join EL, and draw EM perpendicular to LM; then will LE be the distance of Block-Island 66.8 miles, and the angle ELM= 12° 16′ will be the course made good, LM the difference of latitude, and EM the departure.

To find the same by LOGARITHMS.

For the first course, S. S. E. 15 miles.

To find the diff. of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to distance 15	1.17609	Is to distance 15	1.17609
So is co-sine course 2 pts.	9.96562	So is sine course 2 pts.	9.58284
To diff. lat. 13.9	1.14171	To departure 5.7	0.75893

Second Course S. E. 34 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 45°	9.84949	Is to sine course 45°	9.84949
So is distance 34	1.53148	So is distance 34	1.53148
To diff. latitude 24	1.38097	To departure 24	1.38097

Third course W. by S. 16 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 78° 45′	9.29024	Is to sine course 78° 45′	9.99157
So is distance 16	1.20412	So is distance 16	1.20412
To diff. latitude 3.1	0.49436	To departure 15.7	1.19569

Fourth course W. N. W. 39 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 67° 30′	9.58284	Is to sine course 67° 30′	9.96562
So is distance 39	1.59106	So is distance 39	1.59106
To diff. lat. 14.9	1.17390	To departure 36	1.55668

Fifth course S. by E. 40 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 11° 15′	9.99157	Is to sine course 11° 15′	9.29024
So is distance 40	1.60206	So is distance 40	1.60206
To diff. lat. 39.2	1.59363	To departure 7.8	0.89230

Though this method of finding the difference of latitude and departure by logarithms is certain, yet the same may be more readily found by the tables of difference of latitude and departure, as in Case I. Plane Sailing.

TRAVERSE TABLE.

Place all these courses, distances, &c. in the traverse table, then add up all the westings, eastings, northings, and southings, separately, and set down their respective sums at the bottom of each column; and as the westing is greater than the easting, subtract the easting therefrom; the difference 14,2 shews that the ship's departure is so much west of her first meridian.

Courses.	Dist.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. S. E.	15		13.9	5.7	
S. E.	34		24.0	24.0	
W. by S.	16		3.1		15.7
W. N. W.	39	14.9			36.0
S. by E.	40		39.2	7.8	
From sum	—	14.9	80.2	37.5	51.7
Take	—	—	14.9		37.5
Rests	—	—	65.3		14.2

Again, the fouthing being greater than the northing, fubtract the northing from it, and the remainder fhews how far the fhip is to the fouthward of her firft place.

To find the direct Courfe or Bearing of Block Ifland from the fhip.

As the diff. lat. 65,3	1.81491
Is to radius 45°	10.00000
So is the departure 14,2	1.15229
To tang. cou. 12° 16′	9.33738

Which, becaufe the difference of latitude is foutherly, and the departure wefterly, is S. 12° 16′ W. Whence Block Ifland bears from the fhip N. 12° 16′ E. or N. by E. 1° 1′ E.

To find the diftance of the Ifland.

As fine of cou. 12° 16′	9.32728
Is to the depart. 14,2	1.15229
So is radius 90°	10.00000
To the diftance 66,8	1.82501

By INSPECTION.

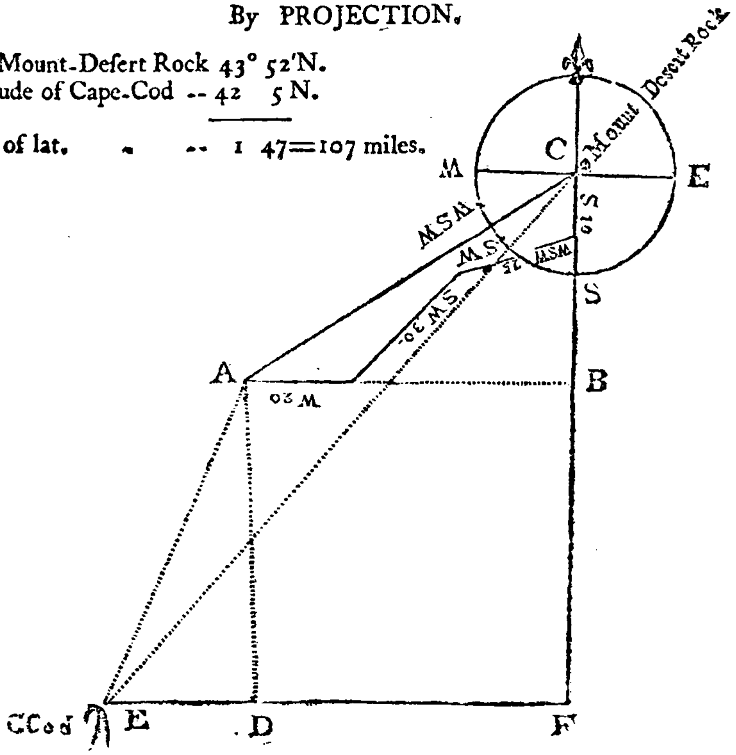
Find the courfe and diftance by Cafe 6th of Plane Sailing.

EXAMPLE II.

A fhip from Mount-Defert Rock in the latitude of 43° 52′ N. fails for Cape-Cod in the latitude of 42° 5′ N. whofe departure from the meridian of Mount-Defert Rock is 94 miles weft; but by reafon of contrary winds fhe is obliged to fail on the following courfes, viz. South 10 miles, W.S.W 25 miles, S.W. 30 miles, and Weft 20 miles. Required the bearing and diftance of the two places, the courfe and diftance failed by the fhip, and the bearing and diftance of her intended port?

By PROJECTION.

Lat. Mount-Defert Rock	43° 52′N.
Latitude of Cape-Cod	42 5 N.
Diff. of lat.	1 47=107 miles.



Let C represent Mount-Desert Rock, draw the meridian CF, which make equal to 107 miles the difference of latitude between the two places; and perpendicular thereto the line FE equal to the departure 94 miles, then is E the place of Cape-Cod. With the chord of 60°, sweep about the centre C, a circle ESW to represent the compass, and upon it note the various courses sailed. The first course being South, the distance 10 miles is set off from C towards F upon the meridian, and this point represents the place of the ship after sailing her first course; continue setting off the various courses and distances as in the last example, viz. W.S.W. 25 miles, S.W. 30 miles, and West 20 miles to the point A; then will A represent the place of the ship after sailing these courses. Join CE, AC, AE; draw AB perpendicular to the meridian CF, and AD parallel thereto; then will AC=76,2 miles be the distance made good, AE=72,6 miles the distance of Cape-Cod from the ship; CE the distance of the two places=142,4 miles; ACB=57° 36′, the course made good; EAD=24° 10′ the course to Cape-Cod, and ECF the course from Mount-Desert Rock to Cape-Cod =41° 18′, &c.

By LOGARITHMS.

To find the bearing and distance of the two places by Case VI. Plane Sailing.

To find the bearing.		To find the distance.	
As diff. lat. 107	2.02938	As radius 90°	10.00000
Is to radius 45°	10.00000	Is to diff. of lat. 107	2.02938
So is departure 94	1.97313	So is sec. course 41° 18′	10.12421
To tang. course 41° 18′	9.94375	To the distance 142,4	2.15359

Whence the course from Mount-Desert Rock to Cape-Cod is S. 41° 18′ W. distance 142 miles. The same may be found by the scale, or by inspection.

The difference of latitude and departure for the several courses being calculated, by Case I. Plane Sailing, and arranged in the traverse table, it appears that the difference of latitude made good by the ship is 40,8 miles, and the departure 64,3 miles; now by Case VI. Plane Sailing, these numbers are found to correspond to a course of S. 57° 36′ W. and distance 76,2 miles.

TRAVERSE TABLE.

Courses.	Dist.	Diff. Lat. N.	Diff. Lat. S.	Depart. E.	Depart. W.
South.	10		10.0		
W. S. W.	25		9.6		23.1
S. W.	30		21.2		21.2
W.	20				20.0
	Diff. Lat.		40.8	Dep.	64.3

Subtract the difference of latitude made good by the ship, 40,8 miles, from the whole difference of latitude, 107 miles, and there remain 66,2 miles, which is the difference of latitude between the ship and Cape-Cod. In the same manner by subtracting the ship's departure, 64,3 miles, from the whole departure, 94 miles, there remain 29,7 miles for the departure between the ship and Cape-Cod. With this difference of latitude, 66,2, and departure, 29,7, the bearing of Cape-Cod is found, by Case VI. Plane Sailing, S. 24° 10′ W. and its distance 72,6 miles.

All the preceding calculations may be made by logarithms, by the ſcale, or by inſpection; but we ſhall leave them to exerciſe the learner; and for the ſame purpoſe ſhall add the following example.

Example III.

A ſhip in the latitude of 37° 10′ N. is bound to a port in the latitude of 33° 0′ N. which lies 180 miles weſt of the meridian of the ſhip; but by reaſon of contrary winds ſhe ſails the following courſes, viz. S. W. by W. 27 miles—W. S. W. ½ W. 30 miles—W. by S. 25 miles—W. by N. 18 miles—S. S. E. 32 miles—S.S.E. ¾ E. 27 miles—S. by E. 25 miles—South 31 miles, and S.S.E. 39 miles. Required the latitude the ſhip is in, and her departure from the meridian, with the courſe and diſtance to her intended port?

The difference of latitude and departure made on each courſe, are given in the adjoined traverſe table: hence it appears that the difference of latitude made good is 169.4 miles, the departure 47.4 miles, and by Caſe VI. Plane Sailing, the courſe S. 15° 38′ W. and diſtance 175.9 miles; and the courſe to the intended port S. 58° 42′ W. diſtance 155.2 miles; the latitude in being 34° 21′ N.

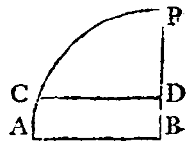
TRAVERSE TABLE.

Courſes.	Diſt.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. W. by W.	27		15.0		22.4
W.S.W. ½ W	30		8.7		28.7
W. by S.	25		4.9		24.5
W. by N.	18	3.5			17.7
S. S. E.*	32		29.6	12.2	
S. S. E. ¾ E.	27		23.2	13.9	
S. by E.	25		24.5	4.9	
South.	31		31.0		
S. S. E.*	39		36.0	14.9	
		3.5	172.9	45.9	93.3
			3.5		45.9
	Diff. Lat.		169.4	Dep.	47.4

* Inſtead of putting the courſe S. S. E. 32 miles, and S. S. E. 39 miles, you might make one entry only, calling it S. S. E. 71 miles.

PARALLEL SAILING.

IN Plane Sailing the earth is considered as an extended plane, in which the degrees of latitude are equal; but this supposition is very erroneous, because the earth is nearly of a spherical figure, in which the meridians all meet at the poles, and of course the length of a degree of longitude decreases in receding from the equator. To illustrate this, let PB represent the semi-axis of the earth, B the centre, P the pole, PCA a quadrant of the meridian, AB the radius of the equator, and CD (parallel thereto) the radius of a parallel of latitude. Then it is evident that CD will be the co-sine of AC, or the co-sine of the latitude of the point C, to the radius AB: now if the quadrantal arch PCA be supposed to revolve round the axis PB, the point A will describe the circumference of the equator, and C the circumference of a parallel of latitude; and the former circumference will be to the latter as AB to CD (as may easily be deduced from Art. 57, Geometry); that is, as radius to the co-sine of the latitude of the point C: and since both these circumferences are supposed to be divided into 360°, it follows that the length of a degree of the equator is to the length of a degree of any parallel, as radius is to the co-sine of the latitude of that parallel. Hence we obtain the following theorems.



THEOREM I.

The circumference of the equator is to the circumference of any other parallel of latitude, as radius is to the co-sine of that latitude.

THEOREM II.

As the length of a degree of the equator is to the length of a degree on any other parallel of latitude, so is radius to the co-sine of that parallel of latitude.

THEOREM III.

As radius is to the co-sine of any latitude, so are the miles of difference of longitude between two meridians (or their distance in miles upon the equator) to the distance of these two meridians on that parallel of latitude in miles.

THEOREM IV.

As the co-sine of any latitude is to radius, so is the length of any arch on that parallel of latitude (intercepted between two meridians) in miles, to the length of a similar arch on the equator, or miles of difference of longitude.

THEOREM V.

As the co-sine of any latitude is to the co-sine of any other latitude, so is the length of any arch on the first parallel of latitude in miles, to the length of the same arch on the other in miles.

By means of Theorem II. the following table was calculated, which ſhews the breadth of a degree of longitude in every latitude: and may be made to anſwer for any degrees or minutes by taking proportional parts.

The following Table ſhews how many Miles anſwer to a Degree of Longitude at every Degree of Latitude.

D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES.
1	59 . 99	19	56 . 73	37	47 . 92	55	34 . 41	73	17 . 54
2	59 . 96	20	56 . 38	38	47 . 28	56	33 . 55	74	16 . 54
3	59 . 92	21	56 . 01	39	46 . 63	57	32 . 68	75	15 . 53
4	59 . 85	22	55 . 63	40	45 . 96	58	31 . 80	76	14 . 52
5	59 . 77	23	55 . 23	41	45 . 28	59	30 . 90	77	13 . 50
6	59 . 67	24	54 . 81	42	44 . 59	60	30 . 00	78	12 . 47
7	59 . 55	25	54 . 38	43	43 . 88	61	29 . 09	79	11 . 45
8	59 . 42	26	53 . 93	44	43 . 16	62	28 . 17	80	10 . 42
9	59 . 26	27	53 . 46	45	42 . 43	63	27 . 24	81	9 . 39
10	59 . 09	28	52 . 98	46	41 . 68	64	26 . 30	82	8 . 35
11	58 . 90	29	52 . 48	47	40 . 92	65	25 . 36	83	7 . 31
12	58 . 69	30	51 . 96	48	40 . 15	66	24 . 40	84	6 . 27
13	58 . 46	31	51 . 43	49	39 . 36	67	23 . 44	85	5 . 23
14	58 . 22	32	50 . 88	50	38 . 57	68	22 . 48	86	4 . 19
15	57 . 96	33	50 . 32	51	37 . 76	69	21 . 50	87	3 . 14
16	57 . 68	34	49 . 74	52	36 . 94	70	20 . 52	88	2 . 09
17	57 . 38	35	49 . 15	53	36 . 11	71	19 . 53	89	1 . 05
18	57 . 06	36	48 . 54	54	35 . 27	72	18 . 54	90	0 . 00

From what has been ſaid, ariſes the ſolution of the following caſes of parallel ſailing.

CASE I.

The difference of longitude between two places in the ſame parallel of latitude being given, to find the diſtance between them.

Suppoſe a ſhip in the latitude of 49° 30′ north or ſouth, ſails directly eaſt or weſt until her difference of longitude be 3° 30′, required the diſtance ſailed?

By PROJECTION.

Fig. 1.

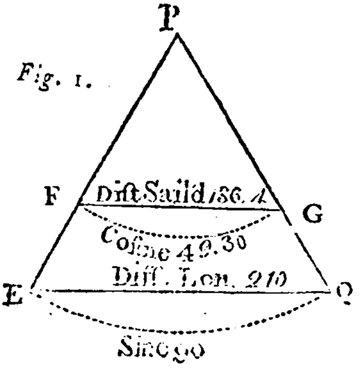
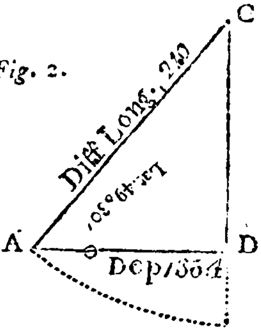


Fig. 2.



Take the fine of 90° from the plane fcale, and with one foot of the compaffes in P (Fig. 1) defcribe the arch EQ; with the difference of longitude 210 miles in the compaffes, and one foot in E, fweep an arch cutting EQ in Q; join PE, PQ which reprefent two meridians, P being the pole and EQ the equator. Take the fine of the complement of the latitude 40° 30′ in your compaffes, and with one foot in P, defcribe the arch FG, cutting PE, PQ in F, G; the length of the chord FG being meafured on the fcale of equal parts will be the departure 136.4 miles.

Or this projection may be made in the following manner. Draw AD (Fig. 2.) of an indefinite length, make the angle DAC equal to the latitude 49° 30′, and AC equal to the difference of longitude 210 miles; draw CD perpendicular to AD; then will the line AD be the diftance or departure required.

By LOGARITHMS.

To find the departure or diftance.

As Radius 90°	10.00000
Is to the difference of longitude 210	2.32222
So is Co-fine latitude 49° 30′	9.81254
To the diftance or departure 136,4	2.13476

By GUNTER.

The extent from radius to the complement of the latitude 40° 30′ on the line of fines, will reach from the difference of longitude 210 to the diftance 136,4 on the line of numbers.

By INSPECTION.

Find the latitude among the degrees in table II. and in the diftance column the difference of longitude, oppofite to which in the column of latitude, is the diftance required.

In the prefent example the latitude is 49° 30′; and as the table is only calculated to fingle degrees, I find the numbers in the tables of 49° and 50°, and take the mean of them; the former is 137,8, the latter 135,0, the mean of which is the fought diftance or departure 136,4.

CASE II.

The diftance between two places on the fame parallel of latitude given, to find their difference of longitude.

Suppofe a fhip in the latitude of 49° 30′ N. or S. and long. 36° 40′ W. fails directly weft 136,4 miles; required the difference of longitude and longitude in?

By PROJECTION.

With the fine of the complement of the latitude 40° 30′ in your compaffes, and one foot in P (Fig. 1ft. of the preceding cafe) defcribe the arch FG, upon which fet off the departure 136,4 miles upon the chord FG, and through the points F and G draw the lines PE and PQ; then with the fine of 90° in the compaffes and one foot in the centre P, defcribe an arch to cut PE, PQ, in E and Q; then the chord EQ being meafured upon the fame fcale of equal parts that the departure was, will be the difference of longitude 210 miles.

Or thus, draw the line AD (Fig. 2d.) which make equal to the given distance 136,4. at D erect DC perpendicular to DA, make the angle DAC equal to the latitude ; then will AC be the sought difference of longitude 210 miles.

By LOGARITHMS.

As Co-sine of latitude 49° 30′	9.81254	Long. left	36° 40′ W.
Is to the distance 136,4	2.13481	Diff. long.	3 30 W.
So is radius	10.00000		
		Long. in	40 10 W.
To the difference of long. 210	2.32227		

By INSPECTION.

Look for the latitude among the degrees as if it was a course, and the departure in the column of latitude ; right against which stands the difference of longitude in the distance column.

Thus in the course 49°, I seek for 136,4 in the latitude column, and find it corresponds to the distance 208 ; and in the course 50°, I find it nearly corresponds to 212 ; half the sum of 208 and 212 is 210, which is the sought difference of longitude.

QUESTIONS TO EXERCISE THE LEARNER.

Question I. A ship in the latitude of 32° N. sails due east till her difference of longitude is 384 miles ; required the distance sailed ?

Answer. 325.7 miles.

Question II. A ship from the latitude of 53° 36′ S. longitude 10° 18′ E. sails due west 236 miles ; required her present longitude ?

Answer. 3° 40′ E.

Question III. If two ships in the latitude of 44° 30′ N. distant 216 miles, should sail directly south until they were in the latitude of 32° 17′ N. what distance are they from each other ?

Answer. By Theorem V. 256 miles.

Question IV. A ship having run due east for three days, at the rate of 5 knots an hour, finds she has altered her longitude 8° 16′, what parallel of latitude did she sail in ?

Answer. 43° 28′ N. or S.

MIDDLE LATITUDE SAILING.

WHEN a ship sails due east or west, or in the same parallel of latitude, we may, by the foregoing theorems in parallel sailing, calculate the difference of longitude from the departure, or the departure from the difference of longitude. But in general a ship crosses several meridians and parallels, and then arrives at a different latitude from that she left; therefore since the miles that make a degree in one parallel are different from those in another parallel on the same side of the equator, we must not make our calculations for either the greatest or the least of the latitudes, but for some intermediate one. The latitude generally used is the arithmetical mean between the latitude left and the latitude arrived at; and with this mean or middle latitude, the difference of longitude is found from the departure, or the departure from the difference of longitude, as in parallel sailing. This method is very much used in short runs and day's works; but in calculating large distances across distant parallels, it is not so accurate as Mercator's Sailing, which will be explained hereafter. The calculations of middle latitude sailing are performed by means of the following theorems, of which the two first are the same as Theorem III. and IV. of parallel sailing, only writing departure for distance and middle latitude for latitude.

THEOREM I.

As Radius is to the co-sine of the middle latitude, so is the difference of longitude to the departure.

THEOREM II.

As the co-sine of the middle latitude is to the radius, so is the departure to the difference of longitude.

In which it must be remembered, that the middle latitude is found by adding both latitudes together and taking half their sum.

Again, since (by case 1. plane sailing) the radius is to the sine of the course, as the distance sailed is to the departure, if we combine this analogy with that of Theorem II. we shall have,

THEOREM III.

As the co-sine of the middle latitude is to the sine of the course, so is the distance sailed to the difference of longitude.

And by case II. plane sailing, we have this analogy; as radius is to the tangent of the course, so is the difference of latitude to the departure; by combining this with Theorem II. we have,

THEOREM IV.

As the co-sine of the middle latitude is to the tangent of the course, so is the difference of latitude to the difference of longitude.

Whence we easily deduce the following,

THEOREM V.

As the difference of latitude is to the difference of longitude, ſo is the coſine of the middle latitude to the tangent of the courſe.

By means of the preceding theorems we have formed the following table, which contains all the rules neceſſary for ſolving the various caſes of middle latitude ſailing.

MIDDLE LATITUDE SAILING.

Caſe.	Given.	Sought.	Solution.
1	Both Latitudes and Longitudes.	Departure Courſe. Diſtance.	Rad. : Diff. Long. : : Co-ſine Mid. Lat. : Dep. { Diff. Lat. : Rad. : : Dep. : Tang. Courſe, { Dif. Lat. : Dif. Lon. : : Coſ. Mid. Lat. : Tang. Cou. { Rad. : Diff. Lat. : : Secant Courſe : Diſtance. { Sine Courſe : Depart. : : Rad. : Diſtance.
2	Both Latitudes and Departure.	Courſe Diſtance Diff. Long.	Diff. Lat. : Rad. : : Dep. : Tang. Courſe. Sine Courſe : Dep : : Rad. : Diſtance. Co-ſine Mid. Lat. : Dep. : : Rad. : Diff. Long.
3	One Latiude, Courſe and Diſtance.	Diff. Lat. Departure. Diff. Long.	Rad. : Diſt. : : Co-ſine Courſe : Diff. Lat. Hence the other latitude and middle latitude are found. Rad. : Diſt. : : Sine Courſe : Departure. { Co-ſine Mid. Lat. : Dep. : : Rad. : Diff. Long. { Co-ſine Mid. Lat. : Sine Courſe : : Diſt. : Dif. Lon.
4	Both Latitudes and Courſe.	Departure Diſtance Diff. Long.	Rad. : Diff. Lat. : : Tang. Courſe : Departure. Co-ſine Courſe : Diff. Lat. : : Rad. : Diſtance. { Co-ſine Mid. Lat. : Dep. : : Rad. : Diff. Long. { Coſ. Mid. Lat. : Tang. Cou. : : Dif. Lat. : Dif. Lon.
5	Both Latitudes and Diſtance.	Courſe Departure Diff. Long.	Diſt. : Rad. : : Diff. Lat. : Co-ſine Courſe. Rad. : Diſt. : : Sine Courſe : Departure. Co-ſine Mid. Lat. : Dep. : : Rad. : Diff. Long.
6	One Latitude, Courſe and Departure.	Diff. Lat. Diſtance Diff. Long.	Rad. : Dep. : : Co-tang. Courſe : Diff. Lat. Hence the other latitude and middle latitude are known. Sine Courſe : Departure : : Rad. : Diſtance. Co-ſine Mid. Lat. : Dep. : : Rad. : Diff. Long.
7	One Latitude, Diſtance and Departure.	Courſe Diff. Lat. Diff. Long.	Diſt. : Rad. : : Dep. : Sine Courſe. Rad. : Diſt. : : Co-ſine Courſe : Diff. Lat. Hence we obtain the other latitude and middle latitude. Co-ſine Mid. Lat. : Dep. : : Rad. : Diff. Long.

We ſhall now proceed to illuſtrate theſe rules, by working an example in every caſe.

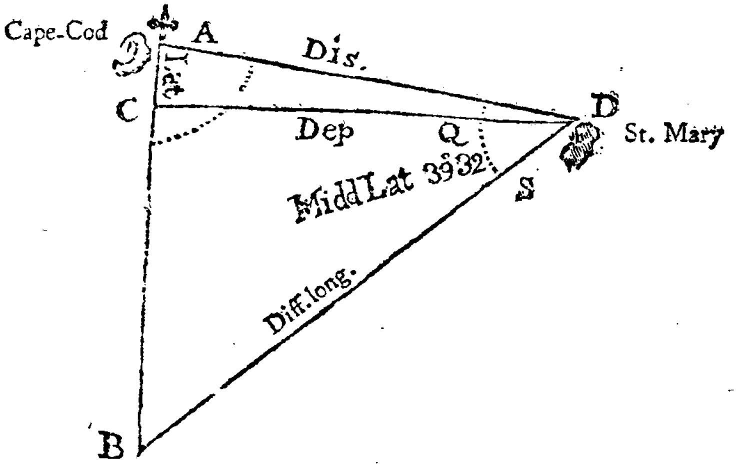
CASE I.

The latitudes and longitudes of two places given, to find their bearing and diſtance.

Required the bearing and diſtance between Cape-Cod light-houſe, in the latitude of 42° 5′ N. longitude 70° 14′ W. and the Iſland of St. Mary, (one of the Weſtern-Iſlands) in the latitude of 37° N. and longitude 25° 6′ W.

Cape-Cod's lat.	42° 5′ N.		42° 5′	Long.	70° 14′ W.
St. Mary's lat.	37 0 N.		37 0	Long.	25 6 W.
Diff. lat.	5 5	Sum	79 5		45 8
	60				60
		Mid. lat.	39 32		
In miles	305			Diff. long.	2708 miles.

By PROJECTION.



Draw the east and west line DC; with the chord of 60° describe the arch QS about the centre D, cutting DC in Q; upon this arch set off, from Q to S, the middle latitude 39° 32′; through D and S draw the line DB, which make equal to the difference of longitude 2708 miles; from B let fall upon DC the perpendicular BC, which continue towards A making AC equal to the difference of latitude 305 miles; * join AD, and it is done. For A will be the situation of Cape-Cod, D the situation of St. Mary; CD will be the departure, which being measured will be found to be 2089 miles; the distance will be represented by AD, which being measured will be found to be 2113 miles, and the course from Cape-Cod to St. Mary will be represented by the angle CAD=81° 42′; therefore the course will be S. 81° 42′ E. or E. $\frac{1}{4}$ S. nearly.

Note. This course is put S. 81° 42′ E. because St. Mary being in a less northern latitude than Cape Cod is to the southward of it; it is also to the eastward of Cape Cod, because it is in a lesser western longitude.

By LOGARITHMS.

To find the departure, (by Theo. I.)

As radius 90°	10.00000
Is to diff. of long. 2708	3.43265
So is co-sine mid. lat. 39° 32′	9.88720
To the departure 2089	3.31985

To find the distance.

As radius 90°	10.00000
Is to the diff. lat. 305	2.48430
So is sec. of course 81° 42′	10.84056
To the distance 2113	3.32486

Note. The log. of the departure above found 3.31985 is rather less than the log. of 2089 = 3.31994; but in finding the course by the departure, I have used the quantity found at the first operation, and shall do the same in any future calculations.

To find the course.

As diff. of lat. 305	2.48430
Is to radius 45°	10.00000
So is the departure 2089	3.31985
To tang. of course 81° 42′	10.83555

Note. The course may be found without the departure, by Theo. V. Middle Latitude Sailing.

As the diff. of lat. 305	2.48430
Is to the diff. of long. 2708	3.43265
So is co-sine mid. lat. 39° 32′	9.88720
	13.31985
	2.48430
To tang. of course 81° 42′	10.83555

* If the place A is to the southward of D, the line AC should be set off upon the line CB, from C towards B.

By GUNTER.

Extend from the radius, or 90°, to 50° 28′ the complement of the middle latitude, on the line of ſines; that extent will reach from the difference of longitude 2708, to the departure 2089, on the line of numbers.

2dly. Extend from the difference of latitude 305, to the departure 2089 on the line of numbers; that extent will reach from radius, or 45°, to the courſe 81° 42′ on the line of tangents.

3dly. Extend from the courſe 81° 42′, to the radius 90°, on the line of ſines; that extent will reach from the departure 2089, to the diſtance 2113 miles on the line of numbers.

By INSPECTION.

RULE. Look for the middle latitude, as if it was a courſe in plane ſailing, and the difference of longitude in the diſtance column, oppoſite to which, in the column of latitude, will ſtand the departure; having the difference of latitude and departure, the courſe and diſtance are found (as in Caſe VI. Plane Sailing) by ſeeking in Tab. II. with the difference of latitude and departure, until they are found to agree in their reſpective columns; for oppoſite to them will be found the diſtance in its column, and the courſe will be found at the top of that table, if the departure be leſs than the difference of latitude, otherwiſe at the bottom.

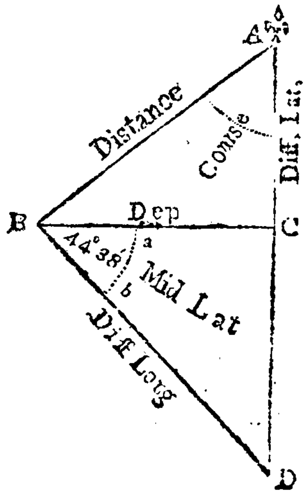
Thus with one tenth of the difference of longitude 270.8, or 271, I enter Table II. and oppoſite to it, in the diſtance column of the tables of 39° and 40°, I find 210.6 and 207.6 in the latitude column; now the middle latitude being nearly 39½°, I take the mean of theſe, 209.1, for the departure, which being multiplied by 10 gives the whole departure 2091. Again I enter Table I. with one tenth of the departure 209.1, and one tenth of the difference of latitude 30.5, and find that they agree nearly to a courſe of 7¼ points, and a diſtance of 211, which multiplied by 10, gives the ſought diſtance 2110 miles nearly.

CASE II.

Both latitudes and departure from the meridian given, to find the courſe, diſtance, and difference of longitude.

A ſhip in the latitude of 49° 57′ N. and longitude of 15° 16′ W. ſails ſouth-weſterly till her departure is 789 miles, and latitude in 39° 20′ N. Required the courſe, diſtance, and longitude in.

Latitude left	49° 57′ N.	
Latitude in	39 20 N.	
Diff. of lat.	10 37	=637 miles.
Sum of lats.	89 17	
Middle lat.	44 38	



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By PROJECTION.

Draw the meridian ACD, on which take AC equal to the difference of latitude 637 miles; draw CB perpendicular to AC, and make it equal to the departure 789 miles; about B as a centre describe an arch a b, on which set off the middle latitude 44° 38′; through B and b draw the line BD, meeting ACD in D; join AB and it is done; for AB will be the distance sailed, which being measured will be found = 1014 miles; BD will be the difference of longitude = 1109 miles, and the angle CAB will represent the course from the meridian 51° 5′.

By LOGARITHMS.

To find the course.		To find the distance.	
As the diff. of lat. 637	2.80414	As sine course 51° 5′	9.89101
Is to radius 45°	10.00000	Is to the departure 789	2.89708
So is the departure 789	2.89708	So is radius 90°	10.00000
To tang. course 51° 5′	10.09294	To the distance 1014	3.00607

To find the difference of longitude.			
As co-sine mid. lat. 44° 38′	9.85225	Longitude sailed from	15° 16′ W.
Is to the departure 789	2.89708	Diff. long. 1109 miles	18 29 W.
So is radius 90°	10.00000		
		Longitude in	33 45 W.
To diff. of long. 1109	3.04483		

By GUNTER.

1st. The extent from the difference of latitude 637 to the departure 789, on the line of numbers, will reach from radius, or 45°, to the course 51° 5′ on the line of tangents.

2dly. The extent from 51° 5′ to radius, or 90°, on the line of sines, will reach from the departure 789, to the distance 1014 on the line of numbers.

3dly. The extent from the complement of middle latitude 45° 22′, to radius, or 90°, on the line of sines, will reach from the departure 789, to the difference of longitude 1109 on the line of numbers.

By INSPECTION.

Rule. With the difference of latitude and departure, find the course and distance (as in Case VI. of plane sailing) by seeking in Tab. II. until the difference of latitude and departure are found to correspond, right against which in the distance column will be the distance; and if the departure be less than the difference of latitude, the course will be found at the top of that table, otherwise at the bottom.

Then take the middle latitude as a course, and find the departure in the latitude column, the number corresponding in the distance column will be the difference of longitude.

In the present example, I take one tenth of the difference of latitude 637, and the departure 789; that is 63,7 and 78,9, the nearest numbers to these are 63,6 and 78,5, standing together over 51°, against the distance 101, which being multiplied by 10 gives 1010; whence the course by inspection is S. 51° W. and the distance 1010. Then I take one tenth of the departure, that is 78,9 and seek it in the column of latitude of 45° (which is the nearest to the middle latitude 44° 38′), the nearest number I find is 79.2, opposite which in the distance column stands 112, which being multiplied by 10 gives 1120 for the difference of longitude; this value differs a little from that found by logarithms, which is owing to the odd miles of middle latitude neglected, for if we were also to find the difference of long. for the middle latitude 44° and to proportion for the odd minutes, the result would come out nearly the same as by logarithms.

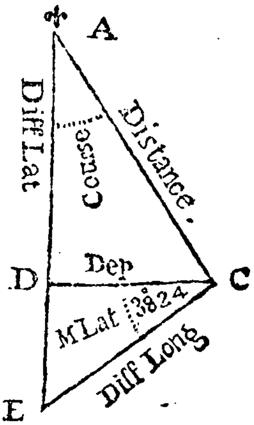
CASE III.

One latitude, course and distance given, to find the difference of latitude and difference of longitude.

A ship in the latitude of 42° 30′ N. and longitude of 58° 51′ W. sails S. E. by S. 591 miles. Required the latitude and longitude in?

By PROJECTION.

Draw the meridian ADE (as in case VI. plane sailing) upon A as a centre describe an arch with the chord of 60°, and upon it set off, from where it cuts AD, the course S. E. b. S. or 3 points, through that point of the arch, and the point A, draw the line AC which make equal to the distance 591 miles; from C let fall upon AD the perpendicular CD; then will CD be the departure 328 miles, and AD the difference of latitude 491 miles. Hence we obtain the latitude arrived at, and the middle latitude; draw the line CE making an angle with DC of 38° 24′ = the middle latitude; and the distance CE will be the difference of longitude 419 miles, hence the longitude in is obtained.



By LOGARITHMS.

To find the difference of latitude.		
As radius 8 pts.		10.00000
Is to the distance 591		2.77159
So is co-sine course 3 pts.		9.91985
To the diff. of lat. 491.4		2.69144
Latitude left	42° 30′ N.	
Diff. of lat.	8 11 S.	
Latitude in	34 19 N.	
Sum of lats.	76 49	
Middle lat.	38 24	
Long. left	58° 51′ W.	
Diff. of long. 419=	6 59 E.	
Longitude in	51 52 W.	

To find the departure.	
As radius 8 pts.	10.00000
Is to the distance 591	2.77159
So is sine course 3 pts.	9.74474
To the departure 328.3	2.51633
To find diff. long. with departure.	
As co-sine mid. lat. 38° 24′	9.89415
Is to the departure 328.3*	2.51633
So is radius 90°	10.00000
To diff. of long. 419 miles	2.62218
Without the departure.	
As co-si. m. lat. 38° 24′ ar. co.	0.10585
Is to sine course 3 pts.	9.74474
So is distance 591	2.77159
To diff. of long. 419 miles	2.62218

* The logarithm of the departure was found by the preceding canon to be 2.51633, differing a little from the logarithm of 328.3.

By GUNTER.

1st. The extent from radius 8 points to the complement of the course 5 points on the line marked S R, will reach from the distance 591 to the difference of latitude 491 on the line of numbers.

2dly. The extent from radius 8 points to the course 3 points on the line S R, will reach from the distance 591 to the departure 328 on the line of numbers.

3dly. The extent from the complement of middle latitude 51° 36′ to radius 90° on the line of sines, will reach from the departure 328 to the difference of longitude 419 on the line of numbers.

By INSPECTION.

Rule. With the course and distance find the difference of latitude and departure (as in Case I. of plane sailing) by finding the given course at the top or bottom of the tables, either among the points or degrees; in that page and opposite the distance taken in its column, stand the difference of latitude and departure in their columns. Then take the middle latitude as a course and find the departure in the latitude column, against it in the distance column stands the difference of longitude.

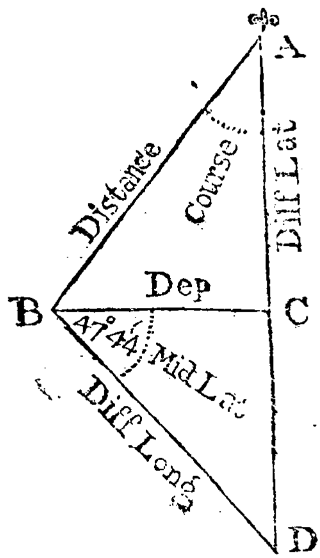
Thus, under the course three points, and against the tenth of the distance 591 = 59,1 or 59 stand 49,1 and 32,8; these multiplied by 10 give 491 for the difference of latitude and 328 for the departure. Now taking the middle latitude 38° 24′ or 38° as a course, and a tenth of the departure 328 = 32,8 in the column of difference of latitude (the nearest is 33.1) against which stands 42 in the distance column; this multiplied by 10 gives 420 for the difference of longitude nearly.

CASE IV.

Both latitudes and course given, to find the departure, distance, and difference of longitude.

Suppose a ship sailing from a place in the latitude of 49° 57′ N. and longitude of 30° W. makes a course good of S. 39° W. and then by observation is in the latitude of 45° 31′ N.; it is required to find her distance run, and longitude in.

Latitude from	49° 57′ N.
Latitude by obs.	45 31 N.
	4 26
	60
Diff. lat.	266
Sum of lats.	95° 28′
Mid. lat.	47 44



By PROJECTION.

Draw the meridian ACD, on which set off AC equal to the difference of latitude 266 miles; draw CB perpendicular to AC; draw the line AB, making an angle equal to the course 39° with AC, and meeting BC in B; through B draw BD, making an angle equal to the middle latitude 47° 44′ with the line BC, and it is done; for AB will be the distance 342.3 miles, BC the departure 215.4 miles, and BD the difference of longitude 320.3 miles.

By LOGARITHMS.

To find the departure.

As radius 45°	10.00000
Is to the diff. lat. 266	2.42488
So is tang. course 39°	9.90837
To the departure 215.4	2.33325

To find the distance.

As co-sine of the course 39°	9.89050
Is to the diff. lat. 266	2.42488
So is radius 90°	10.00000
To the distance 342.3	2.53438

To find the longitude in.

Longitude sailed from	30°	0′	W.
Diff. long. 320 miles or	5	20	W.
Longitude in	35	20	W.

To find the difference of longitude by the departure.

As co-sine mid. lat. 47° 44′	9.82775
Is to the departure 215.4	2.33325
So is radius 90°	10.00000
To the diff. of long. 320.3	2.50550

The diff. of long. may be found without the departure, by Theo. IV. Mid. Lat. Sail. thus:

As co-sine mid. lat. 47° 44′	9.82775
Is to tang. of course 39°	9.90837
So is the diff. lat. 266	2.42488
	12.33325
	9.82775
To the diff. long. 320.3	2.50550

By GUNTER.

1st. The extent from radius 45° to the course 39° on the line of tangents, will reach from the difference of latitude 266 to the departure 215.4 on the line of numbers.

2dly. The extent from the complement of the course 51° to the radius 90° on the line of sines, will reach from the difference of latitude 266 to the distance 342.3 on the line of numbers.

3dly. The extent from the complement of the middle latitude 42° 16′ to radius 90° on the line of sines, will reach from the departure 215.4 to the difference of longitude 320.3 on the line of numbers.

By INSPECTION.

Find the course among the points or degrees (in Tab. I. or II. as in Case II. Plane Sailing) and the difference of latitude in its column, against which stand the distance and departure in their columns; then take the middle latitude as a course, and find the departure in the latitude column, against which, in the distance column, stands the difference of longitude.

Thus, with the course 39°, and half the difference of latitude 133, I enter Table I.; the nearest number in the table is 132.9, which corresponds to the distance 171, and to the departure 107.6; these doubled give the distance 342, and the departure 215.2 miles.

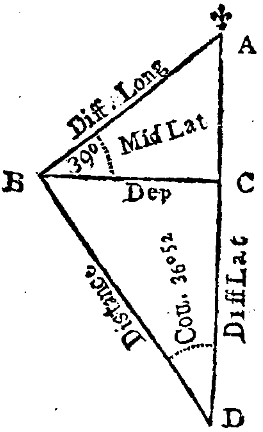
Then with the middle latitude 47° 44′ or 48° as a course, I enter Table II. and seek for half the departure 107.6 in the latitude column, the nearest number to which is 107.7, which corresponds to the distance 161; this doubled gives the difference of longitude 322 miles nearly.

CASE V.

Both latitudes and distance given, to find the course, departure, and difference of longitude.

Suppose a ship sails 300 miles north-westerly, from a place in the latitude of 37° N. and longitude 32° 16′ W. until she is in the latitude of 41° N. what are her course and longitude in?

Latitude left	37° 0′ N.		37° 0′ N.
Latitude in	41 0		41 0
	4 0	Sum	78 0
	60	Mid.lat.	39 0
Diff. lat.	240		



By PROJECTION.

Draw the meridian ACD, on which set off DC equal to the difference of latitude 240 miles; draw the line CB perpendicular to DC; take the distance 300 in your compasses, and with one foot in D sweep an arch cutting CB in B; join DB; make the angle CBA equal to the middle latitude 39° and draw BA cutting DCA in A, and it is done; for BC will be the departure 180 miles, BA the difference of longitude 231.6 miles, and the angle BDC will represent the angle of the ship's course with the meridian, which will therefore be N. 36° 52′ W.

By LOGARITHMS.

To find the course.

As the distance 300	2.47712
Is to radius 90°	10.00000
So is diff. lat. 240	2.38021
To co-sine course 36° 52′	9.90309

To find the departure.

As radius 90°.	10.00000
Is to the distance 300	2.47712
So is sine course 36° 52′	9.77812
To the departure 180.0	2.25524

To find the difference of longitude by the departure.

As co-sine mid. lat. 39°	9.89050
Is to the departure 180.0	*2.25524
So is radius 90°	10.00000
To diff. of long. 231.6	2.36474

To find the longitude in.

Long. left	32° 16′	W.
Difference of longitude	3 52	W.
Longitude in	36 08	W.

* This logarithm, by the preceding operation, was found equal to 2.25524, differing a little from the logarithm of 180.0.

By GUNTER.

1st. The extent from the distance 300 to the difference of latitude 240, on the line of numbers, will reach from radius 90° to the complement of the course = 53° 8′, on the line of sines.

2dly. The extent from radius 90° to the course 36° 52′ on the line of sines, will reach from the distance 300 to the departure 180 on the line of numbers.

3dly. The extent from the complement of the middle latitude 51° to the radius 90° on the line of sines, will reach from the departure 180 to the difference of longitude 231.6 on the line of numbers.

By INSPECTION.

Find the course (as in Case IV. Plane Sailing) by seeking in Table II. till against the distance taken in its column, be found the difference of latitude in one of the following columns; then adjoining to it stands the departure; which, if less than the difference of latitude, the course is found at the top of the table, but if greater, at the bottom; then take the middle latitude as a course, and find the departure in the column of difference of latitude, against which, in the distance column, stands the difference of longitude.

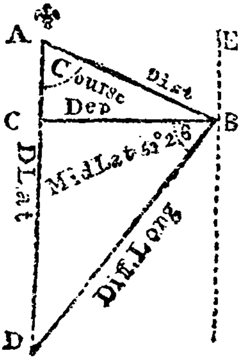
Thus the distance 300, and the difference of latitude 240, are found to correspond nearly to a course of 37°, and a departure of 180.5; then taking the middle latitude 39° as a course, I seek the departure 180.5 in the latitude column, corresponding to which, in the distance column, is the difference of longitude 232.

CASE VI.

One latitude, course, and departure given, to find the difference of latitude, distance, and difference of longitude.

A ship in the latitude 50° 10′ S. and longitude of 30° 00′ E. sails E.S.E. until her departure is 957 miles; required her distance sailed, and latitude and longitude in.

By PROJECTION.



Draw the meridian ACD, and parallel thereto, at a distance equal to the departure 957 miles, draw the line EB; make the angle CAB equal to the course 6 points, and draw AB meeting EB in B; from B let fall upon AD the perpendicular BC; then will AC be the difference of latitude 396.4 miles, and AB the distance sailed 1036 miles; having thus obtained the middle latitude 53° 28′, make the angle CBD equal thereto, and draw BD meeting ACD in D; then will BD be the difference of longitude 1608 miles.

By LOGARITHMS.

To find the diff. of latitude.		To find the distance.	
As radius 4 pts.	10.00000	As sine course 6 pts.	9.96562
Is to the departure 957	2.98091	Is to the departure 957	2.98091
So is co-tang. course 6 pts.	9.61722	So is radius 8 pts.	10.00000
To diff. of lat. 396,4	2.59813	To the distance 1036	3.01529
Latitude left	50° 10′ S.	To find the diff. of longitude.	
Diff. of lat. 396 miles	6 36 S.	As co-sine mid. lat. 53° 28′	9.77473
		Is to the departure 957	2.98091
Latitude in	56 46 S.	So is radius 90°	10.00000
Sum of latitudes	106 56		
Middle latitude	53 28	To the diff. of long. 1608	3.20618

Longitude left	30° 00′ E.
Diff. of long. 1608 =	26 48 E.
Long. in	56 48 E.

By GUNTER.

1st. The extent from the course 6 points to the radius 4 points, on the line marked T. R. will reach from the departure 957, to the difference of latitude 396,4 on the line of numbers.

2dly. The extent from 6 points to the radius or 8 points, on the line marked S. R. will reach from the departure 957, to the distance 1036, on the line of numbers.

3dly. The extent from the complement of the middle latitude 36° 32′ to the radius 90°, on the sines, will reach from the departure 957, to the difference of longitude 1608, on the line of numbers.

By INSPECTION.

Find the course among the points or degrees, Tab. I. or Tab. II. (as in case 3d. of Plane Sailing) and the departure in its column, corresponding to which in the columns of distance and difference of latitude, are to be found the distance and difference of latitude respectively; then with the middle latitude as a course, seek the departure in the column of latitude, corresponding to which in the distance column, stands the difference of longitude.

Thus, I enter Table I. above 6 points and seek for $\frac{1}{10}$th of the departure 95,7, the nearest to which is 96.1 and the corresponding numbers are 104 and 39.8, which multiplied by 10, give the distance 1040, and the difference of latitude 398 nearly; the middle latitude being nearly 53½°, I seek in the table of 53°, for the distance corresponding to a tenth of the departure = 95,7, and find it to be 159; then I seek for the same number 95,7 in the table of 54°, and find the number corresponding in the distance column to be 163, half the sum of these two numbers is 161, which multiplied by 10 gives the difference of longitude 1610 nearly.

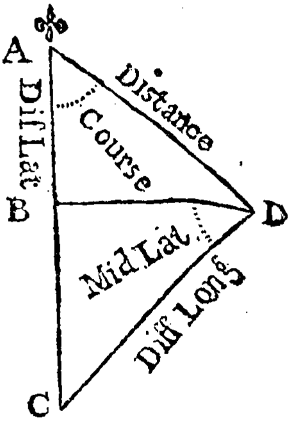
CASE VII.

One latitude, distance sailed, and departure from the meridian given, to find the course, difference of latitude and difference of longitude.

A ship in the latitude of 49° 30′ N. and longitude of 25° 0′ W. sails south easterly 645 miles, until her departure from the meridian be 500 miles; required the course steered, and the latitude and longitude the ship is in?

By PROJECTION.

Draw the line BD equal to the departure 500 miles, and perpendicular thereto draw the meridian line ABC; take an extent equal to the diſtance 645 in your compaſſes, and with one foot in D ſweep an arch cutting AB in A, join AD, then will AB be the difference of latitude 407,5 miles, and BAD the courſe, S. 50° 49′ E.; hence we have the latitude in, and middle latitude; make the angle BDC equal to the middle latitude and draw DC cutting ABC in C, then DC will be the difference of longitude 721,1 miles.



By LOGARITHMS.

To find the courſe.

As the diſtance 645	2.80956
Is to radius 90°	10.00000
So is the departure 500	2.69897
To ſine courſe 50° 49′	9.88941

To find the diff. of lat.

As radius 90°	10.00000
Is to the diſtance 645	2.80956
So is co-ſine courſe 50° 49′	9.80058
To the diff. of lat. 407,5	2.61014

To find the difference of longitude.

As co-ſine mid. lat. 46° 6′	9.84098
Is to the departure 500	2.69897
So is radius 90°	10.00000
To the diff. of long. 721,1	2.85799

Latitude left	49° 30′ N.
Diff. lat. 408	6 48 S.
Latitude in	42 42 N.
Sum of the latitudes	92 12
Middle latitude	46 6

Longitude left	25° 0′ W.
Diff. long. 721 =	12 1 E.
Longitude in	12 59 W.

By GUNTER.

1ſt. The extent from the diſtance 645, to the departure 500, on the line of numbers, will reach from the radius 90°, to the courſe 50° 49′, on the line of ſines.

2dly. The extent from radius 90°, to the complement of the courſe 39° 11′, upon the line of ſines, will reach from the diſtance 645 to the difference of latitude 407,5 on the line of numbers.

3dly. The extent from the complement of the middle latitude 43° 54′, to the radius 90°, on the line of ſines, will reach from the departure 500, to the difference of longitude 721,1, on the line of numbers.

By INSPECTION.

As in Case V. Plane Sailing, find the course by seeking in Table II. till against the distance, in its column, be found the given departure in one of the following columns, adjoining to which in the other column will be the difference of latitude, which if greater than the departure the course will be at the top, but if less the course will be found at the bottom. Then take the middle latitude as a course, and find the departure in the column of difference of latitude, against which, in the distance column, will be found the difference of longitude.

Thus, one third of the distance, 215, and one third of the departure, 166,7, are found nearly to correspond to a course of 51 degrees, and a difference of latitude of 135,3 which multiplied by 3 gives the sought difference of latitude 406 nearly; then with the middle latitude, 46°, as a course, I enter the table and seek for one fifth of the departure =100, in the latitude column, the distance corresponding, 144, being multiplied by 5 gives the difference of longitude 720 nearly.

QUESTIONS FOR EXERCISE.

Question I. Required the bearing and distance between two places; one in the latitude of 37° 55′ N. and longitude of 54° 23′ W. the other in the latitude of 32° 38′ N. and longitude of 17° 5′ W.?

Answer. S. 80° 9′ E. and N. 80° 9′ W. distance 1855 miles.

Question II. Required the direct course and distance, from a place in the latitude of 36° 55′ S. and longitude of 20° 0′ E. to another place in the latitude of 32° 38′ S. and longitude of 8° 54′ W.

Answer. N. 79° 46′ W. distance 1447 miles.

Question III. A ship from the latitude of 37° 30′ S. and longitude of 60° E. sails N. 79° 56′ W. 202 miles, required the latitude and longitude in?

Answer. Latitude 36° 55′ S. longitude 55° 50′ E.

Question IV. A ship from the latitude of 34° 35′ N. and longitude of 45° 16′ W. sails S. 83° 36′ E. 101 miles; required her latitude and longitude?

Answer. Latitude 34° 24′ N. longitude 43° 14′ W.

MERCATOR'S SAILING.

THE errors of the plane chart and plane ſailing are in part corrected by the preceding method of middle latitude; but in calculating the ſituations of diſtant places in high latitudes, this method is liable to great errors: to remedy this inconvenience, a chart was invented and publiſhed in the year 1566, by GERRARD MERCATOR, a Flemiſh Geographer, in which all the meridians are parallel to each other, but proportionally lengthened ſo as to conform to the ſpherical figure of the earth. The principles on which this chart was conſtructed were firſt explained in the year 1599, by Edward Wright, an Engliſhman, and are as follows.

By Theorem II. of parallel ſailing, the length of a degree or mile of longitude is to the length of a correſponding degree or mile of the meridian, as the co-ſine of the latitude is to the radius, that is (*by art.* 58 *Geo.*) as radius is to the ſecant of the latitude. Hence if the meridians are ſuppoſed to be parallel to each other, or the length of a degree or mile of longitude to remain the ſame in every latitude, the degree or mile of latitude muſt be increaſed in proportion to the ſecant of the latitude. Hence the length of the firſt mile of latitude from the equator will be repreſented by the ſecant of 1′, the ſecond mile by the ſecant of 2′, the third mile by the ſecant of 3′, &c. Therefore the length of the expanded arch of the meridian may be found by a continual addition of ſecants, to every degree and minute of the quadrant, as in Table III. by means of which this chart (called Mercator's chart) may be conſtructed, and all the caſes of Mercator's ſailing may be projected and calculated.

In uſing this table, the degrees are to be found at the top or bottom, and the miles at the ſide; in the angle of meeting is the length of the correſponding expanded arch, uſually called the *meridional parts*. If you wiſh to find the arch of the expanded meridian intercepted between any two parallels, or, as it is uſually called, the *meridional difference of latitude*, you muſt, *when both places are on the ſame ſide of the equator, ſubtract the meridional parts of the leſſer latitude from the meridional parts of the greater, the remainder will be the meridional difference of latitude; but if they are on different ſides of the equator, the ſum of the meridional parts of both latitudes is the meridional difference of latitude required.*

EXAMPLE I.

Required the meridional parts correſponding to the latitude 42° 34′?

Look in the bottom or top of the table for 42°, marked 42d. and in the right or left hand column marked (M) for 34′, in the former and oppoſite the latter ſtand 2828, the meridional parts correſponding to 42° 34′.

EXAMPLE II.

Required the meridional difference of latitude between Cape-Cod, in the lat. of 42° 5′ N. and the Iſland of St. Mary, in the latitude of 37° N.?

Cape-Cod's lat. 42° 5′ N.	Mer. parts	2788
St. Mary's lat. 37° 0′ N.	Mer. parts	2393
Meridional difference of latitude		395

EXAMPLE III.

Required the meridional difference of latitude between Cape-Hatteras, in the lat. of 35° 8′ N. and the Cape of Good Hope, in the latitude of 34° 29′ S.?

C. Hatteras's lat. 35° 8′ N.	Mer. par.	2254
C. of G. Hope's lat. 34° 29′ S.	Mer. par.	2207
Sum is meridional difference of lat.		4461

From these principles it follows, that in sailing upon any rhumb, *the true or proper difference of latitude is to the departure as the meridional difference of latitude is to the difference of longitude.* Hence if MI (in the figure of Case I. following) be the proper difference of latitude, IO the departure, MO the distance, the angle IMO the course, and we take MT equal to the meridional difference of latitude, and draw TH parallel to IO to cut MO continued in H; the line TH will represent the difference of longitude; for *(by art. 55 geom.)* MI : IO : : MT : TH. Now in the triangle MTH, by making MT radius, we have MT : radius : : TH : tang. TMH, that is, *the meridional difference of latitude is to radius as the difference of longitude is to the tangent of the course.* By making MH or TH radius we have other analogies, which combined with those in plane sailing, furnish the solutions of the various cases of Mercator's sailing contained in the following table.

MERCATOR'S SAILING.

Case.	Given.	Sought.	Solutions.
1	Both Latitudes and Longitudes.	Course Distance Departure.	Having both lat. the mer. diff. lat. is found by Table III. Mer. Diff. Lat. : Rad. : : Diff. Long. : Tang. Course. { Rad. : Prop. Diff. Lat. : : Secant Course : Distance. { Co-sine Course : Prop. Diff. Lat. : : Rad. : Distance. { Rad. : Prop. Diff. Lat. : : Tang. Course : Departure. { Mer. Diff. Lat. : Diff. Long. : : Prop. Diff. Lat. : Dep.
2	Both Latitudes and Departure.	Course Distance Diff. Long.	Merid. Diff. Lat. being found by Table III. we have, Prop. Diff. Lat. : Radius : : Departure : Tang. Course. { Radius : Prop. Diff. Lat. : : Sec. Course : Distance. { Sine Course : Departure : : Radius : Distance. { Rad. : Mer. Dif. Lat. : : Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. : : Mer. Diff. Lat. : Diff. Long.
3	One Latitude Course and Distance.	Departure Diff. Lat. Diff. Long.	Radius : Distance : : Sine Course : Departure. Rad. : Dist. : : Co-sine Course : Prop. Diff. Lat. Hence we have the other latitude and mer. diff. lat. by Tab. III. Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long.
4	Both Latitudes and Course.	Distance Departure Diff. Long.	Co-sine Course : Prop. Diff. Lat. : : Rad. : Distance. Rad. : Prop. Diff. Lat. : : Tang. Course : Departure. Mer. diff. lat. being found in Table III. we have, Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long.
5	Both Latitudes and Distance.	Course Departure Diff. Long.	Dist. : Rad. : : Prop. Diff. Lat. : Co-sine Course. Radius : Distance : : Sine Course : Departure. Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long.
6	One Latitude Course and Departure.	Diff. Lat. Distance Diff. Long.	Rad. : Dep. : : Co-tang. Course : Prop. Diff. Lat. Hence we have the other latitude and merid. diff. lat. Sine Course : Departure : : Radius : Distance. { Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. : : Mer. Diff. Lat. : Diff. Long
7	One Latitude Distance and Departure.	Course Diff. Lat. Diff. Long.	Dist. : Rad. : : Dep. : Sine Course. Rad. : Dist. : : Co-sine Course : Diff. Lat. Hence we obtain the other latitude and merid. diff. lat. { Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. : : Mer. Diff. Lat. : Diff. Long.

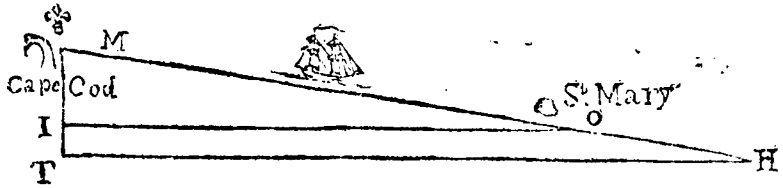
CASE I.

The latitudes and longitudes of two places given, to find the direct course and distance between them.

Required the bearing and distance from Cape Cod Light-House in the latitude of 42° 5′ N. and longitude of 70° 14′ W. to the island of St. Mary, one of the Western Islands, in the latitude of 37° N. and longitude of 25° 6′ W. ?

Cape Cod's lat.	42° 05′ N.	Meridional parts	2788	Long.	70° 14 W.
St. Mary's lat.	37 00 N.	Meridional parts	2393		25 06 W.
	5 05	Mer. diff. lat.	395		45 08
	60				60
Difference of lat.	305			Diff. long.	2708

By PROJECTION.



Draw the meridian MT equal to the meridional difference of latitude 395 miles, set off alſo upon it MI equal to the proper difference of latitude 305 miles; perpendicular to MT draw TH and IO, make TH equal to the difference of longitude 2708 miles, draw MH cutting IO in O; then will the angle TMH be the courſe S. 81° 42′ E, and OM the diſtance 2113 miles.

By LOGARITHMS.

To find the courſe.		To find the diſtance.	
As the mer. dif. lat. 395	2.59660	As radius 90°	10.00000
Is to radius 45°	10.00000	Is to the proper dif. lat. 305	2.48430
So is the dif. of long. 2708	3.43265	So is ſecant of courſe 81° 42′	10.84056
To tang. of courſe 81° 42′	10.83605	To the diſtance 2113 miles	3.32486

By GUNTER.

1ſt. Extend from the meridional difference of latitude 395 to the difference of longitude 2708, on the line of numbers; that extent will reach from the radius or 45°, to the courſe 81° 42′ on the line of tangents.

2dly. Extend from the complement of the courſe 8° 18′ to radius 90° on the line of ſines, that extent will reach from the proper difference of latitude 305, to the diſtance 2113 on the line of numbers.

By INSPECTION.

With the meridional difference of latitude and difference of longitude uſed as difference of latitude and departure, find the courſe, by inſpecting the tables until thoſe numbers are found to correſpond; with this courſe and the proper difference of latitude, find the correſponding diſtance.

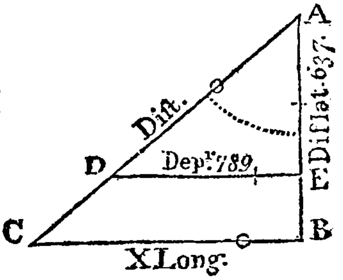
Thus one tenth of the merid. diff. lat. and diff. long. are found to agree nearly to a courſe of 7¼ pts. with this courſe and one tenth of the proper difference of latitude 30,5 is found to correſpond to the diſtance 208; this multiplied by 10 gives the diſtance 2080, differing a little from the reſult by logarithms, owing to the neglect of a few minutes in the courſe.

CASE II.

Both latitudes and the departure given; to find the course, distance, and difference of longitude.

A ship in the latitude of 49° 57′ N. and longitude of 15° 16′ W. sails south-westerly until her departure is 789 miles, and then by observation is in the latitude of 39° 20′ N. required her course, distance and longitude in?

Lat. left	49° 57′N.	Mer. parts	3470
Lat. in	39 20 N.	Mer. parts	2571
Diff. lat.	10 37=637mi.	M.dif.lat.	899



By PROJECTION.

With the proper difference of latitude and departure, project as in Case VI. Plane Sailing; by drawing the meridian AEB, on which take AE equal to the proper difference of latitude 637 miles; erect ED perpendicular to AE and make it equal to the departure 789 miles; join AD and continue it towards C; make AB equal to the meridional difference of latitude 899 miles, and draw BC perpendicular to AB, to cut AC in C, and it is done. For AD will be the distance 1014 miles, BC the difference of longitude 1114 miles, and the angle BAC will be the course S. 51° 5′ W.

By LOGARITHMS.

To find the course.		To find the distance.	
As the prop. dif. of lat. 637	2.80414	As radius	10.00000
Is to radius 45°	10.00000	Is to prop. diff. lat. 637	2.80414
So is the departure 789	2.89708	So is sec. course 51° 5′	10.20191
To tang. course 51° 5′	10.09294	To the distance 1014	3.00605

To find the diff. of long.			
As radius 45°	10.00000	Longitude left	15° 16′ W.
Is to mer. dif. lat. 899	2.95376	Diff. of long. 1114 =	18 34 W.
So is tang. course 51° 5′	10.09294	Longitude in	33 50 W.
To diff. of long. 1114	3.04670		

The diff. of long. may also be found by saying, as prop. dif. of lat. : dep. :: mer. diff. lat. : diff. of long.

By GUNTER.

1st. The extent from the diff. of lat. 637 to the dep. 789 on the line of numbers, will reach from radius 45° to the course 51° 5′ on the line of tangents.

2dly. The extent from the course 51° 5′ to radius 90° on the sines, will reach from the departure 789 to the distance 1014 on the line of numbers.

3dly. The extent from the radius 45° to the course 51° 5′ on the line of tangents, will reach from the merid. diff. of lat. 899 to the difference of longitude 1114 on the line of numbers.

By INSPECTION.

Find the courſe by Plane Sailing, Caſe VI. by ſeeking in the tables with the proper difference of latitude and departure till they are found to agree in their reſpective columns, correſponding to which will be the diſtance in its column, and the courſe will be found at the top of that column if the departure is leſs than the proper difference of latitude, otherwiſe at the bottom; with the ſame courſe, find the meridional difference of latitude in the latitude column, correſponding to which in the departure column is the true difference of longitude.

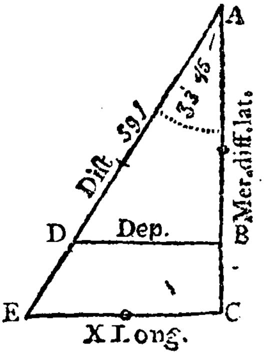
Thus with one tenth of the true difference of latitude and departure 63,7 and 78,9, I find the courſe 51°, and the diſtance 101 which multiplied by 10 gives nearly the true diſtance 1010; in the ſame table, oppoſite to one tenth of the meridional difference of latitude 89,9, I find the departure 111.1, which multiplied by 10 gives the difference of longitude 1111 miles.

CASE III.

One latitude, courſe and diſtance given, to find the difference of latitude and difference of longitude.

A ſhip in the latitude of 42° 30′ N. and longitude of 58° 51′ W. ſails S. W. by S. 591 miles; required the latitude and longitude in?

By PROJECTION.



Draw the meridian ABC, and ADE, making an angle with it equal to the courſe 3 points, make AD equal to the diſtance ſailed, 591 miles, and from D let fall upon AB the perpendicular BD; then will BD be the departure, and AB the difference of latitude, 491 miles, Hence we have both latitudes, and the meridional difference of latitude to which make AC equal, and draw CE parallel to BD meeting ADE in E, then will CE be the difference of longitude, 419,6 miles.

By LOGARITHMS.

To find the diff. of latitude.		To find the diff. of longitude.	
As radius 8 points	10.00000	As radius 4 points	10.00000
Is to the diſtance 591	2.77159	Is to the mer. dif. lat. 628	2.79796
So is co-ſine courſe 3 pts.	9.91985	So is tang. courſe 3 points	9.82489
To prop. diff. lat. 491,4	2.69144	To diff. of long. 419,6	2.62285

Lat. left	42° 30′ N.	Mer. parts 2822	Long. left		58° 51′ W.
Dif. lat. 491=	8 11 S.		Diff. of long.	420=	7 00 W.
Lat. in	34 19 N.	Mer. parts 2194	Long. in		65 51 W.
		Mer. diff. lat. 628			

By GUNTER.

1ſt. The extent from radius 8 points to the complement of the courſe 5 points, on the line marked S R, will reach from the diſtance 591 to the difference of latitude 491.4 on the line of numbers.

2dly. The extent from the radius 4 points to the course 3 points, on the line marked T R, will reach from the meridional difference of latitude 628 to the difference of longitude 419.6 on the line of numbers.

By INSPECTION.

As in Case I. Plane Sailing, find the course at the top or bottom of the tables, either among the points or degrees, and in that page, opposite the distance, will be found the difference of latitude and departure in their respective columns; then in the same table find the meridional difference of latitude in the latitude column; corresponding to which, in the departure column, will be the difference of longitude.

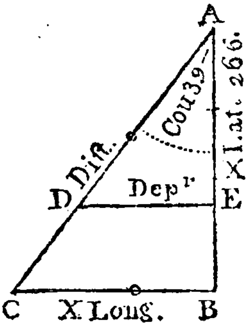
Thus, under the course 3 points, and opposite one third of the distance 197, stands 163.8 in the latitude column, which multiplied by 3 gives the difference of latitude 491.4 miles; then find one fourth of the meridional difference of latitude 157 in the latitude column, against which stands 105 in the departure column, which multiplied by 4 gives 420, the difference of longitude.

CASE IV.

Both latitudes and course given, to find the distance, and difference of longitude.

A ship from the latitude of 49° 57′ N. and longitude of 30° W. sails S. 39° W. till she arrives in the latitude of 45° 31′ N. required the distance run and longitude in?

Lat. left	49° 57′N.	Mer. parts	3470
Lat. in	45 31 N.	Mer. parts	3074
Diff. lat.	4 26=266 miles.	Mer. dif. lat.	396



By PROJECTION.

Draw the meridian AEB, on which take AE equal to the proper difference of latitude 266 miles, and AB equal to the meridional difference of latitude 396 miles; make the angle BAC equal to the course 39°, and draw ED, BC, perpendicular to AB, cutting ADC in D and C; then will AD be the distance 342 miles, and BC the difference of longitude 321 miles.

By LOGARITHMS.

To find the distance.		To find the diff. of longitude.	
As the co-sine course 39°	9.89050	As radius 45°	10.00000
Is to the prop. dif. of lat. 266	2.42488	Is to mer. dif. of lat. 396	2.59770
So is radius 90°	10.00000	So is tang. course 39°	9.90837
To the distance 342.3	2.53438	To the diff. of long. 320,7	2.50607

Longitude left		30° 0′ W.
Diff. of long.	321 =	5 21W.
Longitude in		35 21W.

By GUNTER.

1ft. The extent from the complement of the courfe 51° to the radius 90° on the fines, will reach from the proper difference of latitude 266, to the diftance 342,3 on the line of numbers.

2dly. The extent from radius 45° to the courfe 39° on the line of tangents, will reach from the meridional difference of latitude 396, to the difference of longitude 321 on the line of numbers.

By INSPECTION.

As in Cafe II. Plane Sailing, find the courfe among the points or degrees and the proper difference of latitude in its column, adjoining to which are the diftance and departure in their refpective columns; then in the fame table, find the merid. diff. lat. in the lat. column, adjoining to which in the departure column is the difference of longitude.

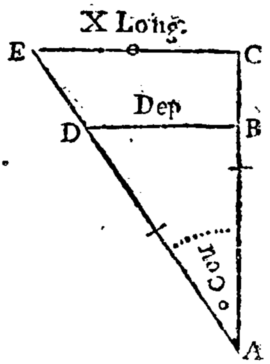
Thus under the courfe 39° and oppofite the half diff. of lat. 133 (the neareft to which is 132.9) ftand 171 and 107.6, thefe doubled give the diftance 342 and departure 215.2; and in the fame table oppofite the half mer. diff. of lat. 198 found in the latitude column, ftands 160.5 in the dep. column, which doubled gives the difference of longitude 321 miles, nearly as before.

CASE V.

Both latitudes and diftance given, to find the courfe and difference of longitude.

A fhip from the latitude of 37° N. and longitude of 32° 16′ W. fails 300 miles north-wefterly, until fhe is in the latitude of 41° N.; required the courfe fteered, and longitude in?

Lat. left	37° N.		Mer. parts	2393
Lat. in	41 N.		Mer. parts	2702
Diff. lat.	4°=240 m.		Mer. diff. lat.	309 miles.



By PROJECTION.

Draw the meridian ABC; make AB equal to the proper difference of latitude 240, and AC equal to the meridional difference of latitude 309 miles; draw BD and CE perpendicular to ABC; with an extent equal to the diftance 300 in your compaffes, and one foot in A, fweep an arch cutting BD in D; draw AD, which continue to cut CE in E, and it is done: for the angle BAD is equal to the courfe 36° 52′, BD is the departure, and CE is the difference of longitude 231.7 miles.

By LOGARITHMS.

To find the course.		To find the diff. of longitude.	
As the distance 300	2.47712	As radius 45°	10.00000
Is to radius 90°	10.00000	Is to mer. diff. of lat 309	2.48996
So is prop. diff. lat. 240	2.38021	So is tang. course 36° 52′	9.87501
To co-sine course 36° 52′	9.90309	To the diff. long. 231.7	2.36497

Longitude left	-	32° 16′ W.
Diff. of longitude 232	=	3 52 W.
Longitude in		36 08 W.

By GUNTER.

1st. The extent from the distance 300 to the proper difference of latitude 240, on the line of numbers, will reach from the radius or 90° to 53° 8′, the complement of the course, on the line of sines.

2dly. The extent from radius 45° to the course 36° 52′, on the line of tangents, will reach from the meridional difference of latitude 309 to the difference of longitude 231.7, on the line of numbers.

By INSPECTION.

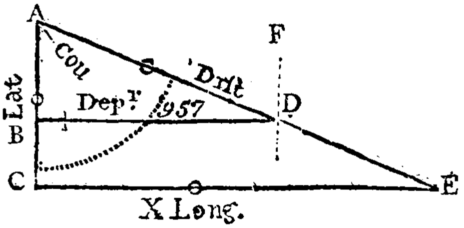
As in Case IV. Plane Sailing, seek in the tables till against the distance taken in its column be found the given difference of latitude in one of the following columns; adjoining to it stands the departure, which if less than the difference of latitude, the course is found at the top, otherwise at the bottom; in the same table find the meridional difference of latitude in the latitude column, adjoining to which in the departure column stands the difference of longitude.

Thus the distance 300 and the difference of latitude 240, are found to correspond to a course of 37°, and a departure 180,5; and in the latitude column, opposite half the meridional difference of latitude 154,5 (the nearest to which is 154.1), stands 116.2 in the departure column, which doubled gives the difference of longitude 232.4.

CASE VI.

One latitude, course and departure given, to find the distance, difference of latitude and difference of longitude.

A ship from the latitude of 50° 10′S. and longitude of 30° E. sails E. S. E. until her departure is 957 miles; required the distance sailed, and the latitude and longitude in?



By PROJECTION.

Draw the meridian ABC, and at a distance from it equal to the departure 957 miles draw the line FD parallel to ABC; make the angle BAD equal to the course 6 points, draw AD cutting FD in D; from D let fall upon AB the perpendicular DB; then will AD be the distance 1036 miles, AB the difference of latitude 396 miles; hence we have both latitudes, and the meridional difference of latitude 667 miles, make the line AC equal thereto, and draw CE perpendicular to AC meeting AD continued in E; then will CE be the difference of longitude 1610 miles.

By LOGARITHMS.

To find the distance.		Lat. left	50° 10′ S.	M. parts 3490
As the sine course 6 pts.	9.96562	Dif. lat. 396′=	6 36 S.	
Is to the departure 957	2.98091			
So is radius 8 pts.	10.00000	Lat. in	56 46 S.	M. parts 4157
To the distance 1036	3.01529	Merid. diff. lat.		667
To find the diff. of lat.		As radius 4 pts.		10.00000
As radius 4 pts.	10.00000	Is to the merid. dif. lat. 667		2.82413
Is to the departure 957	2.98091	So is tang. course 6 pts.		10.38278
So is co-tang. course 6 pts.	9.61722			
		To dif. lon. 1610′=26°50′E.		3.20691
To prop. dif. of lat. 396.4m.	2.59813	Long. left	30 00 E.	
		Long. in	56 50 E.	

By GUNTER.

1st. The extent from the course 6 points to radius 8 points on the line marked S. R. will reach from the departure 957 to the distance 1036 on the line of numbers.

2dly. The extent from radius 4 points to the complement of the course 2 points, on the line marked TR, will reach from the departure 957 to the difference of latitude 396 on the line of numbers.

3dly. The same extent (from the radius 4 points to the course 6 points on the line marked T R) will reach from the meridional difference of latitude 667, to the difference of longitude 1610, on the line of numbers.

By INSPECTION.

As in Case III. Plane Sailing, find the course either in Table I. or Table II. and the departure in its column, corresponding to which stand the distance and difference of latitude in their respective columns: in the same table find the meridional difference of latitude, in the latitude column; corresponding to which in the departure column will be the difference of longitude.

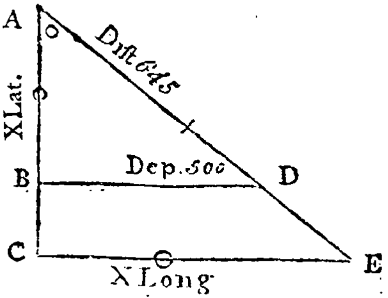
Thus over the course 6 points, and against one fifth of the departure 191,4 stand 79,2 and 207, which multiplied by 5 give the difference of latitude 396 miles, and the distance 1035 miles; then in the latitude column find a tenth of the meridional difference of latitude 66,7, the nearest to that is 66,6, against which, in the departure column, stands 160,8, which multiplied by 10 gives 1608, the difference of longitude.

CASE VII.

One latitude, distance sailed, and departure given, to find the course, difference of latitude and difference of longitude.

A ship in the latitude of 49° 30′ N. and the longitude of 25° W. sails south-easterly 645 miles, making 500 miles departure; required the course steered, and the latitude and longitude in?

By PROJECTION.



Draw the meridian ABC, on any point of which erect the perpendicular BD equal to the departure 500 miles, with an extent equal to the distance 645 miles in your compasses, and one foot in D sweep an arch cutting AB in A, join AD; then will AB be the proper difference of latitude 407,5 miles, and the angle BAD will be the course 50° 49′; hence we have the other latitude, and the meridional difference of latitude, to which make AC equal; and draw CE parallel to BD, meeting AD produced in E; then will CE be the difference of longitude, 722,6 miles.

By LOGARITHMS.

To find the course.

As the distance 645	2.80956
Is to the radius 90°	10.00000
So is the departure 500	2.69897
To sine of course 50° 49′	9.88941

To find the diff. of long.

As radius 45°	10.00000
Is to the mer. dif. lat. 589	2.77012
So is tang. course 50° 49′	10.08879
To diff. long. 722.6	2.85891

Or thus,

As prop. dif. lat. 407.5 *	2.61014
Is to the departure 500	2.69897
So is the mer. diff. lat. 589	2.77012
	5.46909
	2.61014
To diff. long. 722,7	2.85895

To find the diff. of lat.

As radius 90°		10.00000
Is to the distance 645		2.80956
So is co-sine course 50° 49′		9.80058
To dif. l. 407,5 = 6° 48′ S.		2.61014
Lat. left	49 30 N.	M. par. 3428
Lat. in	42 42 N.	M. par. 2839
Mer. diff. lat.		589
Long. left	25° 00′ W.	
Diff. long.	12 03 E.	
Long. in	12 57 W.	

Hence the ship's course is S. 50° 49′ E. Lat. in 42° 42′ N. Long. in 12° 57′ W.

By GUNTER.

1st. The extent from the distance 645 to the departure 500 on the line of numbers, will reach from the radius 90° to the course 50° 49′ on the line of sines.

2dly. The extent from radius 90° to the complement of the course 39° 11′ on the line of sines, will reach from the distance 645 to the difference of latitude 407,5 on the line of numbers.

3dly. The extent from the radius 45° to the course 50° 49′ on the line of tangents, will reach from the mer. diff. of lat. 589 to the difference of longitude 722.6 on the line of numbers. Or, the extent from the proper

* This log. was found above, it differs a little from the log. of 407,5.

difference of latitude 407,5 to the departure 500, will reach from the meridional difference of latitude 589 to the difference of longitude 722.7 on the line of numbers.

By INSPECTION.

Find the courſe and difference of latitude, as in Caſe V. Plane Sailing, by ſeeking in Tab. II. till the diſtance and departure are found to correſpond in their reſpective columns, adjoining to which in the column of latitude will be found the true difference of latitude; which if greater than the departure the courſe is found at the top; but if leſs, the courſe is found at the bottom; with this courſe ſeek the meridional difference of latitude in the latitude column, adjoining to which in the departure column will be found the difference of longitude.

Thus one third of the diſtance 215, and one third of the departure 166,7 are found nearly to correſpond to a courſe of 51 degrees, and a difference of latitude of 135.3, which multiplied by 3, gives the true difference of latitude 406 nearly.

Then one fourth of the meridional difference of latitude 147, in the latitude column, is found nearly to correſpond to the departure 181.9; this multiplied by 4, gives 727.6 the difference of longitude nearly.

Having explained the method of calculating ſingle courſes by Middle Latitude and Mercator's Sailing, it now remains to explain the method of calculating compound courſes. To do this, you muſt conſtruct a traverſe table, and find the difference of latitude and departure for each courſe and diſtance, as in Traverſe Sailing; and from thence the whole difference of latitude, departure and latitude in; with the departure and latitudes, find the difference of longitude and longitude in, as in Caſe II. of Middle Latitude or Mercator's Sailing.

This method is exact enough for working any ſingle day's work at ſea, except in high latitudes, where it will be a little erroneous; in this caſe, the difference of longitude and longitude in may be calculated for every ſingle courſe and ſhort diſtance; but in general, this nicety in calculation may be neglected.

To illuſtrate the method of working compound courſes, we ſhall here work an example, by Middle Latitude and Mercator's Sailing.

EXAMPLE.

A ſhip from Cape Henlopen, in the latitude of 38° 47′ N. longitude 75° 10′ W. ſails the following true courſes, viz. E. by S. 20 miles, E. N. E. 15 miles, S. E. 26 miles, South 16 miles, W. S. W. 6 miles, N. W. 10 miles, and Eaſt 30 miles; required her latitude and longitude?

TRAVERSE TABLE.

Courſes.	Dis.	Diff. Lat. N.	Diff. Lat. S.	Departure. E.	Departure. W.
E. by S.	20		3.9	19.6	
E. N. E.	15	5.7		13.9	
S. E.	26		18.4	18.4	
South.	16		16.0		
W.S.W.	6		2.3		5.5
N. W.	10	7.1			7.1
Eaſt.	30			30.0	
		12.8	40.6	81.9	12.6
			12.8	12.6	
		D. Lat.	27.8	69.3	Dep.

By conſtructing the Traverſe Table with theſe courſes and diſtances, it appears that the ſhip has made 27.8 miles of ſouthing, and 69.3 miles of eaſting; and by ſubtracting the ſouthing from the latitude of Cape Henlopen, there remains the latitude in 38° 19′ N.

Cape Henlopen's latitude	38° 47′ N.	Meridional parts	2528
Latitude in	38 19 N.	Meridional parts	2492
Sum of latitudes	77 6		36
Middle latitude	38 33		

By inspection of Table II. it appears that the difference of latitude 27.8 and departure 69.3 correspond to a course of 68° nearly and a distance of 75 miles; and in the same page of the table, opposite to the meridional difference of latitude, found in the column of latitude, stands the difference of longitude 89 miles in the departure column; this subtracted from the longitude of Cape Henlopen 75° 10′ W. leaves the longitude in 73° 41′W. by Mercator's Sailing. Or, with the middle latitude 38° 33′ to 39° as a course, find the departure 69.3 in the latitude column, opposite to which is 89 in the distance column, which is the difference of longitude by Middle Latitude Sailing; consequently the longitude in is 73° 41′ W. as above.

Thus we see that such examples are performed as in Traverse Sailing and Case II. of Mercator's or Middle Latitude Sailing, either by inspection as above, or by the scale or logarithms.

Having gone through the necessary problems in Mercator's Sailing, we shall now shew how Mercator's Chart may be constructed by means of the Table of Meridional Parts.

To construct a Mercator's Chart to commence at the Equator.

Suppose it was required to construct the Chart in the plate affixed to this work, which begins at the equator, and reaches to the parallel of 50 degrees; and contains 95 degrees of longitude west of the meridian of London.

Draw the line AD representing the equator, then take, from any scale of equal parts, the number of minutes contained in 95 degrees, viz. 5700, which set off from A to D; subdivide this line into 95 equal parts representing degrees of longitude. Through A and D, draw the lines AB, DC perpendicular to AD, and make each of them equal to 3474 which are the meridional parts corresponding to 50 degrees. Join BC which must be subdivided in the same manner as the line AD; and through the corresponding points of the lines AD, BC, must be drawn (at the distance of 10° or 20°) the lines parallel to AB, representing meridians of the earth; these lines must be numbered 0, 10, 20, &c. beginning at the line AB which represents the meridian of London. Set off in like manner upon the meridians AB, DC, (beginning from the equator AD) the meridional parts corresponding to each degree of latitude from 0° to 50°; and through the corresponding points (at the distance of 10° or 20°) draw lines, parallel to the equator AD, to represent the parallels of latitude. Then the upper part of the Chart will represent the north, the lower the south, the right hand the east, and the left hand the west (which is generally supposed in Charts unless the contrary is expressly mentioned).

If the Chart does not commence at the equator, but is to serve for a certain portion of the globe contained between two parallels of latitude on the same side of the equator; you must draw the meridians as directed in the last example; then subtract the meridional parts of the least latitude of the Chart, from the meridional parts of the other latitudes, and set off these differences on the extreme meridians, draw lines through the corresponding points and they will be the parallels of latitude on the Chart.

If the Chart is to be bounded by parallels of latitude on different ſides of the equator; you muſt draw a line repreſenting the equator, and perpendicular to it draw lines to repreſent the meridians, continuing them on both ſides of the equator; then ſet off the parallels of latitude on both ſides of the equator, in the ſame manner as in the firſt example.

Take from the table of latitude and longitude of places, the latitude and longitude of each particular place contained within the bounds of the Chart, and lay a ruler over its latitude and another croſſing that over its longitude; the point where theſe croſs will repreſent the propoſed place upon the Chart. The moſt remarkable points of a ſea-coaſt being thus laid down, lines may be drawn from point to point which will form the out-lines of the ſea-coaſt, iſlands, &c. to which may be annexed, the depths of water expreſſed in common arabiac numbers; the time of high water on the full and change days expreſſed in roman numbers; the ſetting of the tide expreſſed by an arrow; and whatever elſe may be thought convenient for the chart to contain.

This chart is not to be conſidered as a juſt repreſentation of the earth's ſurface, for in it the figures of iſlands and countries are diſtorted towards the poles, as is evident from its conſtruction. But as the degrees of latitude and longitude are increaſed in the ſame proportion, it is plain that the bearings between places will be the ſame on the chart as on the globe: and ſince the meridians are right lines, it follows, that the rhumbs, which form equal angles with the meridians, will be ſtraight lines, which render this projection of the earth's ſurface much more eaſy and proper for the mariner's uſe than any other.

Having the latitude and longitude of a ſhip or place, to find the correſponding point on the chart.

RULE. Lay a ruler acroſs the chart in the given parallel of latitude; take in your compaſſes the neareſt diſtance between the given longitude and the neareſt meridian drawn acroſs the chart; put one foot of the compaſſes in the point of interſection of the ruler and meridian, and extend the other along the edge of the ruler on the ſame ſide of the meridian as the place lies, and that point will repreſent the place of the ſhip.

If the longitude on the Chart be counted from a different meridian from that you reckon from, you muſt reduce the given longitude to the longitude of the Chart, by adding or ſubtracting the difference of longitude of thoſe meridians; and then prick off the ſhip's place as before directed. Or, you may draw a meridian line through the place you reckon your longitude from; then meaſure off the ſhip's longitude on the equator, and apply it to the edge of the ruler, from this meridian, and you will obtain the ſhip's place.

To find the bearing of any place from the ſhip.

RULE. Lay a ruler acroſs the given place and place of the ſhip; ſet one foot of the compaſſes in the centre of ſome compaſs near the ruler, and take the neareſt diſtance to the edge of the ruler; ſlide one foot of the compaſſes along that edge keeping the other extended to the greateſt diſtance, and obſerve what point of the compaſs it comes neareſt to, for that will be the bearing required.

To find the diſtance of any place from the ſhip.

RULE. Take the diſtance between the ſhip and given place in your compaſſes and apply it to the ſide of the chart or graduated meridian, ſetting one foot as much above one place as the other is below the other place; the number of degrees between the points of the compasses will be the distance nearly.

When the places bear north and south of each other this rule is accurate; but when they bear nearly east and west, and the distance is large, it will err considerably; but in general it is exact enough for common purposes; if greater accuracy is required, it is best to find the distance by calculation.

If any one wishes to estimate the distance accurately by the Chart, he must proceed in the following manner:

1. If the place be in the same longitude that the ship is in, then the preceding rule is accurate.

2. If the place be in the same latitude as the ship, or bear east or west, the distance cannot be obtained without calculating it by Case I. of Parallel Sailing.

3. If the place be neither in the same latitude, nor in the same longitude as the ship, the distance must be found in the following manner: Lay a ruler over both places, and draw through one of them a parallel to the equator; take the difference of latitude between both places in your compasses from the equator; slide one foot on that parallel, keeping the other extended so that both points shall be on the same meridian, and note the point of the ruler which is touched by the other foot of the compasses, take the distance from this point to the given place through which the parallel was drawn and apply it to the equator, and you will have the sought distance.

The bearing and distance of any two places from each other are found in the same manner as the bearing and distance of any place from the ship.

EXAMPLE.

Required the bearing and distance between the east end of Long-Island and the north part of Bermudas?

A ruler being laid over both places as directed in the preceding rule, it will be found to lay parallel to the N.W. by N. and S.E. by S. line; and the distance between the two places being taken in the compasses, and applied to the graduated meridian, will measure about 10 degrees or 600 miles; therefore these places bear from each other N.W. by N. and S.E. by S. and their distance is 600 miles nearly.

OF THE

Log-Line and Half-Minute Glafs.

VARIOUS methods have been propofed for meafuring the rate at which a fhip fails, but that moft in ufe is by the Log and Half-Minute Glafs.

The Log is a flat piece of thin board, of a fectoral or quadrantal form *(fee the annexed plate)* loaded in the circular fide with lead fufficient to make it fwim upright in the water: to this is faftened a line about 150 fathoms long, called the Log-line, which is divided into certain fpaces called knots, and is wound on a reel which turns very eafily. The Half-Minute Glafs is of the fame form as an hour glafs, and contains fuch a quantity of fand as will run through the hole in its neck in half a minute of time.

The making of the experiment to find the velocity of the fhip is called heaving the log, which is thus performed.—One man holds the reel, and another the half-minute glafs; an officer of the watch throws the log over the fhip's ftern, on the lee fide, and when he obferves the ftray line is run off the reel (which is about ten fathoms, this diftance being ufually allowed to carry the log out of the eddy of the fhip's wake) and the firft mark (which is generally a red rag) is going off, he cries *turn!* the glafs holder anfwers *done!* who watching the glafs, the moment it is run out fays *ftop!* the reel being immediately ftopt, the laft mark run off fhews the number of knots, and the diftance of that mark from the reel is eftimated in fathoms. Then the knots and fathoms together, fhew the diftance the fhip has run the preceding hour, if the wind has been conftant. But if the gale has not been the fame during the whole hour, or time between heaving the log, or if there has been more fail fet or handed, there muft be allowance made for it according to the difcretion of the artift. Sometimes when the fhip is before the wind, and a great fea fetting after her, it will bring home the log; in fuch cafes it is cuftomary to allow one mile in ten, and lefs in proportion, if the fea be not fo great; a proper allowance ought alfo to be made if there be a head fea.

This practice of meafuring a fhip's rate of failing is founded upon the following principle: That the length of each knot is the fame part of a fea mile, as half a minute is of an hour. Therefore the length of a fea knot fhould be $\frac{1}{120}$ of a fea mile; but by various admeafurements it has been found that the length of a fea mile is about 6120 feet; hence the length of a knot ought to be 51 feet: each of thefe knots is divided into 10 fathoms. If the glafs be only 28 feconds in running out, the length of the knot ought to be 47 feet and 6 tenths. Thefe are the lengths generally recommended in books of navigation, but it may be obferved, that in many trials it has been found, that a fhip will generally over-run her reckoning with a log-line thus marked; and fince it is beft to err on the fafe fide, I fhould recommend to fhorten the above meafures by 3 or 4 feet; making the length of a knot 7 or $7\frac{1}{2}$ fathoms of 6 feet each, to correſpond with a glaſs that runs 28 ſeconds.

In heaving the log you muſt be careful to veer out the line as faſt as the log takes it; for if the log is left to turn the reel itſelf, the log will come home and deceive you in your reckoning. You muſt alſo be careful to meaſure the log-line pretty often, leſt it ſtretch and deceive you in the diſtance. The like regard muſt be had that the half-minute glaſs be juſt 30 ſeconds, otherwiſe no account of the ſhip's way can be kept; the glaſs is much influenced by the weather, running ſlower in damp weather than in dry. The method uſually recommended to try if the glaſſes are accurate is this; on a round nail or peg hang a ſmall thread, that has a muſket ball fixed at one end, $39\frac{1}{8}$ inches being carefully meaſured from the centre of the ball to the loop which goes over the peg; then make it ſwing, and count one for every time it paſſes under the peg, beginning at the ſecond time it paſſes, and the number of ſwings which it makes during the time the glaſs is running out ſhews the ſeconds which that glaſs runs. For experience ſhews that a ſecond pendulum is about $39\frac{1}{8}$ inches in length.

To correct the diſtance when the log-line and half-minute glaſs are faulty.

If there be any error in the log-line or glaſs, the meaſured diſtance muſt be corrected in the following manner, ſuppoſing that a 30″ glaſs requires 50 feet to a knot.

(1.) If the glaſs only is faulty, you muſt ſay, *as the ſeconds run by the glaſs are to 30 ſeconds, ſo is the diſtance given by the log to the true diſtance.* Thus, if a ſhip ſails $8\frac{1}{2}$ knots per hour, by a glaſs of 36 ſeconds, the true number of knots per hour will be 7,1; for, 36 : 30 : : 8,5 : 7,1.

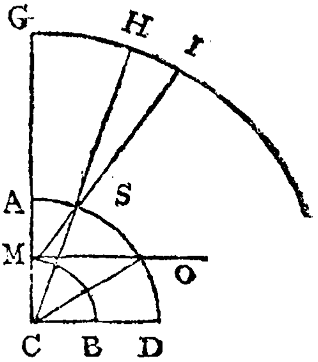
(2.) If the log-line only is faulty, you muſt ſay, *as 50 feet is to the diſtance of a knot on the line, ſo is the diſtance run by the log to the true diſtance.* Thus, if a ſhip ſails 7 knots per hour by a log-line meaſuring 53 feet, her true diſtance will be 7,4 miles per hour, becauſe, 50 : 53 : : 7 : 7,4.

(3.) If the log-line and glaſs are both faulty, you muſt ſay, *as 50* multiplied by the length of the glaſs is to 30 multiplied by the length of the line, ſo is the meaſured to the true diſtance.* Thus, if a ſhip ſails 6 knots per hour, with a glaſs of 24 ſeconds and a log-line of 60 feet per knot, her true velocity will be 9 miles per hour; becauſe $50 \times 24 : 30 \times 60 :: 6 : 9$.

* Inſtead of multiplying the length of the glaſs by 50, and the line by 30, you may multiply the former by 5 and the latter by 3. If any one chooſes to mark the log-line at leſs than 50 feet for a glaſs of 30 ſeconds, he muſt put his eſtimated length of the knot, inſtead of 50, in all the above rules.

On Parallax, Refraction, and Dip of the Horizon.

PARALLAX (or diurnal parallax), is the difference between the true altitude of the sun, moon, or star, observed at the centre of the earth, and its apparent altitude, observed at any point of the earth's surface.



The true place of any star S, is that point of the heavens H, in which it would be seen by an eye placed in the centre of the earth at C. And the apparent place is that point of the heavens I, where the star appears to an eye upon the surface of the earth at M. This difference of places, is what is called absolutely the *parallax*, or the *parallax in altitude*. This parallax diminishes the altitude of a star, or increases its zenith distance. The parallax is greatest in the horizon, called the horizontal parallax, COM. From hence it decreases all the way to the zenith A or G, where it is nothing; the real and apparent places there coinciding. Having the horizontal parallax, the parallax in altitude is easily calculated by the following rule: *As radius is to the co-sine of the apparent altitude, so is the horizontal parallax to the parallax in altitude.* This rule is easily proved; for in the triangle CMO, we have CO to CM as radius to the sine of the angle COM (which is equal to the horizontal parallax); and in the triangle CMS we have CS (which is equal to CO) is to CM as the sine of the angle CMS (or the sine of the star's apparent zenith distance) to the sine of the angle CSM (which is equal to the parallax in altitude.) Hence, radius is to the co-sine of the apparent altitude as the sine of the horizontal parallax to the sine of the parallax in altitude. But since the horizontal parallax is small in all the heavenly bodies, the sines of the parallaxes must be nearly proportional to the arches; hence we may say, as radius is to the co-sine of the apparent altitude, so is the horizontal parallax to the parallax in altitude.

The sun's parallax in altitude is given in Table XV. for every 5° or 10° of altitude. The moon's horizontal parallax is given in the 7th. page of the month of the Nautical Almanac, for every noon and midnight at the meridian of Greenwich.

REFRACTION OF THE STARS,

Is an inflexion of the rays of those luminaries, in passing through our atmosphere, by which their apparent altitudes are increased. This refraction of the rays of light takes place in passing from any medium into another; and it may be illustrated by the following experiment. Make a mark, or place any thing at the bottom of a bason or bucket, then retire till the hither edge of the bason just hides the mark from your sight; then keeping your eye steady, let another person fill the bason gently with water; as the bason fills you will perceive the mark come into view, and appear to be elevated above its former situation. In the same manner the refraction of the atmosphere causes all the stars and planets to appear more elevated than they really are. The mean quantity of this refraction is given in Table XIII. All observed altitudes of the sun, moon, planets, or fixed stars, must be decreased by the numbers taken from this table, which are to be taken out with the observed altitude of the object.

The refraction varies with the temperature and density of the air, increasing by cold or greater density, and decreasing by heat or rarity of the atmosphere. By means of Table XIII. and the observed heights of the barometer and thermometer, we may calculate the true refraction at any time, by the following rule, given by Dr. Bradley.

As the mean height of the barometer 29,6 inches is to the true height, so is the mean tabular refraction to the corrected refraction; and as 350 increased by the height of Farenheit's thermometer is to 400, so is the corrected refraction to the true refraction. Hence if the barometer be at its mean height, and the thermometer be at 10°, the refraction will be increased one-ninth part (because, 350+10 : 400 : : 1 : $1\frac{1}{9}$). In this case the horizontal refraction would be increased from 33′ to 36′ 40″; and the refraction for the altitude of 5° would be increased from 9′ 53″ to 10′ 59″. In addition to the above, we may also observe, that there is sometimes an irregular refraction near the horizon, caused by the vapours near the earth's surface.

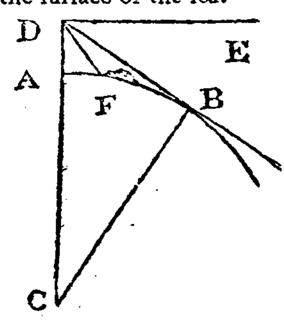
The refraction makes any terrestrial object appear more elevated than it really is: the quantity of this elevation varies at different times, but is in general about $\frac{1}{11}$ of the angle formed at the centre of the earth, between the object and the eye of the observer.

In Table XVIII. is given the correction of the moon's altitude for the combined effect of parallax and refraction. The numbers of that table are to be added to the observed altitudes, to obtain the true altitudes. That table is to be entered with the apparent zenith distance of the moon's centre at the top, and the moon's horizontal parallax in the side column; under the former and opposite to the latter is the correction sought.

DIP OF THE HORIZON,

Is the angle of depression of the visible horizon below the true, arising from the elevation of the observer's eye above the surface of the sea.

Thus, let AFB be the surface of the earth, C its centre, D the eye of the observer; join CD, draw DB touching the surface in B, and draw also DE perpendicular to CD: then will DE be the true horizon, and DB the visible horizon (exclusive of the terrestrial refraction.) But in observing an altitude with a Hadley's quadrant, the image of the object is brought down to the visible horizon in the direction DB; therefore the angle of elevation given by the quadrant is too great by the angle BDE. This angle is decreased a little by means of the terrestrial refraction, which makes the point B appear within the limit of the visible horizon of the observer at the point D. The quantity of this dip is given in Table XIV. for every probable height of the observer expressed in feet, and is evidently subtractive from the observed altitude.



When the limit B, of the horizon, is not visible by reason of the land at F, an observation of the altitude of any object may be made, by bringing its reflected image to the surface of the water at F. The dip, in that case, will be equal to the angle EDF; and its values for various altitudes and distances of the land, are given in Table XVII. which numbers are to be used instead of those of Table XIV. when occasion may require. This table is to be entered in the top column, with the height of the eye above the surface of the sea in feet, and in the left hand column with the distance of the ship in sea miles; and directly under the former, and opposite to the latter, stands the dip of that point in minutes of a degree, which is to be subtracted from the observed altitude instead of the numbers of Table XIV. In calculating this table, attention was paid to the terrestrial refraction.

To find the Sun's Declination.

THE declination of the ſun is given to the neareſt minute in Tab. V. for every noon at Greenwich, from the year 1800 to 1804; and this table will anſwer for ſome years beyond that period, without any material error: if great accuracy is required, the declination may be taken from the ſecond page of the month of the nautical almanac,* where it is marked to ſeconds. This declination may be reduced to any other meridian, by means of Table VI. in the following manner.

To find the ſun's declination at noon, at any place.

RULE. Take out the declination for noon at Greenwich from Table V. (or from the nautical almanac); find your longitude in from Greenwich (or London) in the top column of Table VI. and the day of the month in the ſide column; under the former, and oppoſite to the latter, is a correction in minutes and ſeconds, which is to be applied to the declination taken from Table V.; to know whether it is additive or ſubtractive, you muſt look at the top of that column where you found the day of the month, and you will ſee it noted whether to add or ſubtract, according as your longitude is eaſt or weſt. This correction being applied, you will have the declination at noon at the given place.

EXAMPLE I.

Required the true declination of the ſun at the end of the ſea-day, October 10, 1804, in the longitude of 52° E. of Greenwich.

Sun's declination Oct. 10, at Greenwich at the end of the ſea day, or beginning of the day in the N. A. by Tab. V.		6° 40′ S.
Variation of dec. Tab. VI. Oct. 10. in 52° E. long.	ſub.	0 3
True dec. noon Oct. 10, in long. 52° E.		6 37 S.

EXAMPLE II.

Required the ſun's declination at noon ending the ſea day of March 12, 1804, in the longitude of 115° W. of Greenwich.

Sun's declination March 12, by Tab. V. - -		3° 16′ S.
Var. Tab. VI. March 12, long. 115° W.	ſub.	7
True declination, noon March 12, long. 115° W.		3 9 S.

The preceding correction ought always to be applied to the declination uſed in working a meridian obſervation to determine the latitude, though many mariners are in the habit of neglecting it.

* In finding the declination, or any other quantity, in the nautical almanac, you muſt be careful to note the difference between the civil, nautical, and aſtronomical account of time. The civil day begins at midnight, and ends the following midnight, the interval being divided into 24 hours, and is reckoned in numeral ſucceſſion from 1 to 12, then beginning again at 1 and ending at 12. The nautical or ſea day begins at noon, 12 hours before the civil day, and ends the following noon; the firſt 12 hours are marked P. M. the latter A. M. The aſtronomical day begins at noon, 12 hours after the civil day, and 24 hours after the ſea day; it is divided into 24 hours, numbered in numeral ſucceſſion from 1 to 24, beginning at noon, and ending the following noon. All the calculations of the nautical almanac are adapted to aſtronomical time; the declination marked in the nautical almanac, or in Table V. is adapted to the beginning of the aſtronomical day, or to the end of the ſea day; it being the end of the ſea day when mariners want the declination to determine their latitude.

To find the ſun's declination at any time, under any meridian.

RULE. Reduce the ſun's declination from noon at Greenwich to the noon under the given meridian, by the preceding rule. Then enter Table VI. with the time from noon at the top, and the day of the month in the ſide column; under the former, and oppoſite to the latter, is the correction to be applied to that reduced declination. To know whether it is additive or ſubtractive, you muſt look at the top of the column where you found the day of the month, and you will find it noted whether to add or ſubtract, according as the time is before or after noon.

EXAMPLE III.

Required the ſun's declination October 10, 1804, ſea account, at 8h. 21′ in the forenoon, in the longitude of 52° E. of Greenwich.

Sun's declination Oct. 10, at Greenwich, at noon, by Tab. V.		6° 40′ S.
Variation for 52° E. long. - -	ſub.	3
Declination at noon, October 10, in long. 52° E.		6 37 S.
Variation of dec. for 3h. 39′ from noon* Oct. 10.	ſub.	3
True declination Oct. 10. in long. 52° E. at 8h. 21′ A. M.		6 34 S.

EXAMPLE IV.

Required the ſun's declination May 10, 1804, ſea account, at 5h. 30m. P. M. in the longitude of 35° 30′ W. of Greenwich ?

Variation of declination May 10, in long. 35° 30′W. additive	1′ 37″
Variation of declination for 5h. 30′ P. M. additive	3 44
Sum additive	5 21
May 10, ſea account, is May 9, by N. A. at which time ſun's declination - -	17 22 42
True declination May 10, 5h. 30′ P. M. ſea account in long. 35° 30′ W. - -	17 28 03 N.

EXAMPLE V.

Required the ſun's declination March 26, 1804, ſea account, at 3h. P. M. in the longitude of 120° E. of Greenwich ?

Variation of declination March 26, in long. 120° E.	ſub.	7′ 50″
Variation for 3 hours P. M.	add	2 56
Diff. is ſubtractive becauſe the greateſt number is ſo		0 4 54
March 26, ſea acc. is Mar. 25 by N.A. at which time ſun's decl.		1 51 11N
True declination March 26, 3 h. P. M. ſea account		1 46 17N

* In the preſent example, the time is Oct. 10. 8h. 21′ A. M. which evidently wants 3h. 39′ of the end of the ſea day Oct. 10, for which time the declination is marked in Table V.

Deſcription and Uſe of the QUADRANT or SEXTANT of REFLEXION.

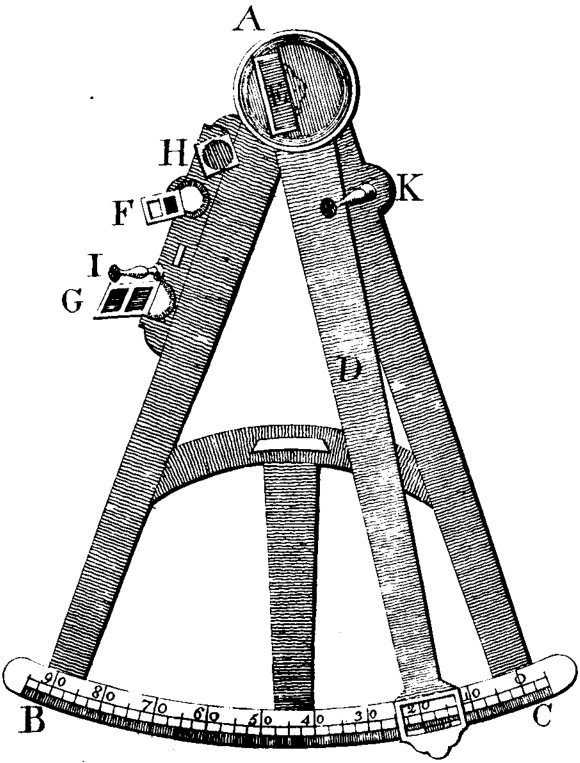
MR. JOHN HADLEY was the firſt publiſher of the deſcription of the *Quadrant of Reflexion*, for meaſuring angular diſtances; and the inſtrument ſtill bears his name, although it has been aſcertained that Sir Iſaac Newton invented a ſimilar inſtrument many years before, but never made it public: one of our countrymen, Mr. Thomas Godfry, of Philadelphia, had alſo contrived an inſtrument on the ſame principles ſome time before Hadley made known his diſcovery.

In the adjoined plate we have given a figure of the quadrant; the principal parts of which are, the graduated arch BC, the index D, the vernier, the index glaſs E, the horizon glaſſes G and H, the dark glaſſes or ſcreens H, and the ſight vanes K and I.

The graduated arch BC contains only 45°, but is to be eſteemed as 90°, and ſo divided, becauſe by the double reflexion the angle is doubled. Each degree is divided into three parts of 20 minutes each; and the arch is numbered from the right to the left, beginning at 0° and ending at 90°. The index D is a flat bar moveable round the centre of the inſtrument, where is fixed the index glaſs E; at the other end is fixed the vernier ſcale: from the bottom of the index a piece of braſs turns up againſt the back of the inſtrument, with a ſcrew to it, ſerving to faſten the index againſt any diviſion. The vernier is a ſmall narrow ſlip of braſs or ivory, fixed to that part of the index which ſlides over the graduated arch; its uſe is to ſubdivide the arch into minutes, and in common quadrants the breadth of it is equal to 7 degrees of the arch, which on the limb of the quadrant is divided into 21 equal parts, but on the vernier is only divided into 20 equal parts; conſequently each diviſion of the ſcale of the vernier is greater than a diviſion of the limb by $\frac{1}{20}$ part of one of theſe diviſions, that is, by one minute. Therefore the difference between the firſt diviſion of the vernier and limb is 1′; the difference of the ſecond diviſion is 2′; the difference of the third diviſion is 3′, &c. And theſe diviſions of the vernier are marked in ſuch manner, that having found the lines which coincide on the limb and vernier, the mark correſponding will be the exceſs of the meaſured angle above that diviſion of the arch of the quadrant which immediately precedes the mark o of the vernier. Thus if the mark o of the vernier pointed exactly to the firſt diviſion of the arch between 6° and 7°, the angle would be 6° 20′; if it pointed to the ſecond diviſion it would be 6° 40′: if the mark o had paſſed juſt beyond this ſecond diviſion, 6° 40′, and the mark 7 of the vernier was found to touch a mark of the arch, the angle would be 6° 47′.

The index glaſs E is a piece of glaſs truly ground, ſilvered on the back, and fixed in a braſs frame perpendicularly to the index: its uſe is to receive the rays proceeding from any object, and reflect them to the horizon glaſſes F and G. At the back of the braſs frame of this glaſs, are two ſcrews ſerving to adjuſt the glaſs perpendicularly to the index.

HADLEY'S QUADRANT.



The principal Parts of this Inſtrument are

The Index . . . . D.
The Index Glaſs . . . . . . E.
The Horizon Glaſses G. *and* . F.
The dark Glaſses or Screens H.
The Sight Vanes K *and* . . . I.

Newbury port Published by Edmund M. Blunt.

The horizon glaſſes F and G are ſmaller pieces of ground glaſs, one part of which is ſilvered, and the other part open or unſilvered, in order to look at an object through it. Theſe are ſet in frames and placed perpendicularly on the limb at G and F, with ſcrews at the back to adjuſt them: their uſe is to receive the rays of any object reflected from the index glaſs, and again to reflect them to the eye through the holes of the ſight vanes K and I. The ſight vane K, and the horizon glaſs F, are uſed in the common or *fore obſervation*, where the obſerver's face is turned towards the objects; the others are uſed in the *back obſervation*, in which the obſerver's back is turned towards the objects. The ſight vane K, of a common quadrant, has two holes in it; that fartheſt from the plane of the inſtrument is uſed in obſerving any object in the unſilvered part of the glaſs; the other is uſed in obſerving the object in the ſilvered part.

A Sextant is exactly ſimilar to a quadrant, only the arch BC is 60° (but is counted 120°, by reaſon of the double reflexion) the adjuſtments of both inſtruments being exactly the ſame. The ſextant being deſigned for more accurate obſervations than a common quadrant, there is generally a greater degree of attention paid to make the work accurate, and to add ſuch things as render it more convenient for uſe: among theſe additions, are (1) the ſcrew fixed at the lower end of the index to regulate its motion; (2) the teleſcope to direct the ſight and magnify the objects, and (3) the handle to hold the ſextant.

To adjuſt the quadrant or ſextant for the fore obſervation.

Firſt. The index glaſs muſt be perpendicular to the plane of the quadrant. To do this, you muſt hold the index glaſs near the eye, and look right down the quadrant in ſuch manner as to ſee the arch of the quadrant direct, and at the ſame time reflected by the index glaſs; then if the arch ſeen direct, together with its reflected image, appear to be in one line, the index glaſs is truly adjuſted; if not, it muſt be rectified by means of the ſcrews placed at the back of the index glaſs; it is eaſy to diſcover which way the inclination is, by preſſing the index glaſs with your thumb while you obſerve the arch.

Secondly. The horizon glaſs muſt be perpendicular to the plane of the inſtrument. To effect this, you muſt (after adjuſting the index glaſs) hold the plane of the quadrant parallel to the horizon, the index being ſet to 0, and obſerve whether the horizon ſeen by reflexion in the horizon glaſs coincide with the direct image; if it does, then it ſtands perpendicular; but if it fall above or below, it muſt be adjuſted by the ſcrews of the glaſs to ſet it perpendicular.

Thirdly. The horizon glaſs muſt be parallel to the index glaſs when 0 on the vernier ſtands againſt 0 on the limb. To effect this, you muſt ſet the index to 0, and bring the image of any diſtant object to coincide with the object itſelf, by means of the lever attached to this glaſs. The horizon may be uſed for this purpoſe in the following manner: hold the plane of the quadrant vertical, and, by the lever on the back, bring the image of the horizon to coincide with the horizon ſeen directly at the edge of the ſilvered part of the glaſs, and this adjuſtment is completed. Inſtead of fixing the glaſſes parallel in this manner, you may examine the *error of the adjuſtment*, or *index error*, and allow it on all the meaſured angles. The index error is found as follows: hold the inſtrument in a vertical poſition, and move the index till the reflected image of the horizon, ſeen in the ſilvered part of the horizon glaſs, forms a ſtraight line with the direct image of the horizon ſeen in the unſilvered part; then the number of minutes by which o on the index differs from o on the arch, is the error of the inſtrument. If o on the index be to the left hand of o on the arch, that number of minutes is to be ſubtracted from all obſervations; but if it ſtand off the arch, or to the right hand of o on the arch, it muſt be added to the obſervations. Inſtead of the horizon you may make uſe of the moon or ſun, by bringing the direct and reflected image of their limbs together, and by this means diſcover the index error as in the former method. There is alſo another very accurate way of finding the index error, by meaſuring the diameter of the ſun, before and behind the mark o on the arch; that is, bring the upper limb of the object to coincide with the lower, and note the angle on the arch of the quadrant or ſextant; then move the index to the right hand of o on the arch, ſo as to bring the lower limb of the ſun to coincide with the upper, and note the angle* on the extra or right hand limb of the inſtrument; half the difference of theſe two angles will be the true correction, or the index error. This correction is to be added to all the angles when the diameter meaſures moſt on the right hand of the arch; but if it meaſures leaſt on that arch, the correction is ſubtractive. Thus if it meaſured 38′ on the arch, and 26′ on the extra arch, half the difference of theſe two, or 6′, is the correction ſubtractive.

Fourthly. There is another adjuſtment neceſſary in nice admeaſurements, particularly in meaſuring the lunar diſtances to determine the longitude. This adjuſtment conſiſts in placing the teleſcope parallel to the plane of the inſtrument. The method of doing this, is by meaſuring the angular diſtance of any two objects (as the ſun and moon) diſtant above 90 degrees; in doing of which, the wires in the focus of the eye-glaſs of the teleſcope muſt be firſt placed parallel to the plane of the inſtrument; then the index muſt be moved, and the ſextant held in ſuch a poſition, that the reflected image of the ſun may appear in nice contact with the moon on the centre of the wire neareſt the ſextant; then taking care that the index is not the leaſt moved, direct the teleſcope, in an inſtant, ſo that the images may appear in the centre of the outer wire which is fartheſt from the ſextant, and if the contact appear the ſame at this wire, the axis of the teleſcope is parallel to the plane of the ſextant; on the contrary, if the limbs of the objects appear to ſeparate or lap over at the wire which is fartheſt from the ſextant, the teleſcope is not parallel, and muſt be corrected by turning one of the two ſcrews of the ring into which the teleſcope is ſcrewed and fixed, having previouſly unturned the other ſcrew; and this method muſt be purſued until the diſtance of the objects is found perfectly the ſame on each wire, which ſtands equidiſtant from the centre of the teleſcope and parallel to each other, in which caſe the axis of the teleſcope will be exactly parallel to the plane of the ſextant. Then you may proceed to meaſure the angles for the obſervations, obſerving to bring the limbs of the objects in exact contact, in the centre, between the two wires beforementioned, and never above or below.

As the adjuſtment of the paralleliſm of the teleſcope is often neglected in taking a lunar obſervation, I ſhall make a few remarks upon the ſubject, in order to ſhow the neceſſity of guarding againſt the error ariſing from this ſource. In meaſuring any angular diſtance by a quadrant or ſextant, *the*

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* In reading off the degrees and minutes of the extra arch, you muſt obſerve that the minutes denoted by the vernier muſt be ſubtracted from the degrees and minutes denoted by that mark of the arch which falls immediately to the right hand of o on the vernier; the remainder will be the true value of the extra arch.

eye of the observer ought to be at the same distance from the plane of the instrument, as that point of the horizon glass where the objects are seen in contact; if the eye be more or less elevated above that plane, the angular distance shewn by the instrument will *always be too great*; the quantity of this error may be estimated by means of the adjoined table, in which the numbers at the top represent the angle formed by a parallel to the plane of the instrument, and the line drawn from the eye of the observer to the point of contact of the horizon glass; the numbers at the left side are the angular distances measured; the corresponding numbers are the corrections, which are *always to be subtracted* from the observed distances. Instead of the angle of elevation given in the top column, we may use the difference of elevation expressed in hundredth parts of an inch, in the second horizontal column; the corresponding tabular numbers being the correction of a common sized instrument, in which the distance between the eye of the observer and the proper point of contact of the horizon glass is 6 inches. If that distance be greater or less than 6 inches, the numbers of the table must be varied in the inverse proportion of that distance. Thus if the angle of elevation is 2° 52′, and the distance measured is 100°, the correction corresponding will be 10′ 13″, to be subtracted from the observed distance 100°. If the elevation of the eye is one-tenth of an inch above the point of contact, the correction for an observed distance 120° will be 1′ 39″ for a common sized instrument; but if the instrument be small, so that the distance of the eye from the point of contact is only 4 inches, this correction must be increased in the ratio of 6 to 4, and will therefore be 2′ 29″.

Distance measured.	Angle of elevation.					
	20′	0°57′	1°26′	1°55′	2°23′	2°52′
	Elevation in hundredths of an inch.					
	5	10	15	20	25	30
Deg.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.
30	0 4	0 15	0 35	1 1	1 36	2 18
40	0 5	0 21	0 47	1 23	2 10	3 7
50	0 7	0 27	1 0	1 47	2 47	4 0
60	0 8	0 33	1 14	2 12	3 26	4 57
70	0 10	0 40	1 30	2 40	4 10	6 0
80	0 12	0 48	1 48	3 12	5 0	7 12
90	0 14	0 57	2 9	3 49	5 57	8 34
100	0 17	1 8	2 34	4 33	7 6	10 13
110	0 20	1 22	3 4	5 27	8 30	12 14
120	0 25	1 39	3 43	6 36	10 19	14 50

The angular distance of the wires of the telescope is useful in estimating the correction to be taken from the preceding table. This angle may be measured in the following manner: fix the telescope in the sextant so that the wires may be perpendicular to the plane of the instrument, the index being fixed at 0, hold the instrument in a vertical position, and fix the index so that the direct and reflected image of the horizon may appear in the same line, which it will do when the index is at 0, if the instrument is rightly adjusted; then move the index till the reflected image be at one wire, and the direct image at the other; the angle moved through by the index, as shewn by the divisions of the arch, will be the angular distance of the two wires;* half of which will be the elevation of the upper, or depression of the lower wire (they being placed at equal distances from the axis of the telescope, which is supposed parallel to the plane of the instrument.) Thus if the arch shewn by the index is 2° 52′, its half, or 1° 26′,

* This may also be obtained by bringing the direct image of the sun, or any distant object, at one wire, and the reflected image at the other, instead of making use of the horizon.

will be the elevation of the upper wire: if the contact of the objects be observed at that wire, and the measured distance is 80°, the tabular correction to be subtracted will be 1′ 48″. If the contact be observed mid-way between the centre and outer wire, the angle of elevation will be the half of 1° 26′, or 43′; the tabular correction corresponding to this elevation and the distance 80° is about 27″.

Most navigators have observed, that when the sun is near the zenith, his observed meridian altitude, and the latitude deduced therefrom, are often erroneous: the chief source of this error is the correction we have just spoken of. For if the sun's altitude was 80°, and his image was seen at the horizon glass (in contact with the horizon) at three-tenths of an inch greater distance from the plane of the instrument than the eye of the observer, the observed altitude (by a common sized instrument) would be too great by 7′ 12″, as is evident from the table. This single example shows the necessity of attending to this correction, when taking an observation to determine the latitude by an object near the zenith.

To take the altitude of the sun by the fore observation.

If the sun is bright, turn down the screens; hold the instrument vertical, and turning towards the sun, direct the sight to that part of the horizon beneath it, and moving the index you may bring the image of the sun towards the horizon; if the image should be faint you may turn back the screens to see the better. Then swing the instrument backwards and forwards, making your eye the centre of motion, keeping the sun in that part of the horizon glass which is at the same distance as the eye from the plane of the quadrant, and keep moving the index at the same time till the sun's lower edge just touches the horizon; the apparent altitude of the sun's lower limb will be had at that instant on the arch of the quadrant. To this observed altitude must be applied the five following corrections. (1) The index error, if there be any. (2) The refraction, which is to be subtracted. (3) The parallax, which is to be added. (4) The dip of the horizon, which is to be subtracted. (5) The semi-diameter of the sun, which is to be added when the lower limb was observed, but subtracted when the upper limb was observed. These corrections being properly applied, you will obtain the true altitude of the sun's centre. But it may be observed, that it is customary at sea to add 12 miles to the observed altitude, for the semi-diameter, dip, and parallax.

To take the altitude of the moon by the fore observation.

The moon's altitude may be taken by the fore observation, exactly in the same manner as the sun's altitude, only here you must bring that edge of the moon into contact with the horizon which is round and well defined, whether it be the upper or lower edge, and the same corrections must be applied as to the sun's altitude, viz. (1) Index error. (2) Parallax and refraction from Tab. XVIII.* to be added. (3) The moon's semi-diameter is to be found in page 7th. of the month of the Nautical Almanac, and corrected for the augmentation Tab. XVI.; this corrected semi-diameter is to be added if the lower limb was observed, but subtracted if the upper limb was observed. (4) The dip of the horizon is to be subtracted. Thus you will obtain the correct altitude of the moon's centre.

*The horizontal parallax of the moon, which is one of the arguments of this table, is found in page 7th of the month of the Nautical Almanac. The other argument being the apparent altitude of that part of the moon which was observed.

To find the altitude of a ſtar by the fore obſervation.

Set the index at o, and holding the plane of the quadrant vertical, direct the ſight to the ſtar, and at the ſame time look for the reflected image of the ſtar in the ſilvered part of the horizon glaſs; move the index a little, which will ſeparate the reflected image from the direct image, the former being diſtinguiſhed from the latter by its motion; continue to advance the index, and follow the reflected image with your eye, directing the ſight lower and lower, and changing the poſition of the quadrant, as the ſtar's image deſcends, till you have brought it down to the horizon; then you muſt ſwing the quadrant, as in obſerving the ſun, to ſee that the ſtar does not dip below it; the index will then ſhew the obſerved altitude of the ſtar: this altitude muſt be corrected, (1) for the index error; (2) the refraction to be ſubtracted; (3) the dip to be ſubtracted; and you will have the true altitude of the ſtar; for none of the ſtars have either ſemi-diameter or parallax, worthy of notice.

To take the meridian altitude of an object.

In places where the object does not ſet, it comes to the meridian twice in 24 hours; once above the pole at its greateſt altitude, and once below it at its leaſt altitude. To obſerve the greateſt meridian altitude, you muſt begin a few minutes before the time of paſſing the meridian, and obſerve the altitude from time to time; when it remains for ſome time without any conſiderable increaſe, you muſt be attentive to obſerve the coincidence of the object with the horizon till it perceptibly dips below the edge of the ſea; the quantity thus obſerved is the greateſt meridian altitude. But when you want to obſerve the leaſt meridian altitude (below the pole) you muſt begin a few minutes before the time of paſſing the meridian, and obſerve from time to time till you obtain the leaſt altitude. In making theſe obſervations it would be convenient to have a watch well regulated, by which you could tell within a minute or two when to begin your obſervations.

To meaſure the diſtance between the ſun and moon.

Turn down one of the ſcreens, and hold the quadrant or ſextant, ſo that its plane may paſs through the ſun and moon; look at the moon through the tranſparent part of the horizon glaſs, and keeping her there, move the index gently until the ſun's image is brought into the ſame part of the horizon glaſs; bring the neareſt limbs of both objects into contact; move the arch of the inſtrument gently up and down, and the ſun will appear to riſe and fall by the ſide of the moon. Move the index until their limbs exactly touch each other; when this is done, the obſervation is made, and the index will ſhew the angular diſtance, which is beſt read off by a magnifying glaſs. But you muſt be careful, in making this obſervation, to bring the point of contact of the moon's limb in the centre of the teleſcope, or at the ſame diſtance from the plane of the inſtrument that the eye of the obſerver is.

To meaſure the diſtance between the moon and a ſtar.

Turn down the green ſcreen if the moon is bright, and direct the plane of the inſtrument through both objects; look at the ſtar through the tranſparent part of the horizon glaſs; keep it there, and bring the moon's image into the ſame part of the glaſs; let the inſtrument gently librate about the ſtar's ray, and the moon will appear to riſe and fall by the ſtar; between the librations move the index till the moon's enlightened limb is touched by the middle of the ſtar, and the obſervation is made.

The round or enlightened limb of the moon, whether it be the neareſt or fartheſt from the ſtar, muſt be brought into contact with it; the point of contact being in the centre of the telescope, or equally distant with the eye from the plane of the instrument.

When the object to be seen by reflexion is to the right hand of that seen directly, the instrument is held with its face upward; but when the object to be seen by reflexion is to the left hand of that seen directly, the instrument is held with its face downward.

A readiness in the use of the quadrant and sextant is best gained by practice, which the learner may render familiar to himself by observing the angular distance of objects on land, or by candles placed in various positions of a room.

All the preceding directions refer to the fore observation, we shall now add a few remarks on the method of adjusting and observing by the back observation.

To adjust the quadrant for the back observation.

(1) The index glass must be set perpendicular to the plane of the instrument as in the fore observation. (2) The horizon glass G must be set perpendicular to the plane of the quadrant, by taking off the fore sight vane and moving the index off the arch of the quadrant till the image of any distant object (as the horizon of the sea) and the object itself lie in a line perpendicular to the plane of the quadrant, and then this part of the adjustment is made the same as for the fore horizon glass, by bringing the image and object together by the two screws of the glass. (3) The other part of the adjustment is to set the plane of the back horizon glass perpendicular to the plane of the index glass when o of the vernier stands against o on the limb; this is done as follows: set the index on twice the dip of the horizon (found in Tab. XIV.) to the right hand of o on the arch; then, holding the quadrant vertical, look at the fore horizon, directly at the edge of the silvered part; and by means of the lever on the back, bring the image of the horizon behind you to coincide with it, and this adjustment is made. Or you may take, by the fore observation, the meridian altitude of the lower limb of the sun, and immediately move the index back through an arch equal to twice the dip, and make the back observation of the sun's lower limb (which in this case appears the uppermost) and if that limb just touches the horizon, the index glass stands right; but if it do not touch, you must make it to do so, by means of the lever on the back, and the adjustment is made. This last method of adjusting must be done quickly, before the sun sensibly alters in altitude; and may be frequently repeated to make the fore and back observations agree.

To take the sun's altitude by the back observation.

Put the stem of the screens H into the hole next the horizon glass G, using them according to the strength of the sun's rays. Then, the back being turned to the sun, hold the instrument in a vertical position with the arch downwards; put the eye close to the hole in the vane I, look for the horizon through the transparent slit in the glass G; with the right hand move the index, until the image of the sun, seen in the silvered part of the glass, stands even with the horizon, seen through the transparent slit, using either the upper or lower edge of the sun as is most convenient. Swing your body gently to the right and left to see if the sun's limb just touches the edge of the horizon; if it does, the observation is well made; and the degrees read off will be the apparent altitude of the sun's limb. The altitude of the moon or a star is obtained in the same manner, only observing to bring the round edge of the moon to the horizon. The altitude obtained in this manner requires the following corrections, viz. (1) The dip must be added. (2) The refraction subtracted. (3) The parallax added.

(4) The ſemidiameter of the ſun or moon muſt be ſubtracted, if the lower limb was obſerved; but added if the upper limb was obſerved. The refraction and parallax of the moon is found in Tab. XVIII. The fixed ſtars have no ſenſible parallax or ſemidiameter.

The back obſervation is but little uſed, upon account of the difficulty of adjuſting and obſerving; various remedies have been propoſed for theſe defects, but none have yet been generally adopted. The back obſervation of the altitude of any object is uſeful only when there is not an open horizon for the fore obſervation; but even in this caſe the fore obſervation might be often uſed, provided you know the diſtance of the horizon, for the dip correſponding might be taken from Tab. XVII. and the true altitude obtained. With a ſextant you may obſerve any altitude above 60° by the back horizon, this altitude being corrected for the dip and ſemidiameter, as in the fore obſervation, and ſubtracted from 180°, leaves the apparent altitude, which leſſened by the refraction, leaves the true altitude; this method I once made uſe of to determine the ſun's meridian altitude, when near Cape Cod looking out for the land; the ſun ſhone bright and the northern horizon was clear, but it was ſo foggy to the ſouthward that it was impoſſible to ſee a quarter of a mile.

Advice to ſeamen in the choice of their quadrants or ſextants.

The joints of the frame muſt be cloſe, without the leaſt opening or looſeneſs, and the ivory on the arch and vernier inlaid and fixed, ſo as not to riſe at the ends, nor above the plane of the inſtrument; all the diviſions on the arch and vernier muſt be exceeding fine and ſtraight, ſo that no two diviſions of the vernier (except the firſt and laſt) may coincide at the ſame time with the diviſions of the arch. All the glaſſes belonging to the quadrant ſhould have their ſurfaces perfectly plane, and their fore and back ſurfaces exactly parallel; to examine the index or horizon glaſs,* you muſt hold it about 10 or 12 inches from the eye, and looking ſlantways obſerve the image of ſome diſtant object; if the image appears clear and diſtinct in every part of the glaſs, it is good; but if it appear notched, or drawn with ſmall lines, the glaſs is veiny, and muſt be rejected; if more than one image is ſeen, the ſurfaces are not parallel, and the glaſs muſt alſo be rejected. To examine the dark glaſſes, you muſt bring the image of a bright diſtant object to coincide with the object ſeen directly; examine their coincidence through the different dark glaſſes, and if they do not ſeparate they are probably not defective. Or you may turn the glaſſes (if poſſible) in their cells, and if there be no ſeparation, they are perfect. If you cannot turn them in their cells, you may place them at various angles with the index glaſs, and ſee if there be no ſeparation. In making this obſervation, you muſt be careful to take objects whoſe angular diſtance does not vary during the time of obſervation. If you uſe the ſame dark glaſſes in the obſervation as in the adjuſtment, there can be no error in the obſerved angle.

Various improvements have been made in the conſtruction of quadrants and ſextants; the moſt remarkable is that made by extending the graduated arch through the whole circumference; an inſtrument of this kind is called a *circle of reflexion* and has many peculiar advantages, but not being generally uſed, we ſhall not here give a deſcription of it.

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* A ſmall error in the paralleliſm of the ſurfaces of the horizon glaſs will not materially affect a meaſured angle, becauſe the angle of incidence is nearly the ſame in all obſervations; but it is of great importance to have the ſurfaces of the index glaſs exactly parallel, particularly in meaſuring great angular diſtances. To remedy this defect of paralleliſm, Dr. Maſkelyne recommends the index glaſs to be left unſilvered on the back, and made rough and blacked.

VARIATION OF THE COMPASS.

IT was many years after the diſcovery of the compaſs, before it was even ſuſpected that the needle did not accurately point to the north pole of the world; the idea of any deviation from it being treated with contempt. But about the middle of the ſixteenth century, obſervations were made in England and France, which fully proved that the needle pointed to the eaſtward of the true north. This difference is called the *variation of the compaſs*, and is named *eaſt* when the north point of the compaſs (or *magnetic north*) is to the eaſtward of the *true* north; but when the deviation is to the weſt of the true north, it is called *weſt variation*. The quantity of this variation is found by obſerving with the compaſs the bearing of any celeſtial object when in the horizon (or, as it is called, the *magnetic amplitude*); the difference between this and the true amplitude found by calculation, is the variation. The ſame may be obtained by obſerving the magnetic azimuth of any celeſtial object (that is, its bearing by the compaſs when elevated above the horizon); the difference between this and its true azimuth found by calculation, is the variation.

Some years after the diſcovery of the variation, it was found that it did not remain conſtant; for the eaſterly variation obſerved in England gradually decreaſed, till the needle pointed to the true north; then it increaſed to the weſtward, and is now above two points.

As all the courſes ſteered by the compaſs muſt be corrected for the variation, it is of great importance to the navigator to know how to find it at any time; to do this, it is neceſſary to find the amplitude or azimuth of a celeſtial object, which may be done as follows:

To obſerve an amplitude by the azimuth compaſs.

When the centre of the ſun is about one of his diameters* above the horizon, turn the compaſs round in the box, until the centre of the ſun is ſeen through the narrow ſlit which is in one of the ſight vanes, exactly on the thread which biſects the ſlit in the other; at that inſtant puſh the ſtop which is in the ſide of the box againſt the edge of the card, and the degree and parts of a degree, which ſtand againſt the middle line on the ſtop, are the magnetic amplitude of the ſun at that time; which is generally reckoned from the eaſt or weſt point of the compaſs.

To obſerve an azimuth by the azimuth compaſs.

Turn the compaſs round in the box until the centre of the ſun is ſeen through the narrow ſlit, which is in one of the ſight vanes, exactly on the thread which biſects the ſlit on the other; or until the ſhadow of the thread falls directly along the line of the index: when either of theſe is effected, puſh in the ſtop againſt the edge of the card, and that degree and parts of a degree, which ſtand againſt the middle line of the ſtop, are the magnetic azimuth of the ſun at that time, which is generally reckoned from

* The obſervation is made at this elevation upon account of the horizontal refraction, which is nearly equal to the ſun's diameter. For greater accuracy, you may take the mean of three or four obſervations before and after the ſun paſſes that altitude.

the north in north latitudes, and from the ſouth in ſouth latitudes. At the time of making this obſervation, you muſt alſo obſerve the altitude of the ſun, in order to obtain the true azimuth.

What is here ſaid of the ſun, is in like manner to be applied to the moon and ſtars.

To find the true amplitude.

RULE.

By Logarithms. To the ſecant of the latitude (rejecting 10 in the index) add the log. ſine of the ſun's declination; the ſum will be the log. ſine of the true amplitude, or diſtance of the ſun from the eaſt or weſt point, towards the north in north declination, but towards the ſouth in ſouth declination.

By Inspection. Find the declination at the top of Table VIII. and the latitude in the ſide column; under the former, and oppoſite to the latter, is the true amplitude. When great accuracy is required, you may proportion for the odd minutes of latitude and declination.

EXAMPLE I.

Required the ſun's true amplitude at riſing, at Annapolis (Maryland) on the 22d December, 1804.

By Logarithms.

Lat. of Annapolis	39° 0'	log. ſec.	0.10950
Sun's declination	23 28	log. ſine	9.60012
True amplitude	30 49	log. ſine	9.70962

By Inſpection.

Under the declination 23° 28' and oppoſite the latitude 39°, ſtands the true amplitude 30° 49'.

Hence the true bearing or amplitude of the ſun at riſing is E. 30° 49′ S. and at ſetting it is W. 30° 49′ S.

EXAMPLE II.

Required the moon's true amplitude at ſetting, off Cape Hatteras in the latitude of 35° 8′ N. when her declination is 13° N.

By Logarithms.

Cape Hatteras' Lat.	35° 8'	log. ſec.	0.08734
Moon's declination	13 0	log. ſine	9.35209
True amplitude	15 58	log. ſine	9.43943

Hence the true amplitude at ſetting is W. 15° 58' N. and at riſing E. 15° 58' N.

By Inſpection.

Under the declination 13°, and oppoſite the latitude 35°, ſtands 15° 56', which is nearly the true amplitude: the exact value may be found, by finding the amplitude for 36° lat. and proportioning the difference for the odd miles in the latitude.

EXAMPLE III.

Required the ſun's true amplitude in the latitude of 42° 30′ N. when the ſun's declination was 20° N.

By Logarithms.

Latitude	42° 30'	log. ſec.	0.13237
Sun's declination	20° N.	log. ſine	9.53405
True amplitude	27° 38'	log. ſine	9.66642

Hence the amplitude at ſetting is W. 27° 38' N. and at riſing E. 27° 38' N.

By Inſpection.

Under the declination 20°, and oppoſite the latitudes 42° and 43°, ſtands 27° 24' and 27° 53'; the mean of theſe gives the true amplitude for the latitude of 42° 30' = 27° 38'.

To find the true azimuth at any time.

At the time of obſerving the magnetic azimuth, you muſt alſo obſerve the altitude of the object; this muſt be corrected as uſual for the dip, parallax, refraction, &c. in order to obtain the true altitude: you muſt alſo find the declination of the object, and the latitude of the place of obſervation; and then the true azimuth may be calculated by the following rule.

Rule. Add together the complement of the latitude, the complement of the true altitude, and the polar diſtance*; from half the ſum, ſubtract the polar diſtance and note the remainder. Then add together the log co-ſecant of the co-latitude, the log co-ſecant of the co-altitude, the log ſine of the half ſum and the log ſine of the remainder; half the ſum of theſe four logarithms, is the log. co-ſine of half the true azimuth, which being doubled gives the true azimuth, reckoned from the north in north latitudes, but from the ſouth in ſouth latitudes.

EXAMPLE I.

In latitude 51° 32′ N. the ſun's true altitude was obſerved to be 39° 28′, his declination being then 16° 37′ N.; required the true azimuth?

			90° 00′		90° 00′
		Altitude	39 28	Declination	16 37
	90° 00′	Co-alt.	50 32	Polar diſt.	73 23
Latitude	51 32 N.				

Co-lat.	38 28	Co-ſecant	0,20617
Co-alt.	50 32	Co-ſecant	0,11239
Polar diſt.	73 23		
Sum	162 23		
½ Sum	81 11	Log. ſine	9,99484
Polar diſt.	73 23		
Remainder	7 48	Log. ſine	9,13263
			19,44603
½ Sum	Log. co-ſine	58° 06′	9,72301
		2	
True azimuth		116 12 from the north.	

The logarithm 9.72301 in this example, is alſo the co-ſine of 121° 54′, which being doubled gives the azimuth = 243° 48′; and it is evident that this value is the ſame as the other, for 243° 48′ counted from the north, weſterly, is the ſame as 116° 12′ counted from the north, eaſterly.

* The polar diſtance of the ſun, moon or ſtar, is the diſtance from the elevated pole; and is found by ſubtracting the declination of the object from 90°, when the latitude and declination are of the ſame name, but by adding it to 90°, when they are of different names.

EXAMPLE II.

In latitude 42° 16′ N. the ſun's altitude was obſerved to be 18° 40′, his declination being then 7° 38′ S.; required the true azimuth?

			90° 00′		90° 00′	
		Altitude	18 40	Declination	7 38 S.	
	90° 00′	Co-alt.	71 20	Polar diſt.	97 38	
Latitude	42 16 N.					
Co-lat.	47 44	Co-ſec.	0,13076			
Co-alt.	71 20	Co-ſec.	0,02347			
Polar diſt.	97 38					
Sum	216 42					
½ Sum	108 21	Log. ſine	9,97734			
Polar diſt.	97 38					
Remainder	10 43	Log. ſine	9,26940			
		Sum	19,40097			

½ Sum log. co-ſine 59° 53′ = 9,70048
2

True azimuth 119 46 from the north.

QUESTIONS TO EXERCISE THE LEARNER.

Queſtion I. Given the ſun's altitude corrected for dip, refraction, &c. 20° 46′, his declination 17° 10′ S. and the latitude of the place 40° 38′ N. required the true azimuth?

Anſwer. 137° 50′ from the north.

Queſtion II. What is the ſun's azimuth in the latitude of 26° 30′ N. in the forenoon, when his correct central altitude is 24° 28′, and his declination 22° 40′ N.?

Anſwer. 75° 44′ from the north.

Queſtion III. At the iſland of St. Helena, the ſun's true central altitude was obſerved to be 30° 22′ in the forenoon, his declination being then 22° 58′ S.; required the azimuth at that time?

Anſwer. 72° 21′ from the ſouth.

Queſtion IV. What true point of the compaſs will the ſtar Aldebaran bear on, at the Cape of Good Hope, January 1, 1804, when its correct altitude is 22° 25′?

Anſwer. 130° 20′ from the ſouth. The anſwers to ſome of theſe queſtions differ 1′ or 2′ from the values obtained by taking the logarithms to ſeconds.

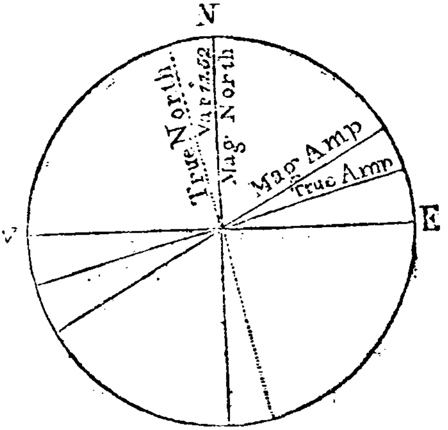
Having the true and magnetic amplitude or azimuth, to find the variation.

Having found the true and magnetic amplitude or azimuth, the variation is eaſily deduced therefrom by the following rule; in which it may be proper again to obſerve, that the amplitude of any celeſtial object is reckoned from the eaſt or weſt point of the horizon, and is called north when to the northward of thoſe points, but ſouth when to the ſouthward. The azimuth is reckoned from the north in north latitudes, but from the ſouth in ſouth latitudes; when it falls on the east side of the meridian, it is named east, but when on the west side, is named west. *If the observed and true amplitude be both north or both south, their difference is the variation; but if one be north and the other south, their sum is the variation; if the true and observed azimuth be both east or both west, their difference is the variation, otherwise their sum; and the variation is easterly, when the point of the compass representing the true bearing is to the right hand of the point representing the magnetic bearing, but is westerly when to the left hand.*

EXAMPLE I.

Suppose the sun's magnetic amplitude at rising is E. 26° 12′ N. the true amplitude is E. 14° 20′ N. required the variation?

From the greater	E. 26° 12′ N.
Take the lesser	E. 14 20 N.
Remains variation	11 52 E.



The variation in this example is easterly because the true amplitude falls to the right of the magnetic, and consequently the magnetic pole falls to the eastward of the true pole; as is evident by the adjoined figure, which represents the compass on which those amplitudes are marked, and which needs no description.

EXAMPLE II.

The moon's true amplitude at rising was found to be E. 15° 20′ N. and her magnetic amplitude E. 10° 0 S. required the variation?

True amplitude	E. 15° 20′ N.
Magnetic amplitude	E. 10 0 S.
The sum is the variation	25 20 W.

EXAMPLE III.

The sun's true azimuth being N. 80° E. and his magnetic azimuth N. 60° E. it is required to find the variation?

True azimuth	N. 80° E.
Mag. azimuth	N. 60 E.
Diff. is the variation	20 E.

EXAMPLE IV.

The star Aldebaran was observed at rising to bear by compass E. N. E. when his true amplitude was N. E. by E. required the variation?

True ampl. N.E. by E. or	E. 33° 45′ N.
Mag. ampl. E. N. E. or	E. 22 30 N.
Difference is the variation	11 15 W.

EXAMPLE V.

The true amplitude of the planet Jupiter was E. 10° N. when his magnetic amplitude was E. 20° S. required the variation?

True amplitude	E. 10° N.
Mag. amplitude	E. 20 S.
Sum is variation	30° W.

The variation thus found, is to be allowed in all courses steered by the compass in order to find the true courses; to make this allowance, you must look towards the point of the compass the ship is sailing upon, and allow the variation from it, *towards the right hand, if the variation be east; but to the left hand, if the variation be west.* Thus, if the ship steers S. E. with one point westerly variation, the true course is S. E. by E. if the variation be one point easterly, the course is S. E. by S.

In the following table is collected a few observations of the variation, made at different times, and in different places.

Places observed at.	Latitude.	Longitude from London.	Year of Obser-vation.	Variation Observed.
Cambridge, (Mass.)	42° 23′ N.	71° 3′ W.	1708	9° 0′ W.
			1742	8 0 W.
			1757	7 20 W.
			1761	7 14 W.
			1763	7 0 W.
			1782	6 46 W.
Boston.	42 23 N.	70 58 W.	1742	8 0 W.
Beverly.	42 36 N.	70 50 W.	1781	7 2 W.
London.	51 32 N.	0 0	1580	11 15 E.
			1672	2 30 W.
			1780	22 41 W.
Paris.	48 51 N.	2 25 E.	1550	8 0 E.
			1660	0 0
			1769	20 0 W.
Funchal Road.	32 38 N.	17 5 W.	1792	18 35 W.
St. Cruz Road.	28 28 N.	16 21 W.	1792	17 35 W.
Bonavista.	16 6 N.	22 41 W.	1792	12 36 W.
St. Jago (Praya Bay)	14 56 N.	23 24 W.	1769	11 10 W.
			1792	12 48 W.
Isle of May.	15 10 N.	23 00 W.	1792	12 00 W.
Ascension.	7 56 S.	14 16 W.	1678	1 0 E.
			1776	10 45 W.
St. Helena.	15 55 S.	5 46 W.	1677	0 40 E.
			1776	13 15 W.
			1794	16 16 W.
Rio de Janeiro.	22 54 S.	42 38 W.	1792	4 55 W.
Tristan d'Acunha.	37 6 S.	11 38 W.	1792	7 0 W.
Cape of Good Hope.	34 29 S.	18 29 E.	1776	21 0 W.
Cape Lagullas.	34 44 S.	20 15 E.	1600	0 0
			1692	11 0 W.
			1776	21 40 W.
			1790	23 30 W.
Isle of Bourbon.	20 52 S.	55 36 E.	1795	15 33 W.
Bombay.	18 57 N.	72 43 E.	1676	12 0 W.
Java Head.	6 45 S.	104 55 E.	1676	3 10 W.
			1786	0 54 W.
Batavia.	6 10 S.	106 57 E.	1793	0 30 W.
At Sea.	29 10 N.	28 47 W.	1795	15 00 W.
At Sea.	27 00 N.	23 38 W.	1795	15 44 W.

Places observed at.	Latitude.	Longitude from London.	Year of Obser-vation.	Variation Observed.
At Sea.	15° 28′N.	20° 43′W.	1795	12° 05′W.
At Sea.	12 14 N.	20 00 W.	1795	11 39 W.
At Sea.	9 47 N.	20 10 W.	1795	11 48 W.
At Sea.	8 54 N.	20 10 W.	1795	10 50 W.
At Sea.	5 46 N.	20 49 W.	1795	11 00 W.
At Sea.	3 16 N.	21 22 W.	1795	10 47 W.
At Sea.	0 0	24 15 W.	1795	8 43 W.
At Sea.	2 33 S.	24 49 W.	1795	7 05 W.
At Sea.	5 48 S.	26 49 W.	1795	5 24 W.
At Sea.	7 59 S.	27 49 W.	1795	4 14 W.
At Sea.	9 27 S.	27 50 W.	1795	3 33 W.
At Sea.	13 19 S.	26 53 W.	1795	3 54 W.
At Sea.	19 47 S.	25 51 W.	1795	2 50 W.
At Sea, near Trinidad.	20 28 S.	28 39 W.	1796	2 35 W.
At Sea.	21 32 S.	25 22 W.	1795	2 25 W.
At Sea.	23 43 S.	23 40 W.	1795	2 31 W.
At Sea.	28 11 S.	18 40 W.	1795	5 28 W.
At Sea.	35 05 S.	5 55 W.	1795	11 10 W.
At Sea.	36 38 S.	0 20 E.	1795	13 40 W.
At Sea.	36 12 S.	4 21 E.	1795	15 19 W.
At Sea.	37 20 S.	7 30 E.	1795	16 57 W.
At Sea.	36 45 S.	19 32 E.	1795	24 33 W.
At Sea.	21 54 S.	53 46 E.	1795	13 59 W.
At Sea.	0 0	32 30 W.	1795	3 0 W.

By the preceding table it appears that the variation at Cambridge, in the ſtate of Maſſachuſetts, is decreaſing at the rate of about 1¼ minutes per year; at London and Paris it is increaſing 10 or 11 minutes per year; and off the Cape of Good Hope it increaſes annually about 7 minutes.

Ships ſailing for India, generally endeavour to croſs the equator between the longitude of 18° and 24° weſt. The variation at the latter place was 8° 43′ W. in the year 1795, as I have found by repeated obſervations, its annual increaſe being about 6 minutes. If, in croſſing the equator, you ſhould find a greater variation, you are to the eaſtward of 24° W. but if a leſs variation, you are to the weſtward of 24° W. the alteration in the longitude being in that place about 2 degrees for 1 degree of variation. But there is always a great uncertainty attending this kind of obſervations, ſince it is not uncommon to find 2 or 3 degrees difference between an azimuth in the morning and evening, when the ſhip during that time has been nearly ſtationary; the ſame difference will ſometimes be found merely from making the obſervation when the ſhip is on a different tack.

To find the LATITUDE by the Meridian Altitude of any object.

TO obtain the latitude of any place, you muſt obſerve with a quadrant or ſextant, the meridian altitude of ſome heavenly body; from this obſerved altitude, you muſt deduce the correct altitude, in the manner preſcribed in the explanation of the uſes of the quadrant; viz. (1) by ſubtracting the dip in the *fore* obſervation, but adding it in the back obſervation; (2) adding the ſemidiameter when the lower limb was obſerved by a fore obſervation, but ſubtracting it when the upper; and the contrary when the back obſervation was uſed; (3) ſubtracting the refraction; (4) adding the parallax; (5) applying the index error, if there be any. Having thus obtained the correct central altitude of the object, you muſt ſubtract it from 90°, and you will have the true zenith diſtance, with which, and the true declination at the time of obſervation, the latitude is found by the following rules.

CASE I.

When the object riſes and ſets.

Rule. If the object bear *ſouth*, when upon the meridian, call the zenith diſtance *north*;* but if it bear *north*, you muſt call the zenith diſtance *ſouth*. Place the zenith diſtance under the declination, and if they are of the *ſame* name, *add* them together; but if they are of *different* names, take their *difference*; this ſum or difference will be the latitude, which will be of the ſame name as the greateſt number.

CASE II.

When the object never ſets.

Many ſtars never ſet, and in high latitudes the ſun is ſometimes above the horizon for ſeveral days, in which caſe the meridian altitude may be obſerved twice in 24 hours; that is, once at the greateſt height above the pole, and again when at their loweſt height upon the meridian below the pole. In the former caſe, the latitude is found by the preceding rule; but in the latter by the following.

Rule. Add the complement of the declination to the meridian altitude; the ſum is the latitude, of the ſame name as the declination.

Note. When the ſun or ſtar is on the equator, or hath no declination, the zenith diſtance is the latitude of the place, which is of the ſame name as the zenith diſtance.

When the ſun or ſtar is in the zenith, the declination is the latitude, and it is of the ſame name as the declination.

* In this rule the ſun is ſuppoſed to be the fixed point, and the zenith is referred to it. Thus if the ſun bears ſouth from an obſerver (or from his zenith) the zenith bears north from the ſun, and it is this latter bearing which is uſed in the rule.

To find the Latitude by the Meridian Altitude of the Sun or Star.

EXAMPLE I.

At the end of the ſea day, June 21, 1804, in the longitude of 60° W. the meridian altitude of the ſun's lower limb bearing ſouth, was found by a fore obſervation to be 40° 6′; required the latitude in, ſuppoſing the correction of the obſerved altitude for dip and ſemidiameter, to be 12 miles.

Obſerved altitude		40°	6′
Dip and ſemi-diameter	add		12
Sum		40	18
Refraction	ſubtract		1
True altitude		40	17
Subtract from		90	00
True zen. diſt.		49	43 N.
Sun's declination, Tab. V.		23	28 N.
Latitude in		73	11 N.

EXAMPLE II.

At the end of the ſea day, Apr. 14, 1804, in the longitude of 135° E. of Greenwich, the altitude of the ſun's lower limb by a fore obſervation was 60° 25′ when on the meridian to the ſouth of me, the correction for dip, &c. being 12 miles; required the latitude in.

Obſerved altitude		60°	25′
Correction	add		12
True altitude		60	37
Subtract from		90	0
True zenith diſtance		29	23 N.
Sun's declination, Tab. V. cor. by Tab. VI. for long.		9	18 N.
Latitude in		38	41 N.

EXAMPLE III.

At the end of the ſea day, May 15, 1804, in the meridian of Greenwich, obſerved the ſun on the meridian to the north of me, the altitude of his lower limb being 30° 6′ by a fore obſervation, the correction for dip and ſemi-diameter being 12 miles; required the latitude.

Obſerved altitude		30°	6′
Dip and ſemidiameter	add		12
Sum		30	18
Refraction ſubtract			2
True altitude		30	16
Subtract from		90	00
True zenith diſtance		59	44 S.
Sun's declination		18	53 N.
Latitude in		40	51 S.

EXAMPLE IV.

At the end of the ſea day, Nov. 17, 1804, in the longitude of 80° E. of Greenwich, by a fore obſervation found the meridian altitude of the ſun's lower limb 50° 6′, bearing S. of me, the eye being 17 feet above the ſurface of the ſea; required the latitude.

Obſerved altitude		50°	6′
Sun's ſemidiameter	add		16
		50	22
Subtract dip and refraction			5
True altitude		50	17
Subtract from		90	0
True zenith diſtance		39	43 N.
Sun's dec. corrected by Tab. VI.		18	59 S.
Latitude in		20	44 N.

EXAMPLE V.

By a fore obſervation, the meridian altitude of the ſun's lower limb was found to be 40° 20′ bearing ſouth of the obſerver, the declination being 9° 56′ N. and the eye 26 feet above the horizon; required the latitude of the place.

Obſerved altitude		40°	20′
Semidiameter	add		16
		40	36
Dip 5′, Refraction 1′	ſub.		6
True altitude ſun's centre		40	30
Subtract from		90	0
Zenith diſtance		49	30 N.
Declination		9	56 N.
Latitude		59	26 N.

EXAMPLE VI.

By a back obſervation with a quadrant of reflexion, the meridian altitude of the ſun's lower limb was 25° 12′ when the declination was 21° 14′ S. and the eye 40 feet above the horizon, the ſun bearing ſouth of the obſerver; required the latitude of the place of obſervation.

Obſerved altitude		25°	12′
Semidiameter	ſub.		16
		24	56
Dip	add		6
		25	2
Refraction	ſub.		2
True altitude of ſun's centre		25	0
True zenith diſtance		65	0 N.
Declination		21	14 S.
Latitude in		43	46 N.

EXAMPLE VII.

Jan. 1, 1804, an obſerver 35 feet above the water, finds by a fore obſervation, that the altitude of Sirius is 53° 35′ when paſſing the meridian to the ſouthward; required the latitude of the place of obſervation.

Obſerved altitude		53°	35′
Dip of horizon	ſub.		6
		53	29
Refraction	ſub.		1
		53	28
True zenith diſtance		36	32 N.
Sirius's declination, Tab. IX.		16	27 S.
Latitude in		20	5 N.

EXAMPLE IX.

January 10, 1804, an obſerver 28 feet above the water, finds the altitude of the north ſtar, when on the meridian below the pole, to be 36° 24′ by a fore obſervation; required the latitude of the place of obſervation.

Obſerved altitude	36°	24′
Subtract dip 5′, ref. 1′		6
True altitude	36	18
Comp. declination Tab. IX.	1	45 N.
Latitude in	38	3 N.

EXAMPLE VIII.

Suppoſe on the 13th June, 1804, ſea account, an obſerver in a high northern latitude, and in the longitude of 65° W. of London, his eye being 28 feet above the ſurface of the water, obſerved by a fore obſervation the altitude of the ſun's lower limb on the meridian below the pole 8° 15′; required the latitude.

The ſun being obſerved below the pole at 12 hours before the end of the ſea day June 13, the correction of declination correſponding in Tab. VI. is —1′ 46″, and the correction for 65° W. long. is +0′ 38″, hence both corrections make 1′ to be ſubtracted from the declination at noon 23° 14′ N. which gives the declination at the time of obſervation 23° 13′ N. whoſe complement is 66° 47′.

Obſerved alt. ſun's low. limb		8°	15′
Semidiameter	add		16
		8	31
Dip	ſubtract		5
		8	26
Refraction	ſubtract		6
True altitude ſun's centre		8	20
Complement of declination		66	47 N.
Latitude in		75	7 N.

To find the Latitude by a Meridian Altitude of the Moon.

THE latitude may be found at ſea by the moon's meridian altitude more accurately than by any other method, except by the ſun; but to do this it is neceſſary to find the time of her paſſing the meridian, and her declination at that time. To facilitate theſe calculations we have given the Tables XXVI. XXVII. and XXVIII. the uſe of which will evidently appear from the following rules and examples.

To find the true time of the moon's paſſing the meridian.

In the 6th page of the Nautical Almanac find the time of the moon's coming to the meridian of Greenwich for one day earlier than the ſea account;* and alſo the time of her coming to the meridian of Greenwich the next day, when you are in weſt longitude, but the preceding day when in eaſt longitude; take the difference between theſe times, with which you muſt enter the top column of Tab. XXVI. and againſt the ſhip's longitude in the ſide column is a number of minutes, which is a correction to be applied to the time taken from the Nautical Almanac, for the day immediately preceding the ſea account, by adding it when you are in weſt longitude, but ſubtracting it when in eaſt longitude; the ſum or difference is the true time of paſſing the meridian of the given place.

EXAMPLE. Required the time of the moon's paſſing the meridian of Philadelphia, April 4th, 1804, ſea account?

The day preceding the ſea account is April 3, on which day the moon paſſes the meridian of Greenwich at 18h. 55m.; and being in weſt longitude, I find alſo the time of her paſſing the meridian the next day, which is 19h. 46m.; the difference of theſe two numbers is 51m.; with this I enter Tab. XXVI. and the neareſt number at the top I find is 52′; under this and oppoſite 75° (the longitude of Philadelphia) is the correction 11′, to be added to 18h. 55m.; therefore the time of paſſing the meridian of Philadelphia is April 4d. 19h. 6m. ſea account; or April 4th. 7h. 6m. A. M. civil account.

To find the moon's declination when on the meridian.

Find the time of her coming to the meridian as above; turn the ſhip's longitude into time, (by Tab. XX.†) and add it thereto if in weſt longitude, but ſubtract it in eaſt, the ſum or difference will be the time at Greenwich. Take out the moon's declination from page 6th. of the Nautical Almanac, for the neareſt noon and midnight; and note their difference if of the ſame name, but their ſum if of different names; enter Table

* Taking it one day earlier than the ſea account reduces it to aſtronomical time, which is uſed in the Nautical Almanac.

† Longitude may be turned into time without the help of Table XX. by multiplying by 4 ſexageſimally, putting the product one denomination lower; and by dividing by 4, time may be turned into degrees, &c. Thus, 80° X 4=320′=5h. 20m. and 15° 16′ X 4=61′ 4″=1h. 1m. 4ſ.; in like manner 1h. 20m. or 80m. divided by 4 gives 20°; 3h. 16m or 196m. divided by 4 gives 49°, which agree with the Table.

XXVIII. with this ſum or difference at the top, and the time at Greenwich in the ſide column, under the former and oppoſite the latter is the correction to be applied to the declination which ſtands firſt in the Nautical Almanac; additive, if that declination be increaſing; ſubtractive, if decreaſing: the ſum or difference will be the true declination at the time of paſſing the meridian.

NOTES.

1. By the above rule, the day of the month on which the moon paſſes the meridian muſt be taken one leſs than the ſea account; when you add to it the longitude (turned into time) and the hours of the ſum exceed 24, you muſt ſubtract 24h. and add one to the day of the month; if the longitude is to be ſubtracted, and is greater than the time of paſſing the meridian, you muſt, previous to the ſubtraction, add 24 hours to the time of paſſing the meridian and ſubtract one from the day of the month: the ſum or difference will be the time at Greenwich. If this time be leſs than 12 hours, you muſt take out the declination for the preceding noon and the following midnight; but if it exceed 12 hours, you muſt take out the declination for the preceding midnight and the following noon.

2. When one of the declinations taken from the Nautical Almanac is north and the other ſouth, the difference between the correction of Table XXVIII. and that declination which ſtands firſt in the Nautical Almanac, will be the true declination; which will be of the ſame name as that firſt declination when the correction of Table XXVIII. is leſs than that firſt declination, but if greater it will be of a contrary name.

3. In the ſame manner we may find the declination for any time in the day, by making uſe of the given time inſtead of the time of the moon's paſſing the meridian.

EXAMPLE. Required the moon's declination at the time of her paſſing the meridian of Philadelphia, April 4, 1804, ſea account?

The time of paſſing the meridian of Philadelphia was found in the preceding example to be, April 4d. 19h. 6m. ſea account, or, April 3d. 19h. 6m. by Nautical Almanac account; to this I add the longitude of Philadelphia, in time 5h. 1m.;* the ſum is, April 4d. 0h. 7m. The declination April 4d. at noon is 21° 56′ S. and on April 4d. 12h. is 19° 59′ S. their difference is 1° 57′; this being found at the top of Table XXVIII. and the time 0h. 7m. in the ſide column, the number correſponding is 1′, which ſubtracted from the firſt declination 21° 56′ S. leaves the declination required 21° 55′ S.

At the time of the moon's paſſing the meridian, you muſt obſerve the altitude of her upper or lower limb, and correct it, by the rules given in page 140. With her correct central altitude and the declination, find the latitude by the rules of page 151. Inſtead of correcting the obſerved altitude by the above mentioned rule, you may correct it by the following approximate method, which ſhortens the calculation, and comes near to the truth when the dip is about 4 or 5 miles, which is nearly the value in common obſervations at ſea.

To find the latitude by the moon's meridian altitude, obtained by a fore obſervation.

To the obſerved altitude of the moon's lower limb add 12 miles, but if her upper limb was obſerved ſubtract 20 miles; with this altitude enter Table XXVII. and take out the miles correſponding and add thereto, the ſum will be the central altitude of the moon;† with this altitude and the moon's declination found as above, the latitude may be found as by a meridian altitude of the ſun.

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* Philadelphia is 75° 14′ W. of London, or 75° 19′ W. of Greenwich; this laſt, turned into time by Table XX. is 5h. 1m. 16ſ. the difference ariſing from calculating the longitude from London inſtead of Greenwich is very trifling.

† The altitude obtained in this way will ſometimes err 2 or 3 miles. If you wiſh to calculate it accurately proceed as follows: Find the time of paſſing the meridian, reduced to Greenwich time, as before; take out the moon's horizontal parallax and ſemi-diameter, for this time, from the 7th. page of the month of the Nautical Almanac; increaſe the ſemi-diameter by the correction of Table XVI. and add it or ſubtract it, according as the lower or upper limb was obſerved; ſubtract the dip of the horizon taken from Table XIV. and add the correction for parallax and refraction taken from Table XVIII. this laſt ſum will be the correct altitude; with which and the declination the latitude may be found as above.

EXAMPLE I.

Suppose that on the 21st. June, 1804, sea account, in long. 80° W. of Greenwich, the meridian altitude of the moon's upper limb was observed to be 40° 0′ to the southward of me, required the true latitude?

June 21st. sea account, is June 20th. by Nautical Almanac, on which day the moon passes the meridian of Greenwich at 10h. 8m. and the next day at 10h. 59m. the daily difference being 51m. In Table XXVI. under 52 (which is the nearest number to 51 in the table) and opposite to the long. 80° stand 12m. which added to 10h. 8m. gives the time of passing the meridian, June 20d. 10h. 20m.

	d. h. m.		
☽ passes merid. June	20 10 20		
Ship's long. 80° in time	5 20	Alt. ☽'s upper limb	40° 0′
		Subtract	20
Time at Greenwich June	20 15 40		
			39 40
June 20, midnight decl.	25° 34′ S.	Add Tab. XXVII.	43
June 21, at noon	26 17 S.		
		☽'s true alt.	40 23
Difference	0 43		
With this difference 0° 43′, and the time		☽'s zen. dist.	49 37 N.
at Greenwich 15h. 40m., I enter Tab.		☽'s declination	25 47 S.
XXVIII. and find the corr.	0° 13′		
this added to	25 34 S.	Latitude	23 50 N.
gives the required decl.	25 47 S.		

EXAMPLE II.

Suppose that on the 25th September, 1804, sea account, in long. 90° E. the meridian altitude of the moon's lower limb was observed 50° 0′ to the south of me, required the true latitude?

September 25 sea account, is September 24 by the Nautical Almanac, on which day the moon passes the meridian of Greenwich at 16h. 57m. and the preceding day at 15h. 55m. differing 1h. 2m. or 62m.; in Table XXVI. under 62′ and opposite the long. 90° is 15m. which subtracted from 16h. 57m. leaves 16h. 42m. the time of passing the meridian of the place of observation.

	d. h. m.		
☽ passes merid. Sept.	24 16 42		
Long. 90° E. in time	6 0		
		☽'s obs. alt. low. limb	50° 0′
Time at Greenwich Sep.	24 10 42	Add	12
Decl. Sep. 24 at noon	25° 43′ N.		
at midnight	26 22 N.	Sum	50 12
		Corr. Tab. XXVII. add	36
difference	0 39		
With this difference 0° 39′, and the		☽'s correct alt.	50 48
time at Greenwich 10h. 42m. I find the			
correction of Table XXVIII.	0° 35′	☽'s zenith distance	39 12 N.
Declination at noon	25 43 N.	☽'s declination	26 18 N.
True declination	26 18 N.	Latitude	65 30 N.

EXAMPLE III.

Suppose on the 25th November, 1804, sea account, in the longitude of 150° W. the meridian altitude of the moon's upper limb was observed 60° 26′, bearing north of me, required the true latitude?

Nov. 25, sea account, is Nov. 24, by the Nautical Almanac, on which day the moon passes the meridian of Greenwich at 18h. 59m. and the next day at 19h. 41m. differing 42m. In Table XXVI. under 42′ and opposite the longitude 150° stands 17m. which added to 18h. 59m. gives 19h. 16m. the time of passing the meridian of the place of observation.

	d.	h.	m.
☽ passes merid. Nov.	24	19	16
Long. 150° W. in time		10	0
Time at Greenwich Nov.	25	5	16

☽'s decl. Nov. 25 at noon	0° 49′ N.
at midnight	1 56 S.
Sum	2 45

With this sum 2° 45′, and the time at Greenwich 5h. 16m. I enter Table XXVIII. and find the correction of declination 1° 12′

Decl. Nov. 25 at noon	0 49 N.
True declination	0 23 S.

Obs. alt. ☽'s upper limb	60° 26
Subtract	20
	60 6
Corr. Tab. XXVII. add	28
☽'s corr. alt.	60 34
☽'s zen. dist.	29 26 S.
☽'s declination	0 23 S.
Latitude	29 49 S.

In this example you must refer to Notes 1, and 2.

To find the Latitude by the Meridian Altitude of a Planet.

FROM page 4th. of the month of the Nautical Almanac, take out the time of the planet's passing the meridian on the day nearest to that on which the observation was made; this will be nearly the time of passing the meridian of the place of observation.*

Turn the ship's longitude into time, and add it to the time of passing the meridian, when in west longitude, but subtract it in east, the sum or difference is the time at Greenwich nearly. Take out the planet's declination, from the Nautical Almanac, for the time immediately preceding, and following the day of observation; and note the difference of the declinations when they are of the same name, but their sum when of different names; and find the interval between these times marked in the Nautical Almanac; take also the difference between the time first marked in the Nautical Almanac and the time of observation at Greenwich (remarking that this time is one day less than the sea account); then, as the former interval of time is to the latter, so is the sum or difference of declinations to the correction of the declination taken first from the Nautical Almanac, additive if that declination is increasing, but subtractive if decreasing: the sum or difference is the declination of the planet at the time of observation. But you must observe that if the correction of declination be greater than the declination first marked in the Nautical Almanac, their difference is the declination which is of a different name from that first declination.

From the observed altitude of the planet (taken by a fore observation) subtract the refraction and dip, the latter being in general about 4 miles, and the remainder subtracted from 90° gives the correct zenith distance; with which, and the declination, the latitude may be found as by an observation of the sun.

EXAMPLE.

Suppose that on the 23d May, 1804, in long. 70° W. Jupiter passed the meridian to the southward of me; his meridian altitude being observed, was 45° 20′, and the dip 4′; required the true latitude.

May 23, sea account, is May 22 by the Nautical Almanac; now on May 19, by the N. A. Jupiter passes the meridian at 9h. 59m.

May 19, by the N. A. Jupiter passes the meridian at	9h.	59m.
To this add the long. 70° W. in time	4	40
Time at Greenwich May 22d.	14	39

Jupiter's declination May 19,	9°	19′	S.
May 25,	9	9	S.
Difference		10	

Then say, As 6 days (which is the interval between May 19 and May 25) is to 3 days 14½ hours (which is the time elapsed between May 19 and May 22d. 14½h.) so is 10 miles to 6 miles, which subtracted from 9° 19′ S. gives 9° 13′ S. the true declination at the time of observation.

Jupiter's observed altitude	45°	20′	
Subtract 4′ for dip, and 1′ for refraction		5	
True altitude	45	15	
Zenith distance	44	45	N.
Declination	9	13	S.
Latitude	35	32	N.

* If you want it more accurately, you must take a proportional part of the difference of the times of coming to the meridian given in the Nautical Almanac, in the same manner as in finding the declination.

To find the Latitude by Double Altitudes.

WHEN by reafon of clouds or other caufes, a meridian obfervation cannot be obtained, you may find the latitude by means of two altitudes of the fun (or of any celeftial object) taken either in the forenoon or afternoon, the intermediate time being meafured by a common watch. This method was much improved by Mr. Douwes of Amfterdam, who, about the year 1740, conftructed a fet of tables fimilar to thofe of Table XXI. of this collection, by means of which the true latitude may in moft cafes be obtained from the latitude by account, by the following rule, which is adapted to double altitudes of the fun.

RULE.

To the log. fecant of the latitude by account (Table XXV.) add the log. fecant of the fun's declination (Table XXV.) rejecting 10 in each index, the fum is the log. ratio.

From the natural fine of the greateft altitude (Table XXII.) fubtract the natural fine of the leaft altitude (Table XXII.) find the logarithm* of their difference (in Table XXIV.) and place it under the log. ratio.

Subtract the time of taking the firft obfervation from the time of taking the fecond, having previoufly increafed the latter by 12 hours when the obfervations are on different fides of noon ; take half the remainder which call half the elapfed time.

With half the elapfed time enter Table XXI. and from the column of half elapfed time take out the logarithm anfwering thereto, and write it under the log. ratio.

Add thefe three logarithms together, and with their fum enter Table XXI. in the column of middle time, where, having found the logarithm neareft thereto, take out the time correfponding to it and put it under half the elapfed time. The difference between thefe times will be the time from noon when the greater altitude was taken.

With this time enter Table XXI. and from the column of log. rifing, take out the logarithm correfponding to it ; from this logarithm fubtract the log. ratio, the remainder will be the logarithm of a natural number, which being found in Table XXIV.† and added to the natural fine of the greater altitude, will give the natural fine of the fun's meridian altitude, which from hence may be found in Table XXII. Having obtained the meridian altitude, the latitude is found by the ufual method.

NOTES.

1. If this computed latitude fhould differ confiderably from the latitude by account, it will be proper to repeat the operation, ufing the latitude laft found inftead of the latitude by account, till the refult gives a latitude nearly agreeing with the latitude ufed in the computation.

2. This problem is beft fuited to fituations, where the fun's meridian zenith diftance is not much lefs than half the latitude ; for in latitudes where the fun approaches near to the zenith,

* The index of this logarithm being one lefs than the number of figures contained in the difference of thefe natural fines. You muft alfo obferve that the altitudes to be ufed are the correct central altitudes.

† Taking a number of figures equal to the index of that logarithm increafed by unity.

the obfervations are to be taken much nearer to noon; and the preceding rule inftead of approximating, will in fome cafes give the refults of fucceffive operations wider and wider from the truth. To remedy this difficulty, a fet of tables has lately been publifhed by Mr. Brinkley, at the end of the nautical almanac for 1799; but the great variety of cafes incident to his method, will hinder it from being generally ufed.

3. The times of obfervation fhould be taken to feconds, or at leaft to quarters, or thirds of a minute of time: and the nearer the fun paffes to the zenith, the more exact you muft be in obferving the altitudes and noting the times.

4. The logarithms of Table XXI. are only calculated to 10 feconds, and for any intermediate number are found by taking the difference between the log. next greater and next lefs; and faying, as 10 feconds is to that difference, fo is the given feconds to the correction to be applied to the tabular logarithm; but when the fun's meridian zenith diftance is great, the neareft tabular numbers may generally be taken without proportioning for the odd feconds.

5. The nearer to noon that one of the obfervations is, the better, and in general the elapfed time between the obfervations ought to be as great or greater than the time of the neareft obfervation from noon.

6. The operation is the fame whether the fun hath north or fouth declination: and alfo whether the fhip be in north or fouth latitude. When the fun hath no declination the log. fecant of the latitude (rejecting 10 in the index) will be the log. ratio; and when the latitude by account is nothing the fecant of the declination (rejecting 10 in the index) will be the log. ratio.

EXAMPLE I.

Being at fea in latitude 46° 30′ north by account, when the fun's declination was 11° 17′ N. at 10h. 2m. in the forenoon, the fun's correct central altitude was 46° 55′, and at 11h. 27m. in the forenoon, his correct central altitude was 54° 9′. Required the true latitude, and true time of the day when the greater altitude was taken?

	Times. H. M. S.	Altitudes.	Nat. Si.			
2 Obf.	11 27 0	54° 9′	81055	Lat. by acc. 46° 30′ Sec.		0.16219
1 Obf.	10 2 0	46 55	73036	Dec. 11 17 Sec.		0.00848
				Log. ratio		0.17067
Elap. Time	1 25 0	Diff. Nat. Sines	8019	Log. Dif. N. Sines		3.90412
½ El. Time	0 42 30			Log. ½ El. Time		0.73429
		Middle Time	1 15 10 (H. M. S.)			4.80908
		½ El. Time	42 30			
		2 Obf. from noon	0 32 40	its log. rifing		3.00608
				Log. ratio fub.		0.17067
		Nat. numb.		685	corrcfp. to log.	2.83541
		Nat. fine, greateft alt.		81055		90° 00′
		Sum is nat.fi. fun's mer. alt.		81740	equal to	54 50
			Sun's zenith diftance			35 10N.
			Sun's declination			11 17N.
			Latitude in			46 27N.

This latitude 46° 27′ differing only 3′ from the latitude by account, may be affumed as the true latitude.

By means of the time of the obfervation from noon above found 32′ 40″, the error of the watch may be found; for, in the prefent example, by fubtracting 32′ 40″ from 12h. we have the time of the laft obfervation 11h. 27′ 20″; but the time by the watch is 11h. 27′ 0″; therefore the watch is 20 feconds too flow; a fmall difference would be found in thefe numbers, if we were to proportion the logarithms of Tab. XXI. to feconds. In the fame manner the error of the watch may be found in the following examples.

EXAMPLE II.

Being at sea in lat 47° 19′ N. by account, when the sun's declination was 12° 16′ N. at 10h. 24m. A. M. per watch, the sun's correct central altitude was 49° 9′, at 1h. 14m. P. M. his alt. was 51° 59′. Required the latitude.

	H. M. S.					
	12 0 0					
	1 14 0					
		Alt.	Nat. Si.	Lat. by acc.	47° 19′	0.16880
2 Obs.	13 14 0	51 59	78783	Sun's declin.	12 16	0.01003
1 Obs.	10 24 0	49 9	75642			
				Log. ratio		0.17883
Elaps. time	2 50 0	Diff. N. S.	3141	Its log.		3.49707
½ Ela. time	1 25 0	Its log. in col. of half elapsed time is				0.44077
Subtract	0 15 0	Col. of mid. time corresponding to				4.11667
True time	1 10 0	Its log. in col. of rising is				3 66542
		Log. ratio subtract				0.17883
		3066	the nat. num. of this log.			3.48659

Nat. sine sun's greatest alt.	78783	90° 00′	
Nat. sine sun's merid. alt.	81849	= 54 56	
Sun's zenith dist.		35 4	N.
Sun's declination		12 16	N.
Lat. in		47 20	N.

Here the latitude found by computation may be relied on, as it differs but one mile from that used in the operation.

EXAMPLE III.

Being at sea in lat. 50° 40′ North per account, when the sun's declination was 20° 0′ South, at 10h. 17m. A. M. per watch, the sun's correct central altitude was found 17° 13′; at 11h. 17m. A. M. per watch, it was found 19° 41′. Required the latitude.

	Times. H. M. S.	Alt.	Nat. Si.			
				Lat. by acc.	50° 40′	0.19803
				Decl.	20 00	0.02701
2 Obs.	11 17 0	19° 41′ =	33682			
1 Obs.	10 17 0	17 13 =	29599	Log. ratio		0.22504
Elaps. time	1 0 0	Diff. Nat. Si.	4083	Its com. log.		3.61098
½ Elap. time	0 30 0	Its log. from col. half elapsed time is				0.88430
	1 0 50	In col. of mid. time corresponding to				4.72032
True time	0 30 50	From noon.	Its log. from col. of rising			2.95599
			Log. ratio subtract			0.22504
		538	Nat. num. of			2.73095
		33682	Nat. sine greatest alt.			
	90° 0′					
	20 1	34220	Nat. sine of sun's mer. alt. 20° 1′.			
Zen. dist.	69 59	N.				
Declination	20 0	S.				
Latitude	49 59	N.				

But as this latitude differs 41 miles from that by account, it will be proper to repeat the operation, using the latitude last found instead of the latitude by account.

		Lat. last found 49° 59′	0,19178
		Decl. 20 0	0,02701
		Log ratio	0,21879
	H. M. S.	Log. diff. N. sines	3,61098
½ Elapsed time	0 30 0	Its log.	0,88430
Middle time	1 0 0	Its log.	4,71407
True time from noon	0 30 0	Its log. in col. of rising is	2,93223
		Log. ratio	0,21879
	517	Nat. num. of	2,71344
	33682	Nat. sine gr. alt.	
		90° 0′	
Nat. S. sun's mer. alt.	34199	= 20 0	
	Zen. dist.	70 0 N.	
	Decl.	20 0 S.	
	The lat.	50 0 N.	

The latitude last found, differing only one mile from that used in the operation, may be depended on as the true latitude. Hence it is plain, that the operation is repeated with very little additional trouble, but few alterations being necessary.

EXAMPLE IV.

Being at sea in the latitude 60° 0′ north by account, when the sun was on the equator, and consequently had no declination, at 1 h. 0 m. P. M. per watch, his correct central altitude was 28° 53′, and at 3 h. 0 m. P. M. per watch, it was 20° 42′. Required the true latitude?

	Times. H. M. S.	Alt.	Nat. Si.		
				Lat. by acc. 60° 0 =	0,30103
				Decl. 0 0 =	0,00000
1 Obs.	1 0 0	28 53	= 48303		
2 Obs.	3 0 0	20 42	= 35347	Log. ratio	0,30103
Elap. T.	2 0 0		12956	Its log.	4,11247
½ Ela. T.	1 0 0	Its log. in col. of ½ Elap. time			0,58700
	2 0 10	Its log. in col. of mid. time			5,00050
Ti. fr. N.	1 0 10	Its log. from col. of rising			3,53482
				Log. ratio	0,30103
		1713	Nat. num.		3,23379
		48303			
			90° 0′		
Nat. Si. Sun's mer. alt.		50016	= 30 1	Sun's meridian alt.	
			59 59	Latitude.	

EXAMPLE V.

Wanting to go through the N. Channel among the Maldives, and by account being in latitude 7° 40′ N. the declination being then 22° 47′ N. at 7h. 25m. 40s. A. M. the true altitude of the sun's centre was 22° 30′ and at 10h. 31m. 48s. A. M. it was found 63° 40′; required the ship's true latitude?

First Operation.

	Times. H. M. S.	Altitudes.	Nat. Sine.		
2 Obser.	10 31 48	63° 40′	89623	Lat. by acc. 7° 40′	Sec. 0,00390
1 Obser.	7 25 40	22 30	38268	Declin. 22 47	Sec. 0,03528
				Log. ratio.	0,03918
Elaps. Time	3 6 8	Diff. Nat. Sines	51355	Log. of the difference	4,71058
½ El. Time	1 33 4	Its logarithm	-	- -	0,40339
					5,15315

	H. M. S.	
Middle Time	3 1 24	
½ Elaps. Time sub.	1 33 04	
2 Obs. before noon	1 28 20	
Its log. in col. of rising		3,86547
Log. ratio subt.		0,03918
Nat. numb. correspond.	6703	3,82629
Nat. sine of gr. Altitude add	89623	
		90° 00′
Nat. sine of Sun's mer. alt.	96326 equal to	74 25
Sun's zenith distance		15 35 S.
Sun's declination		22 47 N.
Ship's latitude resulting		7 12 N.

As the latitude by account differs from the computed latitude, the operation must be repeated.

Second Operation.

				H. M. S.	
Lat. last found 7° 12′	Sec. 0,00344	Log. of		1 28 5	3,86304
Sun's decl. 22 47	Sec. 0,03528	Log. ratio subt.			0,03872
Log. ratio	0,03872	Nat. Number	6673		3,82432
Log. of diff. of Nat. Sines	4,71058	Nat. sine of gr. alt.	89623		
					90° 00′
Log. of ½ Elaps. Time	0,40339	Sun's mer. al. nat. si.	96296 equal to		74 21
Middle Time (H. M. S.) 3 1 9	5,15269	Sun's zenith distance			15 39 S.
½ Elaps. Time 1 33 4		Sun's declination			22 47 N.
2 Obs. before noon 1 28 5		Ship's lat. resulting			7 08 N.

In the former examples we have considered both altitudes as taken at the same place or station; but as that is seldom the case at sea, the necessary correction for any alteration of station must be made as follows:

Let the bearing of the sun be observed by the compass at the instant of the first observation; take the number of points between it and the ship's course, corrected for leeway, if she makes any; with which, if less than eight, or with what it wants of 16 points if more than eight, enter the traverse table, and take out the *difference of latitude* corresponding to the distance run between the observations. *Add* this difference of latitude to the first altitude, if the number of points between the sun's bearing and the ſhip's courſe was *leſs* than eight; but *ſubtract* it from the firſt altitude if the number of points was *more* than eight, and it will be reduced to what it would have been if obſerved at the ſame place where the ſecond was.* The latitude deduced from theſe corrected altitudes will be that of the ſhip at the time of taking the *ſecond* altitude, and muſt be reduced to noon by means of the log.

EXAMPLE VI.

Suppoſe a ſhip from the Bay of Biſcay, bound to the Engliſh Channel, in a briſk gale running N. by E. ¼ E. per compaſs, at the rate of 9 knots per hour, at 10h. 0m. A. M. per watch, obſerved the ſun's correct central altitude 13° 18′ bearing S. ¾ E. by compaſs, and at 1h. 40m. P. M. per watch the ſun's altitude again was found 14° 15′, the latitude by account being 49° 17′ N. and the ſun's declination 23° 28′ S. Required the true latitude?

The correction to the firſt altitude.

The time elapſed between the obſervations is 3h. 40m. and in that time the ſhip failed 33 miles upon the courſe N. by E. ¼ E. which makes an angle of 13½ points with the ſun's bearing at the firſt obſervation S. ¾ E. the complement of which to 16 points is 2½ points. Now in Tab. I. the courſe 2½ points, and diſtance 33m. give 29 miles difference of latitude, which muſt be ſubtracted from the firſt altitude 13° 18′ becauſe the ſhip ſails above 8 points from the ſun; therefore the firſt altitude corrected is 12° 49′, which muſt be uſed in the reſt of the work.

	H. M. S.	Alt. Nat. Si.			
			Lat. by acc.	49° 17′	0,18554
2 Obſ.	13 40 0	14° 15′ = 24615	Decl.	23 28	0,03749
1 Obſ.	10 0 0	12 49 = 22183			
			Log. ratio		0,22303
Ela. T.	3 40 0	Diff. Nat. Si. 2432	Its log.		3,38596
½ El. T.	1 50 0		Its log.		0,33559
	0 10 10	Time correſponding to			3,94458
	1 39 50	Its log. in col. of riſing is			3,97028
		Log. ratio			0,22303
		5588	Nat. num. of		3,74725
		24615			
			90° 0′		
		Nat. Si. M. Alt. 30203 =	17 35		
		Zen. diſt.	72 25 N.		
		Declination	23 28 S.		
		Laitude	48 57 N.		

* This is the only correction neceſſary for to make full allowance for the run of the ſhip; and the unexperienced calculator muſt take care not to fall into the ſame error as Moore, in applying a correction to the elapſed time; (vid. Moore's Epitome, Edit. 14, page 218). A ſmall correction might alſo be applied upon account of the variation of the ſun's declination during the interval between the obſervations.

But as the latitude by computation differs conſiderably from that by account, the work muſt be repeated.

		Latitude laſt found	48° 57′	=0,18262
		Declination	23 28	= 0,03749
		Log. ratio		0,22011
	H. M. S.	Diff. N. S. 2432	Its log.	3,38596
½ Elapſ. time	1 50 0		Its log.	0,33559
Middle time	0 10 0	Its log.		3,94166
Time from noon	1 40 0	Its log. in col. of riſing		3,97170
		Log. ratio		0,22011
	5644	Nat. num. of		3,75159
	24615			
			90° 00′	
	30259	Nat. Si. mer. alt.	17 37	
		Zen. diſt.	72 23 N.	
		Declina.	23 28 S.	
		Tr. lat.	48 55 N.	

This latitude differing only 2 miles from that uſed in the computation, it may be depended upon as the true latitude of the ſhip at the time of the ſecond obſervation. If we had not corrected the firſt altitude, the computed latitude would have been found = 48° 40′ N.

EXAMPLE VII.

Sailing N. E. ½ E. by compaſs, at the rate of 9 knots an hour, at 0h. 31m. 40s. P. M. per watch, I found the altitude of the ſun's lower limb 28° 20′ above the horizon of the ſea, the eye being elevated 20 feet above the ſurface of the water, and the ſun's bearing by compaſs being at the ſame time S. by W. and at 2h. 58m. 20s. P. M. by watch, the altitude of the ſun's lower limb was 16° 41′ above the horizon, the eye being elevated as before, and the latitude by account, at the time of the laſt obſervation, was 48° 0′ north, and the declination 13° 17′ ſouth. Required the true latitude at taking the laſt obſervation.

The correction of theſe altitudes for ſemi-diameter and dip is 12 miles additive, which makes them 28° 32′ and 16° 53′; the refraction correſponding to the firſt is 2 miles, and for the ſecond 3 miles, by ſubtracting which we have the true central altitudes 28° 30′ and 16° 50′. Now the elapſed time between the obſervations is 2h. 26m. 40s. during which the ſhip ſailed 22 miles (at 9 miles per hour) in the direction of N. E. ½ E. per compaſs, the bearing of the ſun at the firſt obſervation being S. by W. which is 12½ points diſtant from the ſhip's courſe; now as 12½ points want 3½ of 16 points, I enter table I. and find the courſe 3½ points, and diſtance 22, correſponding to which in the latitude column is 17 miles, which ſubtracted from the firſt altitude 28° 30′, leaves the corrected firſt altitude 28° 13′; with this, and the ſecond altitude 16° 50′, I calculate the latitude in the following manner:

	H. M. S.	Alt.	Nat. Si.			
1 Obf.	0 31 40	28° 13′	47281	Lat. by acc.	48° 0′	0,17449
2 Obf.	2 58 20	16 50	28959	Declin.	13 17	0,01178
				Log. ratio		0,18627
Ela. T.	2 26 40	Diff.Nat.Si.	18322	Its log.		4,26298
½ ElaT.	1 13 20	Its log. from col. of ½ elapfed time				0,50232
	1 46 20	In col. of mid. time correfponding to				4,95157
	9 33 00	Its log. from col. of rifing				3,01488
		Log. ratio				0,18627

Nat. Si. gr. alt. 47281

674 Nat. num. of 2,82861

90° 0′

Nat. Si. mer. alt. 47955 = 28 39

Zen. dift.	61 21	N.
Decl.	13 17	S.
Lat.	48 4	N.

And as it differs but four miles from the latitude by account, it may be taken as the true latitude of the fhip at the time of the 2d. obfervation.

QUESTIONS FOR EXERCISE.

1. Being at fea in latitude by account 39° 28′ N. when the fun's declination was 20° 41′ N. at 11h. 30m. 15s. A. M. per watch, the altitude of the fun's lower limb was obferved to be 68° 18′ 45″, and at 12h. 26m. 28s. P. M. it was 70° 58′, the height of the eye being 21 feet above the furface of the fea. Required the true latitude of the fhip.
Anfwer, 39° 28′ N.

2. Being at fea in latitude 50° 40′ N. by account, at 10h. 17m. 30s. A. M. per watch, the altitude of the fun's lower limb was obferved to be 17° 4¼′, and at 11h. 17m. 30s. it was 19° 31¼′, the declination being then 20° N. and the height of the eye 21 feet above the fea. Required the latitude in. Anfwer, 50° 1′ N.

3. Suppofe a fhip at fea in latitude 47° 34′ N. by account, at 9h. 55m. 30s. by watch, the altitude of the fun's lower limb was 17° 24′ bearing by compafs S. by E. ¼ E. and at 12h. 54m. 10s. his altitude was 21° 45½′, the declination being then 19° 30′ S. the height of the eye 20 feet above the fea, and the fhip's courfe by compafs was E. ½ S. at the rate of 7 knots per hour. What was the true latitude? Anfwer, 47° 24′ N.

4. At 11h. 28m. 20s. A. M. per watch, the altitude of the fun's lower limb was 28° 18′, the fun bearing then S. by W. by compafs. At 2h. 58m. 20s. P. M. his altitude was 16° 40′, the height of the eye 20 feet, his declination being then 13° 17′ N. and the latitude by account 47° 50′ N. the fhip's courfe during the elapfed time was N. E. with her larboard tacks on board,* failing at the rate of 6 knots, and made half a point lee-way. What latitude was fhe in when the laft altitude was taken?
Anfwer, 48° 9′ N.

* The larboard fide of a fhip is the left fide, when the obferver is aft looking towards her head, and ftarboard is the right fide. When a fhip is failing with her larboard tacks on board, the lee-way is allowed to the right hand; but if her ftarboard tacks are on board, it is allowed to the left hand.

In calculating the anfwers to thefe queftions, proportional parts were taken for the odd feconds; a fmall difference would be found if the neareft logarithms only were taken.

To find the Latitude by one Altitude of the Sun, having your watch previously regulated.

RULE.*

ADD together the log. co-sine of the latitude by account, (Table XXV.) the log. co-sine of the declination, (Table XXV.) the logarithm in the column of rising (Table XXI.) corresponding to the time from noon when the observation was taken, rejecting 20 in the index; the natural number of the remainder (found in Table XXIV. and) added to the natural sine of the observed altitude (Table XXII) will give the natural sine of the meridian altitude, from which the latitude may be obtained by the common rules.

If the computed latitude differs considerably from the latitude by account, it is best to repeat the operation, using the latitude last found instead of the latitude by account. This method of finding the latitude by a single altitude of the sun, may be applied to any other celestial object.

EXAMPLE I.

Being at sea in latitude 49° 50′ N. by account, when the sun's declination was 20° S. at 11h. 28m. per watch well regulated, the sun's correct central altitude was 19° 41′ to the southward of me. Required the true latitude.

Lat.	49° 50′	Co-sine	9.80957		
Decl.	20 0	Co-sine	9.97299		
Time from noon	0h. 32m.	Log. rising	2.98820	Mer. alt.	20° 3′
				Zen. dist.	69 57 N.
	590	Nat. num.	2.77076	Decl.	20 0 S.
Obs. alt.	19° 41′	Sine	33682		
				Latitude	49 57 N.
Mer. alt	20° 3′	Sine	34272		

EXAMPLE II.

At sea in latitude by account 60° N. when the sun was on the equator at 1h. 0m. P. M. per watch well regulated. The sun's correct central altitude was 28° 53′ to the south of me. Required the latitude.

Lat.	60° N.	Co-sine	9.69897		
Decl.	0	Co-sine	10.00000		
Time from noon	1h.	log. rising	3.53243	Mer. alt.	30° 0′
				Zen. dist.	60 0 N.
	1704	Nat. num.	3.23140	Decl.	0 0
Obs. alt.	28° 53′	Sine	48303		
				Lat.	60 0 N.
Mer. alt.	30 0	Sine	50007		

* In calculating by this rule, it is necessary to have your watch well regulated; this may be done by an observation taken the preceding morning, or in the evening following the observation; it being impossible to regulate the watch and determine the latitude by a single altitude without other data; though Moore (in his Epitome, page 217, 218, Edition 14) seems to think it may be done; for all his examples are calculated on that supposition.

To find the Time at Sea, and regulate a Watch.

WE have already noticed the difference between the civil, astronomical and nautical computation of time; but as it is a subject of great importance, it may not be unnecessary again to repeat, that a civil day is reckoned from midnight to midnight, and is divided into 24 hours; the first 12 hours are marked A. M. the latter 12 hours P. M. being reckoned from midnight in a numeral succession from 1 to 12, then beginning again at 1 and ending at 12. Astronomers begin their computation at the noon of the civil day, and count the hours in a numeral succession, from 1 to 24, so that the morning hours are reckoned from 12 to 24. Navigators begin their computation at noon, 12 hours before the commencement of the civil day (and 24 hours before the commencement of the astronomical day); marking their hours from 1 to 12, A. M. and P. M. as in the civil computation.

There are two kinds of time, mean and apparent. *Mean Time* is that shewn by a clock regulated to mean solar time. *Apparent Time*, is that shewn by the sun; commencing at the passage of his centre over the meridian of any place. There is sometimes a difference of a quarter of an hour between mean and apparent time; which is owing to the unequal motion of the earth in its orbit, and the inclination of its axis. This difference is called the *equation of time*, and is contained in page 2 of the nautical almanac. It is necessary to take notice of it, in determining the longitude by any time-keeper like Harrison's; but is not necessary in any other nautical observation, because the calculations of the nautical almanac are adapted to apparent time.

We may obtain the apparent time at sea, when the ship makes no way through the water, by observing an altitude of the sun in the morning and noting the time of observation by a watch, and in the afternoon observing when the sun is at the same altitude and noting the time by the same watch; for half the sum of these times, increased by 6 hours when one of the times noted by the watch is before 12h. and the other after 12h. is the true time of the sun's passage by the meridian as shewn by the watch; hence the error of the watch may be found. A small correction is necessary for the variation of the sun's declination during the interval between the observations; but it is unnecessary to give any examples of this method, since it can be but of little use at sea, by reason of the motion of the vessel.

The best method of obtaining the apparent time at sea, is by observing by the fore observation, the altitude of the sun's lower limb when it changes its altitude fastest, or bears nearly east or west; to this we must add the semi-diameter and subtract the dip (or instead thereof add 12 miles,* which answers very well for a common sized vessel); subtract also the refraction taken from Tab. XIII. and the remainder will be the correct altitude. The ship's latitude must be found at the time of observa-

* These 12 miles are taken instead of the difference between the semi-diameter and dip, and is in general sufficiently exact.

tion by carrying the reckoning forward to that time. The declination must be taken from Tab. V. or from the Nautical Almanac, and corrected for the ship's longitude, and the distance of the sun from the meridian (by Tab. VI.) Then *if the latitude and declination be both north or both south, subtract the declination from 90° and you will have the polar distance; but if one be north and the other south, add the declination to 90° and you will have the polar distance.*

Having thus found the correct altitude, latitude, and polar distance, the apparent time of observation may be found by either of the three following methods, of which the first is the most simple, since it does not require the table of natural sines, all the logarithms being found in Tab. XXV. This method is simplified by means of the table of hours affixed to the table of log. sines; in using which, you must observe, that if the sine or co-sine of the logarithm sought is marked at the top of the table, the name of hour, either A. M. or P. M. is also to be found at the top, and the contrary if the sine or co-sine is marked at the bottom.

To find the apparent time by the sun's altitude.

FIRST METHOD.

Add together the correct altitude of the sun's centre, the latitude and the polar distance; from the half sum subtract the sun's altitude and note the remainder. Then add together the log. secant of the latitude (this and all the other logs. being found in Table XXV.) the log. co-secant of the polar dist. (rejecting 10 in each index) the log. co-sine of the half sum, and the log. sine of the remainder, half the sum of these four logarithms being sought for in the column of log. sines, will correspond to the hour of the day in the hour columns.

EXAMPLE I.

Suppose on the 10th of October, 1804, sea account, at 8h. 21m. A. M. per watch, in the latitude of 51° 30′ N. long. 52° E. of Greenwich per account, the altitude of the sun's lower limb by a fore observation was 13° 32′, and the correction for semi-diameter and dip 12 miles; required the apparent time of the observation?

By Example III. page 135, the declination is 6° 34′ S. this added to 90° gives the polar distance 96° 34′. To the sun's observed altitude 13° 32′, I add 12 miles and subtract the refraction 4′, the remainder is the correct alt. 13° 40′.

☉'s Cor. alt.	13° 40′		
Lat.	51 30	Secant	0.20585
Pol. dist.	96 34	Co-secant	0.00286
Sum	161 44		
½ Sum	80 52	Co-sine	9.20067
☉'s Alt.	13 40		
Rem.	67 12	Sine	9.96467
			2)19.37405
		Sine	9.68702

corresponding to which in the column marked A. M. is 8h. 7m. 9s.
Time per watch 8h. 21m.

Watch too fast 13 51

Y

Hence the time of taking this obſervation is Oct. 10, 8h. 7′ 9″ A. M. ſea account, or, which is the ſame thing, Oct. 10, 20h. 7′ 9″, reckoning from noon to noon; the time by the nautical almanac being October 9d. 20h. 7m. 9s.

EXAMPLE II.

Suppoſe on the 10th of May, 1804, ſea account, at 5h. 30m. P. M. per watch, in lat. 39° 54′ N. long. by account 35° 30′ W. of Greenwich, the altitude of the ſun's lower limb by a fore obſervation was 15° 45′, the dip and ſemi-diameter being 12 miles, and conſequently his correct altitude 15° 54′; required the apparent time of the obſervation?

By Example IV. page 135, the ſun's declination is 17° 28′ N. which ſubtracted from 90° leaves the polar diſtance 72° 32′.

☉'s Alt.	15°	54′		
Lat.	39	54	Secant	0.11511
Pol. diſt.	72	32	Co-ſecant	0.02050
Sum	128	20		
½ Sum	64	10	Co-ſine	9.63924
☉'s Alt.	15	54		
Remainder	48	16	Sine	9.87288
				2)19.64773
			Sine	9.82386

corresponding to which in the column P. M. is 5h. 34′ 26″ the true time of day.

Time per watch	5	30
Watch too ſlow		4′ 26″

EXAMPLES TO EXERCISE THE LEARNER.

1. In lat. 36° 39′ S. ☉'s declination 9° 27′ N. the altitude of the ſun's lower limb in the morning was obſerved 10° 33′.* Required the apparent time? Anſwer, 7h. 23m. 51s.

2. In lat. 36° 21′ S. ☉'s declination 8° 44′ N. alt. ☉'s L. L. in morning 10° 48′*. Required the apparent time? Anſwer, 7h. 22m. 11s.

3. In lat. 29° 25′ N. ☉'s declination 23° 20′ N. obſerved alt. of ſun's lower limb in the afternoon 14° 58′*. Required the time? Anſwer, 5h. 41m.

4. In lat. 3° 31′ S. ☉'s declination 20° 03′ S. obſerved alt. ☉'s L. L. 38° 41′* in the afternoon. Required the time? Anſwer, 3h. 18m. 47s.

5. In lat. 13° 17′ N. ☉'s declination 22° 10′ S. in the morning obſerved altitude of ☉'s L.L. 36° 26′.* Required the time? Anſ. 9h. 17m. 8s.

6. In lat. 21° 36′ S. ſun's declination 3° 37′ S. in the morning obſerved altitude of the ſun's L. L. 35° 48′.* Required the time? Anſwer, 8h. 29m. 50s.

* The correction for dip and ſemi-diameter being 12′ additive.

SECOND METHOD.

Find as in the former method, the sun's correct altitude, the ship's latitude, and the polar distance; thence the sun's correct zenith distance and the complement of latitude; then *add together the zenith distance, co-latitude and polar distance, from half their sum subtract the zenith distance and note the remainder; then add together the log. co-secant of the co-lat. (this and all the other logs. being found in Table XXV.) the log. co-secant of the polar distance (rejecting* 10 *in each index) the sine of the half sum, and the sine of the remainder, half the sum of these four logarithms being found among the log. co-sines, corresponds, in the adjoined column, to the time of day.*

I shall work the two preceding examples by this method.

EXAMPLE I.

	90° 0′		90° 0′	90° 0′
☉'s cor. alt.	13 40	Latitude	51 30	☉'s dec. 6 34
Zen. dist.	76 20	Co-lat.	38 30	Pol. dist. 96 34
Co-lat.	38 30	Co-secant 0.20585		
Pol. dist.	96 34	Co-secant 0.00286		
Sum	211 24			
½ Sum	105 42	Sine 9.98349		
Zen. dist.	76 20			
Rem.	29 22	Sine 9.69055		
		2)19.88275		

Co-sine 9.94137 corresponding to which in the column A. M. is 6h. 7′ 9″ the time of day, which agrees with the other method.

EXAMPLE II.

	90° 0′		90° 0′	90° 0′
☉'s cor. alt.	15 54	Lat.	39 54	☉'s dec. 17 28
Zen. dist.	74 6	Co-lat.	50 6	Pol. dist. 72 32
Co-lat.	50 6	Co-sec. 0.11511		
Pol. Dist.	72 32	Co-sec. 0.02050		
Sum	196 44			
½ Sum	98 22	Sine 9.99535		
Zen. dist.	74 6			
Remainder	24 16	Sine 9.61382		
		2)19.74478		

Co-sine 9.87239 corresponding to which in the column P.M. is 5h. 34m. 27s. the time of day, which agrees nearly with the first method.

By the preceding method you may find the beginning or ending of the twilight, by calculating the hour when the ſun's zenith diſtance is 108° (or when the ſun is 18° below the horizon); for by obſervation it has been found that the twilight begins or ends when the ſun is at that diſtance from the zenith.

EXAMPLE.

Required the time of beginning and ending of the twilight, June 23, 1804, at Boſton?

Zen. diſt.	108° 0′			
Co-lat.	47 37	Co-ſecant	0.13156
Pol. diſt.	66 33	Co-ſecant	0.03744
Sum	222 10		
½ Sum	111 5	Sine	9.96991
Zen. diſt.	108 0		
Remainder	3 5	Sine	8.73069
		Sum	18.86960

Half ſum Co-ſine 9.43480 which correſponds to 2h. 6′ 20″ A. M. and 9h. 53′ 40″ P. M. Therefore the firſt appearance of the twilight in the morning is at 2h. 6′ 20″; and the end of it in the evening is at 9h. 53′ 40″.

THIRD METHOD.

When the ſun or ſtar's declination, and the complement of the latitude are both north or both ſouth,* their ſum, but if one be north and the other ſouth, their difference is the meridian altitude.

From the natural ſine of the ſun's or ſtar's meridian altitude, ſubtract the natural ſine of the true altitude (both being found in Tab. XXII.) then add together the log. co-ſecant of the co-latitude (from Tab. XXV.) the log. ſecant of the ſun or ſtar's declination, (from the ſame table) rejecting 10 in each index, and the log. of the difference of the natural ſines (Tab. XXIV.). The ſum of theſe three logarithms being found in the column of riſing, (Tab. XXI.) the hours, minutes and ſeconds correſponding will be the apparent time from noon, if it was an altitude of the ſun that was taken; but if it was a ſtar, it will be the horary diſtance of the ſtar from the meridian.

The two preceding examples are thus worked by this third method.

* If the ſum exceed 90° ſubtract it from 180°, the remainder will be the meridian altitude. In this rule the complement of the latitude is called by the ſame name as the latitude.

EXAMPLE I.

				90° 0′
			Latitude	51 30 N.
Co-latitude	38° 30′ N.	Co-sec. 0.20585	Co-lat.	38 30 N.
Declination	6 34 S.	Secant 0.00286		
Dif.mer.alt.	31 56	N. sine 52893		
☉'s cor. alt.	13 40	N. sine 23627		

Differ. 29266 log. 4.46636

4.67507 corresponding to

which in the column of rising is 3h. 52′ 51

12

Subtracted from 12h. leaves the true time	8	7	9
Time per watch	8	21	
Watch too fast		13	51

agreeing with the former methods.

EXAMPLE II.

				90° 0′
Co-latitude	50 06 N.	Co-sec. 0.11511	Lat.	39 54
Declination	17 28 N.	Secant 0.02050		
			Co-lat.	50 06
M. alt.	67 34	N. sine 92432		
Correct alt.	15 54	N. sine 27396		

Differ. 65036 log. 4.81315

4.94876 corresponding to which in the column of rising is 5h. 34′ 27″ agreeing nearly with the other methods.

Time p. watch	5	30
Watch too slow	4	27

To find the apparent time by an altitude of a fixed star.

Correct the observed altitude for the dip and refraction (the dip being generally 4 miles, in a common sized vessel.) Find the ship's latitude at the time of observation, and the star's right ascension and declination in Tab. IX.* then add together the star's correct altitude, the ship's latitude, and the polar distance; from the half sum subtract the star's altitude and note the remainder. Then add together the log. secant of the latitude, the log. co-secant of the polar distance, rejecting 10 in each index, the log. co-sine of the half sum, and the log. sine of the remainder, half the sum of these four logarithms will be the log. sine of half the hour angle; take out the corresponding time in the column marked P. M. Table XXV. and apply it to the star's right ascension, by subtracting it when the star is east of the meridian, or adding it when west of the meridian, the sum or difference will be the right ascension of the meridian or mid heaven. From the right ascension of the meridian (increased by 24 hours if necessary) subtract the

* The right ascension and declination of the stars obtained from Tab. IX. are the mean values, which, when very great accuracy is required, must be corrected for two small apparent motions discovered by Dr. Bradley; one called the Aberration, depending on the velocity of light: the other, called the Nutation, depending on a small motion of the earth's axis, caused by the attraction of the moon. The methods of allowing for the Aberration and Nutation, are taught in most treatises of Astronomy.

sun's right ascension the preceding noon at Greenwich, taken from page 2d. of the month in the Nautical Almanac, the remainder will be the apparent time at the ship nearly. To this time apply the longitude of the ship from Greenwich, turned into time, by adding it when it is west, or subtracting it when it is east, the sum or difference will be the apparent time of the observation nearly by the meridian of Greenwich. Then enter Table XXIX. with the daily variation of the sun's right ascension at the top, and the time at Greenwich* in the side column, and in the angle of meeting is a number of minutes and seconds, which subtracted from the above time at the ship, leaves the corrected apparent time required.

EXAMPLE I.

Suppose, Sept. 9, 1804, sea account, in lat. 7°45′S. longitude 30°18′E. of Greenwich, the altitude of the star Procyon, being then east of the meridian, should be 28° 16′ and the dip 4′; required the time.

By Tab. IX. for year 1800 Procyon's right asc.	7h 28′ 49″	Dec.	5° 44′ 0″ N.
Variation in $4\frac{3}{4}$ years Add	15	Sub.	0 36
For the year 1804, Sept. right ascen.	7 29 04	Dec.	5 43 24 N.
			90
		Pol. dist.	95 43

Star's obs. alt.	28°	16′		
Dip		4		
	28	12		
Ref. Tab. XIII.		2		
Cor. alt.	28	10		
Latitude	7	45	Secant	0.00399
Pol. dist.	95	43	Co-sec.	0.00217
Sum	2)131	38		
$\frac{1}{2}$ Sum	65	49	Co-sine	9.61242
Alt.	28	10		
Remainder	37	39	Sine	9.78592
			Sum	2)19.40450
$\frac{1}{2}$ Sum.			Sine	9.70225

corresponding to which in the column P. M. is 4h. 2m. 0s.

	4h.	2m.	0s.
Star's right ascension	7	29	4
Right ascension of the meridian	3	27	4
Increased by	24		
	27	27	4
Sept. 9, sea acc. is Sept. 8, by N. A. Sun's right as. noon	11	6	53
Time at the ship nearly	16	20	11
Ship's longitude 30° 18′ in time	2	1	12
Time at Greenwich nearly	14	18	59

Sun's right ascension Sept. 8	11h. 6′ 53″
Sept. 9	11 10 29
Daily difference	3 36

The correction of Table XXIX. corresponding is 2m. 9s. which subtracted from 16h. 20′ 11″ leaves 16h. 18m. 2s. the true time at the ship or 4h. 18m. 2s. past midnight.

* Table XXIX. is only calculated to 12h. If the time at Greenwich exceeds 12h. you must first take out the correction for 12h. and add it to the correction taken out for the rest of that time; the sum will be the sought correction.

EXAMPLE II.

Suppose April 16, 1804, sea account, in lat. 48° 56′ N. long. 66° W. the observed altitude of Aldebaran when west of the meridian, should be 22° 25′, and the dip 4′; required the apparent time at the ship?

		h. ′ ″	
By Table IX. for the year 1800, R. Asc.	Aldeb.	4 24 27	Dec. 16° 6′ 0″ N
Variation for $4\frac{1}{3}$ years	Add	15	Add 0 36
For the year 1804, R. Asc.		4 24 42	Dec. 16 6 36 N.
			90
			P. dist. 73 53 24

Obs. alt. Aldeb.	22°	25′		
Dip		4		
	22	21		
Refraction		2		
Cor. alt. Aldeb.	22	19		
Latitude	48	56	Secant	0.18248
Pol. dist.	73	53	Co-sec.	0.01741
Sum	2)145	8		
$\frac{1}{2}$ Sum	72	34	Co-sine	9.47654
Alt.	22	19		
Remainder	50	15	Sine	9.88584
			Sum	2)19.56227

$\frac{1}{2}$ Sum. Sine 9.78113 corresponding to which in the column P. M. is

	h.	′	″
in the column P. M. is	4h.	57′	20″
Star's Right Ascension	4	24	42
Right Ascension of the merid.	9	22	2
April 16, sea acc. is Ap. 15, by N.A. when ☉'s rt. as. noon	1	33	46
App. time at ship nearly	7	48	16
Long. 66 W. in time	4	24	
App. time at Greenwich	12	12	16

		h.	′	″
Sun's Rt. Ascen.	April 15	1h.	33′	46″
	April 16	1	37	27
Daily difference			3	41

Daily difference 3 41. The correction of Tab. XXIX. corresponding is 1′ 52″, which subtracted from 7h. 48′ 16″ the app. time at the ship nearly, leaves 7h. 46m. 24s. the correct time at the ship.

This method of obtaining the time by the stars is certain, could a good horizon be obtained; but as that is not always the case, it is best to regulate your watch by the sun.

To find the LONGITUDE at SEA, by the LUNAR OBSERVATIONS.

AMONG the various methods proposed for finding the longitude at sea, none has been more justly celebrated, nor is of greater utility, than that by measuring the distance of the moon from the sun or a fixed star, usually called the LUNAR OBSERVATIONS. To facilitate this method, a work is annually published by the Commissioners of Longitude in England, which contains the distance of the moon from the sun or a fixed star, for every three hours, calculated for the meridian of Greenwich. An observation of these distances being made in any place, the time at Greenwich may be deduced therefrom, which compared with the apparent time of observation, will give the difference of meridians.

The distances of the moon from the sun and proper stars, are generally given in the Nautical Almanac from one object on each side of her, to afford a greater number of opportunities of observation, and to enable the observer to correct, in a great degree, the errors of the instrument, or of the adjustments, or a faulty habit of observing the contact of the limbs; because the errors have a natural tendency to correct each other, in taking the mean of observations made with stars on different sides of the moon. Previous to making the observation, the Nautical Almanac must be examined, to see from what objects the distances are computed, and it is from them only the distances must be measured.

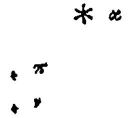
There are only nine stars from which the distances are computed in the Nautical Almanac; and as it is of the greatest importance to be able to discover them easily, I shall here add a number of remarks which will be found useful for that purpose.

The best way of discovering any star, is by means of a celestial globe: if that cannot be obtained, the time of the star's passing the meridian, and its meridian altitude, may be calculated, and by observing it at that time, it may be easily discovered. The distances marked in the Nautical Almanac afford also to the observer a ready means of knowing the star from which the moon's distance is to be observed; for he has nothing to do but to set his quadrant or sextant to the distance computed roughly at the apparent time, estimated nearly for the meridian of Greenwich, and direct his sight to the east or west of the moon, according as the distance at Greenwich was found in the 8th and 9th, or 10th and 11th pages of the month; and having found the reflected image of the moon upon the horizon glass, sweep the sextant to the right or left, and that image will pass over the sought star, if above the horizon and the weather clear: the star is always one of the brightest, and is situated nearly in a line perpendicular to the moon's horns, or, which is the same thing, in the line of the moon's shorter axis produced.

The computed distance made use of in sweeping for the star, is found in this manner. Reckon the apparent time at the ship in the manner of astronomers (by counting 24 hours from noon to noon, and taking the day one less than the sea account); to this time apply the longitude turned into time, by adding in weſt, and ſubtracting in eaſt longitude; the ſum or difference will be the apparent time at Greenwich nearly. Take the diſtances from the Nautical Almanac for the time immediately preceding and following this eſtimated time, and note the difference of theſe diſtances. Then ſay, as 3h. or 180′ is to the difference of the diſtances, ſo is the difference between the apparent time at Greenwich and the next preceding time ſet down in the Nautical Almanac, to a number of minutes, which is to be added to the next preceding diſtance taken from the Nautical Almanac, if it is increaſing, but ſubtracted if decreaſing; the ſum or difference will be the diſtance to which the quadrant or ſextant is to be fixed.

In ſweeping for the ſtars by this method, it will often happen that two or more are ſwept upon at once: this might cauſe ſame difficulty to an inexperienced obſerver, who would be at a loſs to know which to make uſe of. To remove this, the following deſcription of theſe ſtars is added, which is an improvement of that formerly publiſhed in the American edition of Moore's Navigation. The deſcription of Regulus was given by an ingenious correſpondent.

α Arietis.



This ſtar bears about weſt, diſtant 23° from the Pleiades, or Seven Stars; it is of the ſecond magnitude, and may be known by means of the ſtar π of the third magnitude, ſituated S.W. of it, 3½ degrees diſtant. South of the ſtar π, at the diſtance of 1½°, is the ſtar ν, of the fourth magnitude. The northernmoſt of theſe ſtars is α Arietis.

Aldebaran.

About 35° E. of α Arietis, and 14° S. E. of the Pleiades or Seven Stars, lies the bright ſtar Aldebaran. Near this ſtar, to the weſtward, are ſix or ſeven ſtars of the third and fourth magnitude, forming with it a figure reſembling the letter V, as is repreſented in the adjoined figure, where Aldebaran is marked α. At the diſtance of 23° from Aldebaran, in a S. E. direction, are three very bright ſtars, ſituated in a ſtraight line near to each other, forming the belt of Orion.

Pollux.

At the diſtance of 45° from Aldebaran, in the direction of E. N. E. lies the ſtar Pollux, which is a bright ſtar, though not of the firſt magnitude. N. W. of it, diſtant 5°, is the ſtar Caſtor, of nearly the ſame magnitude, and you will almoſt always ſweep both at once: the ſouthernmoſt is the one to be uſed.

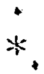
Regulus.

E. by S. ½ S. from Pollux, at the diſtance of 37½°, lies the ſtar Regulus, of the firſt magnitude; to the northward of which (at the diſtance of 8°) is a ſtar of the ſecond magnitude; near to theſe are five ſtars of the third magnitude; the whole forming a cluſter reſembling a ſickle, repreſented in the adjoined figure, Regulus being in the extremity of the handle. A line drawn from the northern polar ſtar, through its pointers, paſſes about 12° to the eaſtward of Regulus.

Spica.

E. S. E. from Regulus, at the diſtance of 54°, lies the ſtar Spica, of the firſt magnitude, with no bright ſtar near it: S. W. of this ſtar, at the diſtance of about 16°, are five ſtars of the third and fourth magnitude, ſituated as in the adjoined figure; the two northernmoſt of theſe ſtars η, ν, form a ſtraight line with the ſtar Spica, and by this mark it may be eaſily diſcovered. A line drawn from the northern polar ſtar, through the middle ſtar of the tail of the Great bear, will paſs near to Spica.

Antares.



E. S. E. from Spica, at the diſtance of 46 degrees, lies the ſtar Antares, in 26 degrees of ſouth declination; it is a remarkable ſtar, of a reddiſh colour; on each ſide of it, to the W. N. W. and S. S. E. about 2° diſtant, is a ſtar of the third or fourth magnitude, forming an obtuſe angle with it, no bright ſtar being near.

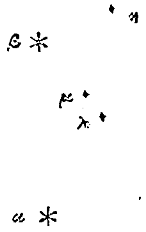
α Aquilæ.

N. E. from Antares, at the diſtance of 60°, lies the very bright ſtar α Aquilæ; N. N. W. of which, at 2° diſtance, is a ſtar of the third magnitude, and S. S. E. of it, at 3° diſtance, another ſtar of a leſſer magnitude, forming a ſtraight line with it. The ſtar α Aquilæ is nearly of the ſame colour as Antares.

Fomalhaut.

S. E. from α Aquilæ, at the diſtance of 60°, lies the ſtar Fomalhaut, which is a bright ſtar of high ſouthern declination, its altitude in northern latitudes being ſmall, never exceeding 20° in the latitude of 40°. It bears nearly ſouth from the ſtar α Pegaſi, diſtant 45 degrees. A line drawn from the pointers, through the northern polar ſtar, and continued to the oppoſite meridian, will paſs very near to α Pegaſi and Fomalhaut.

α Pegasi.



E. by N. from α Aquilæ, at the diſtance of 48°, and weſt from α Arietis, at the diſtance of 44°, lies the ſtar α Pegaſi, which may be known by means of four ſtars of different magnitudes, ſituated as in the adjoined figure, in which α repreſents α Pegaſi, β a ſtar of the ſecond magnitude bearing north of it diſtant 13°; the others are of leſſer magnitude, and two of them, η, μ, form a ſtraight line with the ſtar α Pegaſi, and by this mark it may be eaſily diſcovered.

General obſervations on the taking of a Lunar Obſervation.

The accuracy of a lunar obſervation depends chiefly on the regulation of the watch, and on the exact meaſurement of the diſtance of the moon from the ſun or ſtar; a ſmall error in the obſerved altitudes of thoſe objects does not much affect the reſult of the calculation.

The beſt method of regulating a watch at ſea, is by taking an altitude of the ſun when it changes quickeſt, or when it bears nearly eaſt or weſt, and noting the time by the watch. With this altitude, the latitude of the place, and the sun's declination, find the apparent time of observation by either of the preceding methods; the difference between this time and that shewn by the watch, will show how much the watch is too fast or too slow. A single observation taken with care will generally be exact enough; but if greater accuracy is required, the mean of a number of observations may be taken. If the distance of the sun and moon be observed when the sun is three or four points distant from the meridian, the apparent time of observation may be deduced from the altitude of the sun taken at the precise time of measuring the distance; this will render the use of a watch unnecessary, and will prevent any irregularity in its going from affecting the result of the observation. If a night observation is to be taken, the watch should be regulated by an altitude of the sun taken the preceding evening, and its going examined by means of another observation taken the next morning; for the time found by an altitude of a star cannot be so well depended upon, as the atmosphere in the night is precarious, and the horizon generally ill-defined; but the altitude may be sufficiently exact for finding the correction used in determining the angular distance.

Although all the instruments used in these observations ought to be well adjusted, yet particular care ought to be taken of the sextant used in measuring the distance of the moon from the sun or star, since an error of 1′ in this distance will make an error of nearly 30′ in the longitude deduced therefrom. When a great angular distance is to be measured, the adjustment of the parallelism of the telescope is of primary importance; but when the distance is less than 50°, the telescope may be dispensed with, using a simple sight tube, taking care, however, that the eye and point of contact of the objects on the horizon glass be equally distant from the plane of the instrument.

Whilst one person is observing the distance of the objects, two others ought to be observing their altitudes; and the watch either suspended near one of the observers, or put into the hands of a fourth person appointed to note the times. The observer who takes the angular distance giving previous notice to the others to be ready with their altitudes by the time he has finished his observation, which being done, the time, altitudes, and distance should be carefully noted; and other sets of observations taken, which must be done within the space of 15 minutes, and the mean of all these observations must be taken and worked as a single one.

When a ship is close hauled to the wind, with a large sea, or when sailing before the wind, and rolling considerably, it is difficult to measure the distance of the objects; but when the wind is enough upon the quarter to keep her steady, it is easy to do it, especially in small distances, which are much more easily measured than large ones, and are not so liable to error from an ill adjustment of the telescope: an observer would therefore do well to choose those times for his observations when the distance of the objects is less than 70°. An observation of the sun and moon is generally much easier to take when the altitude of the moon is less than that of the sun, because the sextant will be held in a more natural and easy manner. When the moon is near the zenith the observation is generally difficult to make, because the observer is forced to place himself in a disagreeable posture. For the same reason an observation of the moon and a star is generally much easier to take when the star is lower than the moon. This situation of the objects may in most cases be obtained by making the observations at a proper time of the day. But it must be observed that neither of the objects ought to be at a less altitude than 10°, upon account of the uncertainty of the refraction near the horizon; for by the Example, page 132, it appears that the refraction varies from 33′ to 36′ 40″ only by an alteration of 40° in the thermometer. This alteration might cause an error of two degrees in the longitude.

In taking the altitude of the moon, the round limb, whether it be the upper or lower, must be brought to the horizon. In damp weather it is rather difficult to observe the altitude of the stars, on account of their dimness, particularly α Pegasi and α Arietis. Sometimes they are so dim that they cannot be seen through the holes of the sight vane; in that case it must be turned aside, and the eye held in nearly the same place.

We have here supposed that there were observers enough to measure the altitudes when the distance was observed; but if that is not the case, the altitudes may be calculated in a manner that will be explained hereafter.

Preparations necessary for working a Lunar Observation.

Find the apparent time of observation by astronomical account, which is one day less than the sea account; to this time apply the longitude turned into time by Table XX.* by adding it if it be west, but subtracting it if it be east; the sum or difference † will be the supposed time at Greenwich, or reduced time.

In page 7th. of the month of the Nautical Almanac, find the nearest noon and midnight both before and after the reduced time, take out the moon's semi-diameter and horizontal parallax for this noon and midnight and find their differences.

Then enter Table XII. with these differences in the side column, and the reduced time at the top; opposite the former and under the latter are the corrections,‡ to be applied respectively to the semi-diameter and horizontal parallax, marked down first in the Nautical Almanac; additive if increasing, subtractive if decreasing: the sum or difference will be respectively the horizontal semi-diameter and the horizontal parallax. To this semi-diameter must be added the augmentation from Table XVI. and the sum will be the correct semi-diameter of the moon. The sun's semi-diameter is found in the 3d. page of the month of the Nautical Almanac.

To the observed altitude of the sun's or moon's lower limb add 12 miles; if their upper limb was used subtract 20 miles; and from the star's observed altitude subtract 4 miles, and you will have the apparent altitudes nearly; § and by subtracting them from 90° you will have the apparent zenith distances.

To the observed distance of the moon from a star add the moon's semi-diameter, if her nearest limb was observed, but subtract it if her farthest limb was observed; the sum or difference will be the apparent distance. But to the observed distance of the sun and moon add their semi-diameters, the sum will be the apparent distance.

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* Or by multiplying it by 4 sexagesimally, in the manner directed in the note page 154.

† When the sum exceeds 24 hours, you must subtract twenty-four hours, and add one to the day of the month. And when the hours to be subtracted are more than the hours of the apparent time, 24 hours must be added to the latter previous to the subtraction, and one day taken from the day of the month.

‡ These corrections may be found easily without the table, by saying, as 12 hours is to the reduced time (rejecting 12 hours when more than 12 hours) so is the difference of parallax or semi-diameter for 12 hours to the corresponding correction. When using the table the reduced time may be found to the nearest hour, or if falls mid-way between two hours, the mean of the corrections for both hours may be taken.

§ These altitudes are supposed to be taken by a fore observation; and if you wish to obtain the apparent altitudes to a greater degree of exactness, you ought to subtract the dip of the horizon, and add or subtract the semi-diameter of the object according as the lower or upper limb was observed, but the application of the above numbers will give the altitudes in a common sized vessel, where the dip is 4 or 5 minutes; but if the eye should be very high above the water, you might subtract 1 or 2 minutes from these altitudes, according to the dip in Table XIV. In the following examples of lunar observations we shall suppose the dip to agree with the above numbers.

From the ſun's refraction in Table XIII. take his parallax in altitude in Table XV. the remainder will be the ſun's correction.

The ſtar's refraction in Table XIII. is his correction.

With the moon's horizontal parallax, and apparent zenith diſtance, find her correction in Table XVIII. which is to be entered at the top with the moon's zenith diſtance, and at the ſide with her horizontal parallax; under the former and oppoſite the latter is the ſought correction.*

Moſt of theſe preparations are neceſſary, whatever method is uſed in working the obſervation. The moſt noted methods are thoſe of DUNTHORNE, LYONS, WITCHEL, &c. and improvements on theſe methods by various authors.

DUNTHORNE's and ſimilar methods have one great advantage, there being no difference of caſes; but their methods are tedious by reaſon of the great exactneſs required in proportioning the logarithms to ſeconds. LYON's and WITCHEL's methods do not labour under this inconvenience; but they are embarraſſed with a variety of caſes: ſometimes the corrections are additive, ſometimes ſubtractive, and learners find a difficulty in rightly applying them. The following method has all the advantage of Witchel's, without labouring under this inconvenience. The corrections being always applied in the ſame manner, the logarithmic ſines and coſecants need be taken only to four places of figures and to the neareſt minute; it being in general quite unneceſſary to proportion for the odd ſeconds.

Rule for correcting the apparent Diſtance of the Moon from the Sun.†

Add together the apparent zenith diſtances of the ſun and moon and their apparent diſtance, and note the half ſum of theſe three numbers.

From this half ſum ſubtract the moon's zenith diſtance and call the difference the firſt remainder. From the ſame half ſum ſubtract the ſun's zenith diſtance and call this difference the ſecond remainder.

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* This table contains the correction of the moon's altitude for every 10" of parallax from 53' to 62', and for every degree of zenith diſtance from 1° to 87°; and may be found for any intermediate angle by means of the tables of proportional parts placed at the right hand of every page. As this table is printed in a new form we ſhall give a few examples to explain its uſe.

In finding the correction from this table, the degrees of zenith diſtance muſt be found at the top (neglecting the odd minutes) and the next leſs parallax at the ſide; the number under the former and oppoſite the latter is to be reſerved. Take the difference between this reſerved number and the one next below it in the ſame vertical column, and call it d; take alſo the difference between that reſerved number and the number in the next right hand column on the ſame horizontal line, (correſponding to the next greater degree of zenith diſtance, which ſometimes falls on the firſt column of the next page) and call it D. Then find d at the top of the little table of parallax in the right hand of the page; under this and oppoſite the odd ſeconds of parallax (found in the column marked S.) is the correction ariſing therefrom, which is to be added to the former reſerved number. Then in the other ſide tables for the zenith diſtance find D at the top and the minutes of zenith diſtance at the ſide, (being marked M at the top), under the former and oppoſite the latter is the correction for the odd minutes of zenith diſtance, which is additive except in the two laſt pages of the tables. Theſe ſide tables are marked at the top Add or Subtract, ſo that there can be no difficulty in applying theſe two corrections to the reſerved number, in order to obtain the correction of the moon's altitude for parallax and refraction.

At the top of the ſide tables in every page are marked all the numbers that can be wanted on that page: in the ſide columns the zenith diſtance is marked to every 5 minutes; the correction for any intermediate minute may be found by inſpection. The zenith diſtances are marked at the top of Table XVIII. inſtead of the altitudes; by this means the correction for the odd minutes is additive in the moſt uſeful part of the table: for a lunar obſervation ought not to be taken when the moon's zenith diſtance is as great as is marked in the laſt page of the table.

After a little practice the corrections may be taken from theſe tables in a very expeditious manner.

EXAMPLE I. Required the correction of the ☽'s altitude for the zen. diſt. 55°, and parallax 58' 10"?

Under 55° and oppoſite to 58' 10" is the ſought correction 46' 18".

EXAMPLE II. Required the correction of the ☽'s altitude for the zen. diſt. 55° and parallax 58' 16"?

Under 55° and oppoſite to 58' 10" is 46' 18", the difference between this and the number below it (46' 27") is 9"=d. In the little table of parallax marked 9" at the top, and oppoſite to the odd ſeconds (6) of the moon's horizontal parallax 58' 16" ſtand 5", which added to 46' 18" gives the correction required, 46' 23".

EXAMPLE III. Required the correction of the ☽'s altitude for the zen. diſt. 55° 15' and parallax 58' 16"?

Under 55° and oppoſite to 58° 10' is 46' 18", the difference between this and the number below it 46' 27" is 9"=d; and the difference between it and the number in the right hand column oppoſite to it is 32"=D. In the little table of parallax at the right hand under d=9", and oppoſite 6 the odd ſeconds of parallax ſtand 5", additive. In the table of zenith diſtance under D=32" and oppoſite the odd minutes of zenith diſtance 15 ſtand 8" additive. Therefore by adding 5" and 8" to 46' 18", the ſought correction is found to be 45' 31".

EXAMPLE IV. Required the correction of the ☽'s altitude for the zen. diſt. 19° 20', and horizontal parallax 59'?

Oppoſite 59' and under 19° ſtand 16' 56"; the difference between this and the number oppoſite to it in the next column is D=51". Under 51" in the tables of zenith diſtance, and oppoſite 20' (the odd minutes of zenith diſtance, is 17". to be added to 16' 56" to obtain the ſought correction, 17' 13".

EXAMPLE V. Required the correction of the ☽'s altitude for the zen. diſt 80° 35', and parallax 55'?

Oppoſite 55' and under 80° is 48' 56", to the right of which, in the column marked 81° (which falls in the next page) is 48' 32"; their difference is d=24". Now in the ſide tables for the zenith diſtance, under 24" and oppoſite 35' the odd minutes of zen. diſt. ſtand 14", and as at the top it is marked ſubtract, it muſt be ſubtracted from 48' 56", to obtain the ſought correction 48' 42".

† This rule is ſimilar to that for correcting the moon's diſtance from a ſtar; the only difference conſiſts in reading Sun for Star.

To the conſtant log. 9.6990 add the log. co-ſec. of the half ſum, and the log. ſine of the apparent diſt. (both taken from Tab. XXV.) the ſum, rejecting 20 in the index, is a reſerved logarithm.

To this reſerved logarithm add the log. ſine of the ſun's zenith diſtance, the log. co-ſecant of the firſt remainder, (both taken from Tab. XXV.) and the proportional log. of the correction of the ſun's or ſtar's altitude (from Table XXIII.); the ſum, rejecting 30 in the index, will be the propor. log. of the firſt correction, to be found in Table XXIII.

To the reſerved logarithm add the log. ſine of the moon's zenith diſtance, the log. co-ſecant of the ſecond remainder (both taken from Table XXV.), and the prop. log. of the correction of the moon's altitude (from Table XXIII.); the ſum, rejecting 30 in the index, will be the prop. log. of the ſecond correction, to be found in Table XXIII.

Then to the apparent diſtance add the correction of the moon's altitude and the firſt correction, and ſubtract the ſum of the ſecond correction and the correction of the ſun's altitude; the remainder is the corrected diſtance.

Take the difference between the correction of the moon's altitude and the ſecond correction; with that enter Table XIX. and under the corrected diſtance take out the number of ſeconds correſponding; and in the ſame column, oppoſite the correction of the moon's altitude, take out the number of ſeconds correſponding; the difference between theſe two numbers is a number of ſeconds to be added to the corrected diſtance, when leſs than 90 degrees; but ſubtracted, when above 90 degrees: the ſum or difference will be the true diſtance.*

To determine the longitude from the true diſtance.

In the Nautical Almanac, among the diſtances of the objects, from page 8 to 11, look for the computed diſtance between the moon and the other obſerved object for that given day; if it be found there, the time at Greenwich will be found at the top column; but if it falls between them, as it generally will, take the difference between the diſtances that ſtand immediately before and after the computed diſtance, and alſo the difference between the diſtance ſtanding before it and the computed diſtance.

Then from Table XXIII. take the prop. log. of the firſt found difference, and the prop. log. of the ſecond found difference, and the difference between theſe two logarithms will be the prop. log. of a number of hours, minutes, and ſeconds; which, being added to the time ſtanding over the firſt diſtance in the Nautical Almanac, will give the true time at Greenwich.

The difference between this Greenwich time and that at the ſhip, turned into degrees by table XX. will be the longitude of the place of obſervation, reckoned from the meridian of Greenwich, which will be eaſt if the time at the ſhip be greater than that at Greenwich, but if it be leſs, the longitude will be weſt.

* The diſtance obtained by this rule is not exactly the true diſtance, for it requires ſeveral ſmall corrections to obtain it true to the neareſt ſecond, viz. (1) The refraction taken from Table XIII. ſhould be corrected for the different heights of the Barometer and Thermometer, as directed in page 132. (2) A correction ſhould be applied for the ſpheroidical figure of the earth. And (3) a correction equal to the fourth correction of Witchel's method given in page 62 of the appendix of the ſecond edition of the Requiſite Tables of Maſkelyne, ſhould alſo be applied.—But to notice all theſe corrections would increaſe the calculation very much, and the reſult of a ſingle obſervation, in which all theſe things were noticed, would probably not be ſo accurate as the mean of two or three obſervations, taken at different times of the day, in which theſe corrections were neglected.

EXAMPLE I.

Suppoſe the 19th Feb. 1804, ſea account, the diſtance of the fartheſt limb of the moon from the ſtar Regulus was obſerved 76° 36′ 0″, the altitude of the moon's lower limb 86° 28′, the altitude of Regulus 14° 13′, the apparent time of obſervation 6h. 28m. P. M. the long. by account 115° W. of Greenwich. Required the true longitude ?

Preparation.

	H.	M.
Feb. 19, Sea account, is Feb. 18, by Nautical Almanac at	6	28
Longitude 115° in time	7	40
Reduced time	14	08

☽'s S. D. at midnight	16′	9″
Noon, Feb. 19,	15	59
Difference		4
Tab. XII.		1
	16	2
Aug. (Tab. XVI.)		16
☽'s S. D.	16	18

☽'s Hor. Par. midnight	58′	53″
Noon	58	41
Difference		12
Tab. XII.		2
Hor. Par.	58	51
Cor. for Par 58′ 50″ and Z. D. 3°	3′	2″
d. = 0 and Par. 1″		0
D. = 60″ and Z. D. 20′		20
Cor ☽'s alt.	3	22

✱'s refrac. 3′43″ is its correction in alt.

☽'s obſ. alt. L. L.	86°	28′
Add		12
☽'s app. alt.	86	40
	90	
☽'s zen. diſt.	3	20
✱'s obſ. alt.	14°	13′
Dip.		4
✱ app. alt.	14	9
	90	
✱ zen. diſt.	75	51

Obſ. diſt.	76°	36′	0″
☽'s S. D.		16	18
App. diſt.	76	19	42

To find the correct diſtance and longitude.

Apparent diſtance	76°	20′
☽'s zenith diſtance	3	20
✱'s zenith diſtance	75	51
Sum	155	31
Half ſum	77	45
☽'s zen. diſt.	3	20
Firſt remainder	74	25
Half ſum	77	45
✱'s zen. diſt.	75	51
Second remainder	1	54

Conſtant log.		9.6990
Half ſum 77° 45′	Co-ſec.	10.0100
Diſtance 76° 20	Sine	9.9875
Referred logarithm		9.6965
✱ zen. diſt. 75° 51′	Sine	9.9866
Firſt rem. 74 25	Co-ſec.	10.0163
✱ Corr. in alt. 3′43	P. L.	1.6851
Firſt corr. 7′26	P. L.	1.3845

Referred logarithm		9.6965
☽'s zen. diſt. 3° 20′	ſine	8.7645
Second rem. 1 54	co-ſec.	11.4794
Cor. ☽'s alt. 3′ 22″	P. L.	1.7281
Second corr 3 52	P. L.	1.6685

Apparent diſtance	76°	19′	42″
Add { Firſt correction		7	26
Add { Corr. ☽'s alt.		3	22
	76	30	30
Sub. { Second correction 3.52 } { Corr. ✱ alt. 3.43 }		7	35
	76	22	55
Corr. Tab. XIX. Diff. add.			0
Correct diſtance	76	22	55

By Naut. Alm diſt. at 12h.	= 77°	48′	38″		
15h.	= 76	4	31		
Difference	1	44	7	P. L.	2378
Diſtance at 12h.	77	48	38		
Correct diſtance	76	22	55		
Difference	1	25	43	P. L.	3222
Time	2h	28′	12″	P. L.	0844
Add	12				
Time at Greenwich	14h.	28′	12″		
Time at ſhip	6	28			
Diff. is long. in time	8	0	12 = 120° 3′ W.		

EXAMPLE II.

Suppose the 19th January, 1804, sea account at 4h. 35′ P.M. in the long. of 88° E. of Greenwich by account, the distance of the sun's and moon's nearest limbs was observed 70° 26′ 10″, altitude of the moon's upper limb 52° 33′, altitude of the sun's lower limb 27° 55′. Required the true longitude?

Preparation.

		d.	h.	m.
Jan. 19th sea account, is Jan. 18th by N. A.	Jan.	18	4	35
Long. 88° E. subtract, in time			5	52
Reduced time	Jan.	17	22	43

☽'s S. D. Jan. 17 at midnight	16′ 8″
Jan. 18 at noon	16 9
Difference	1
Table XII.	1
	16 9
Aug. Tab. XVI.	12
☽'s semi-diam.	16 21
☉'s refraction	1′ 47″
☉'s par.	8
Corr. ☉'s alt	1 39

☽'s Hor. Par. midnight	59′ 11″
Noon	59 16
Difference	5
Tab. XII.	4
☽'s Hor. Par.	59 15
Cor. for Par. 59′ 10″ and Z D. 37°	34′ 54″
d. = 6″ and Par 5″	3
D. = 48″ and Z. D. 47′	38
Corr. ☽'s alt.	35 35
Obs. dist.	70° 26′ 10″
☽'s S, D.	16 21
☉'s S D	16 18
App. dist.	70 58 49

☽'s obs. alt. U. L.	52° 33′
Subtract	20
☽'s app. alt.	52 13
	90
☽'s zen. dist. is	37 47
☉'s obs. alt.	27° 55′
Add	12
☉'s app. alt.	28 7
	90
☉'s zen. dist.	61 53

To find the correct distance and longitude.

Apparent distance	70° 59′
☽'s zenith distance	37 47
☉'s zenith distance	61 53
Sum	170 39
Half sum	85 19
☽'s zen. distance	37 47
1st remainder	47 32
Half sum	85 19
☉'s zen. dist.	61 53
2nd remainder	23 26
Apparent distance	70° 58′ 49″
Add { 1st correction	2 55
Add { Corr. ☽'s alt.	35 35
	71 37 19
Sub. { 2nd corr. 48′ 42″ } { Cor. ☉'s al. 1 39 }	50 21
	70 46 58
Cor. T. XIX. { 4 / 1 } Diff. add	3
Correct distance	70 47 1

Constant log.	9.6990
Half sum 85° 19′ co-sec.	10.0014
Distance 70 59 sine	9.9756
Reserved log.	9.6760
☉'s zen. dist. 61° 53′ sine	9.9455
1st rem. 47 32 co-sec.	10.1321
Corr. ☉'s alt. 1′ 39″ P. L.	2.0378
1st correction 2 55 P. L.	1.7914

Reserved log.	9.6760
☽'s zen. dist. 37° 47′ sine	9.7872
2nd rem. 23° 26′ co-sec.	10.4005
Corr. ☽'s alt. 35′ 35″ P. L.	7040
2nd corr. 48′ 42″ P. L.	5677

By N A. Dis. 17d. 21h.		69° 55′ 26″		
18d. at noon		71 33 27		
Difference		1 38 1	P. L.	2640
Dis. 17d. 21h.		69 55 26		
Correct distance		70 47 1		
Difference		51 35	P. L.	5428
Time		1h. 34′ 44″	P. L.	2788
Add		21		
Time at Greenwich,	Jan. 17d.	22h. 34′ 44″		
Time at ship,	18	4 35		
Diff. long. in time		6 0 16 = 90° 4′ E.		

EXAMPLE III.

Suppoſe the 31ſt March, 1804, at 3h. 48′ A. M. ſea account, in the longitude of 155° W. of Greenwich by account, the diſtance of the neareſt limb of the moon from the ſtar Fomalhaut was 80° 48′ 3″, the altitude of the ſtar 23° 59′, the altitude of the moon's lower limb 55° 36′. Required the true longitude ?

Preparation.

March 31, ſea account is March 30 by N. A. 3h. 48′ A. M	or Mar. 30d.	15h.	48m.
Longitude 155° W. in time	Add	10	20
Reduced time	Mar. 31	2	8

☽'s S. D. at noon	14′ 50″
midnight	14 53
Difference	3
Table XII.	0
	14 50
Augm. Tab. XVI.	13
☽'s S. D.	15 3

☽'s Hor. Par. noon	54′ 26″
midnight	54 36
Difference	10
Table XII.	2
☽'s Hor. Par.	54 28
Corr. for Par. 54′ 20″ and Z. D. 34° is	29′ 45″
d. = 6″ and Par 8″	5
D. = 45″ and Z. D. 12′	9
Corr. ☽'s alt.	29 59

☽'s obſ. alt. L. L.	55° 36′
Add	12
☽'s app. alt.	55 48
☽'s zen. diſt	34 12
✱'s obſ. alt.	23 59
Dip	4
✱'s app. alt.	23 55
✱'s zen. diſt.	66 5

✱'s refraction 2′ 8″ is its correction in alt.

Obſ. Diſt.	80° 48′ 3″
☽'s S. D.	15 3
App. diſt.	81 3 6

To find the correct diſtance and longitude.

Apparent diſtance	81° 3′
☽'s zenith diſtance	34 12
✱'s zenith diſtance	66 5
Sum	181 20
Half ſum	90 40
☽'s zen. diſtance	34 12
1ſt remainder	56 28
Half ſum	90 40
✱'s zen. diſtance	66 5
2nd remainder	24 35

Conſtant logarithm	9.6990
Half ſum 90° 40′ co-ſec.	10.0000
Diſtance 81 3 ſine	9.9947
Reſerved log.	9.6937
✱'s zen. diſt. 66° 5′ ſine	9.9610
1ſt rem. 56 28 co-ſec.	10.0791
✱'s cor. in alt. 2′ 8″ P. L.	1.9262
1ſt corr. 3′ 56″ P. L.	1.6600

Reſerved log.	9.6937
☽'s zen. diſt. 34° 12′ ſine	9.7498
2nd rem. 24 35 co-ſec.	10.3809
Cor. ☽'s alt. 29′ 59″ P. L.	7784
2nd cor. 44′ 55″ P. L.	6028

Apparent diſtance		81° 3′ 6
Add { 1ſt correction,		3 56
{ Corr. ☽'s altitude		29 59
		81 37 1
Sub. { 2nd correction 44′ 55″ }		
{ Corr. ✱'s alt. 2′ 8″ }		47 3
		80 49 58
Table XIX. { 1 / 6 }	Add	1
Correct diſtance		80 49 59

By N. A. dif. Mar. 31 at noon	81° 39′ 18″		
at 3 h.	80 17 7		
	1 22 11	P. L	3405
Diſtance at noon	81 39 18		
Correct diſtance	80 49 59		
	49 19	P. L.	5629

Time			1h.	48′	0″
Add time firſt dif.	Mar.	31d.	0	0	0
Time at Greenwich	Mar.	31	1	48	0
Time at ſhip	Mar.	30	15	48	0
Diff. is long. in time			10h.	0′	0″ = 150° 0′ W.

P. L. 2218

EXAMPLE IV.

Suppose the following observations were made May 18, 1804, sea account at 7h. 15m. 25s. P. M. the distance of the nearest limbs of the sun and moon 106° 3′ 58″, altitude of the moon's upper limb 23° 30′, altitude of the sun's lower limb 11° 54′; the longitude by account being 24° W. Required the true longitude?

Preparation.

	h. m. s.
May 18, Sea account is May 17, by the Nautical Almanac, at	7 15 25
Longitude 24° W. in time	1 36
Reduced time May 17d.	8 51 25

☽'s S. D. at noon	15′ 11″
at midnight	15 6
Difference	5
Table XII.	4
	15 7
Augm. Table XVI.	6
☽'s sem. diam.	15 13
☉'s refraction	4′ 21″
☉'s parallax	9
Corr. ☉'s alt.	4 12

☽'s Hor. Par. noon	55′ 45″
midnight	55 26
Difference	19
Table XII.	14
☽'s Hor. Par.	55 31
Cor. for Par. 55′ 30″ and Z. D. 66°	48′ 35″
d. = 10″ and Par. 1″	1
D. = 17″ and Z. D. 50′	14
Cor. ☽'s alt	48 50

Obs. dis.	106° 3′ 58″
☽'s S. D.	15 13
☉'s S. D.	15 51
App. dist.	106 35 2

☽'s obs. alt.	23° 30′
Subtract	20
☽'s app. alt.	23 10
☽'s zen. dist.	66 50
☉'s obs. alt.	11° 54′
Add	12
☉'s app. alt.	12 6
☉'s zen. dist.	77 54

To find the correct distanse and longitude.

Apparent distance	106° 35′
☽'s zenith distance	66 50
☉'s zenith distance	77 54
Sum	251 19
Half sum	125 39
☽'s zen. dist.	66 50
1st remainder	58 49
Half sum	125 39
☉'s zenith distance	77 54
2nd remainder	47 45

Constant logarithm	9.6990
Half sum 125° 39′ co-sec.	10.0901
Distance 106 35 sine	9.9815
Reserved logarithm	9.7706
☉'s zen. dist. 77° 54′ sine	9.9902
1st rem. 58 49 co-sec.	10.0678
Corr. ☉'s alt. 4′ 12″ P. L.	1.6320
1st correction 6′ 14″ P. L.	1.4606

Reserved log.		9.7706
☽'s zen. dist. 66° 50′ sine		9.9635
2nd rem. 47 45 co-sec.		10.1306
Corr. ☽'s alt. 48′ 50″	P. L.	5666
2nd corr. 1° 6′ 41″	P. L.	4313

Apparent distance	106° 35′ 2″
Add { 1st correction	6 14
Add { Corr. ☽'s alt.	48 50
	107 30 6
Sub. { 2nd correction 1° 6′ 41″ / Corr. ☉'s alt. 4 12 }	1 10 53
	106 19 13
Table XIX. { 6 / 1 } Sub.	5
Correct distance	106 19 8

Distance at 9 h.	106° 12′ 9″		
at 12 h.	107 37 3		
	1 24 54	P. L.	3264
Distance at 9 h.	106 12 9		
Correct distance	106 19 8.		
	6 59	P. L.	1.4112
Time	0h. 14′ 48″	P. L.	1.0848
Add	9		
Time at Greenwich	9 14 48		
Time at ship	7 15 25		
Longitude in time	1 59 23 = 29° 51′ W.		

EXAMPLE V.

Suppose that on the 17th July, 1804, sea account, at 7h. 21m. P. M. in the longitude of 85° W. per account, the distance of the farthest limb of the moon from the star α Aquilæ was 74° 46′ 48″, altitude of the star 21° 32′, altitude of the moon's upper limb 26° 52′. Required the true longitude?

Preparation.

		h.	m.
July 17, sea account, is July 16 by N. A.		at 7	21
Longitude 85° West, in time		5	40
Reduced time	July 16d.	13	1

☽'s S. D. at midnight	14′ 48″
July 17, at noon	14 49
Difference	1
Table XII.	0
	14 48
Aug. Tab. XVI.	7
☽'s semidiameter	14 55

☽'s Hor. Par. midnight	54′ 20″
noon	54 21
Difference	1
Tab. XII.	0
☽'s Hor. Par.	54 20
Cor. for Par. 54′ 20″ and Z.D. 63° is	46′ 34″
D. = 20″ and Z. D. 28′	9
Cor. ☽'s alt.	46 43

Alt. ☽'s U. L.	26° 52′
Subtract	20
☽'s app. alt.	26 32
☽'s zen. dist.	63 28
✱ Fom. alt.	21° 32′
Subtract	4
✱ App. alt.	21 28
✱ zen. dist	68 32

✱'s refraction 2′ 24″ is its correction.

Obs. dist.	74° 46′ 48″
☽'s S.D.	14 55
App. dist.	74 31 53

To find the correct distance and longitude.

Apparent distance	74° 32′
☽'s zenith distance	63 28
✱'s zen. distance	68 32
Sum	206 32
Half sum	103 16
☽'s zenith distance	63 28
1st remainder	39 48
Half sum	103 16
✱'s zenith dist.	68 32
Second remainder	34 44

Constant logarithm	9.6990
Half sum 103° 16′ co-sec.	10.0117
Distance 74 32 sine	9.9840
Reserved logarithm	9.6947
✱'s zen. dist. 68° 32′ sine	9.9688
1st rem. 39° 48′ co-sec.	10.1937
Cor. ✱'s alt. 2′ 24″ P. L.	1.8751
First corr. 3′ 20″ P. L.	1.7323

Reserved logarithm	9.6947
☽'s zen. dist. 63° 28′ sine	9.9517
2nd rem. 34 44 co-sec.	10.2443
Corr. ☽'s alt. 46′ 43″ P. L.	6858
Second cor. 1° 0′ 5″ P. L.	4765

Apparent distance	74° 31′ 53″
Add { First correction	3 20
Add { Correction ☽'s alt.	46 43
	75 21 56
Sub. { Second corr. 1° 0′ 5″ } { Corr. ✱ alt. 2 24 }	1 2 29
	74 19 27
Tab. XIX { 5 0 } diff. add	5
Correct distance	74 19 32

Distance at 12h.	74° 54′ 5″	
15h	73 37 57	
	1 16 8	P. L. 3737
Dist. at 12h.	74° 54′ 5″	
Corrected dist.	74 19 32	
	34 33	P. L. 7168
Time	1h. 21′ 41″	P.L. 3431
Add	12	
Time at Greenwich	13 21 41	
Time at the ship	7 21 0	
Differ. is the long. in time	6 0 41 = 90° 10′ W.	

EXAMPLE VI.

Suppose that on the 12th of August, 1804, at 4h. 8m. P. M. sea account, in the longitude of 95° E. of Greenwich by account, the distance of the nearest limbs of the sun and moon was observed to be 68° 3′ 56″, the altitude of the sun's lower limb 31° 27′, the altitude of the moon's upper limb 44° 33′. Required the ship's longitude?

Preparation.

		d.	h.	m.
Aug. 12, sea account is Aug. 11, by N. A.	Aug.	11	4	8
Longitude 95° East in time			6	20
Reduced time	Aug.	10	21	48

☽'s S. D. Aug. 10, midnight	14′ 58″
Aug. 11, at noon	14 55
Difference	3
Table XII.	″ 2
	14 56
Augm. Table XVI.	11
☽'s S. D.	15 7

☽'s Hor. Par. midnight	54′ 55″
noon	54 43
Difference	12
Table XII.	10
☽'s Hor. Par.	54 45
Cor. for Par. 54′ 40″ and Z. D. 45°	37′ 43″
d. = 7″ and Par. 5″	3
D. = 38″ and Z. D. 47′	30
Cor. ☽'s altitude	38 16

Alt. ☽'s U. L.	44° 33′
Subtract	20
☽'s app. Alt.	44 13
☽'s Zen. Dist.	45 47
☉'s alt. L. L.	31° 27′
Add	12
☉'s app. Alt.	31 39
☉'s Zen. dist.	58 21

☉'s Refraction	1′ 32″
☉'s Parallax	0 8
Corr. ☉'s Alt.	1 24

Obs. dist.	68° 3′ 56″
☽'s S. D	15 7
☉'s S. D.	15 50
App. Dist.	68 34 53

To find the correct distance and longitude.

Apparent distance	68° 35′
☽'s Zenith distance	45 47
☉'s Zenith distance	58 21
Sum	172 43
Half sum	86 21
☽'s Zen. dist.	45 47
First rem.	40 34
Half sum	86 21
☉'s Zenith distance	58 21
Second remainder	28 0

Constant logarithm			9.6990
Half sum 86° 21′		co-sec.	10.0009
Distance 68 35		sine	9.9689
Referred logarithm			9.6688
☉'s Zen. dist.	58° 21′	Sine	9.9301
First rem.	40 34	Co-sec.	10.1869
Corr. ☉'s alt.	1′ 24″	P. L.	2.1091
First corr.	2′ 18″	P. L.	1.8939

Referred logarithm			9.6688
☽'s Zen. dist.	45° 47′	Sine	9.8554
Second rem.	28 0	Co-sec.	10.3284
Corr. ☽'s alt.	38′ 16″	P. L.	6725
Second corr.	53′ 44″	P. L.	5250

Apparent distance		68° 34′ 53″
Add { First correction		2 18
Add { Corr. ☽'s alt.		38 16
		69 15 27
Sub. { Second correction	53′ 44″	
Sub. { Corr. ☉'s alt.	1 24	55 8
		68 20 19
Corr. Tab. XIX. {5, 1} Diff. add		4
Correct distance		68 20 23

By N. A. dist. at 10d. 21h.	67° 49′ 9″		
at 11 0	69 12 7		
Difference	1 22 58	P. L.	3364
Dist. at 10d. 21h.	67° 49′ 9″		
Correct distance	68 20 23		
Difference	31 14	P. L	7607
Time	1h. 7′ 46″	P L.	4243
Add	10d. 21h.		
Time at Greenwich	10d. 22h. 7′ 46″		
Time at Ship	11d. 4h. 8′		
Diff. is long. in time	6h. 0′ 14″ = 90° 3′ 30″ E.		

We ſhall now give Mr. Witchell's method of correcting the apparent diſtance of the moon from the ſun or a ſtar, in order that any one may prove his calculations to be juſt, by working by both methods. In this method the obſerved altitudes and diſtance muſt be corrected for the ſemidiameters, &c. as in the former method, and the correction of the moon's, ſun's, or ſtar's altitude, for refraction and parallax, muſt be found in like manner. Then the true diſtance is found by the following rule.

Witchell's method of finding the true diſtance.

Firſt. Add the ☉'s or ✱'s and ☽'s apparent altitudes together, and take half the ſum; ſubtract the leſs from the greater, and take half the difference; then add together

The co-tangent of half the ſum,
The tangent of half the difference, and
The co-tangent of half the apparent diſtance.

Their ſum, rejecting 20 in the index, will be the log. tangent of an angle, which call A, this angle being always leſs than 90°.

Secondly. When the ☉'s or ✱'s altitude is greater than the ☽'s, take the difference between the angle A and half the apparent diſtance; but if leſs, take their ſum. Then add together

The co-tangent of this ſum or difference,
The co-tangent of ☉'s or ✱'s apparent altitude, and
The proportional log. of the correction of ☉'s or ✱'s altitude;

Their ſum, rejecting 20 in the index, will be the proportional logarithm of the firſt correction.

Thirdly. If the ſum of angle A and half the apparent diſtance was taken in the laſt article, take now their difference; but if their difference, take now their ſum. Then add together

The co-tangent of their ſum or difference,
The co-tangent of ☽'s apparent altitude, and
The proportional log. of the correction of the ☽'s apparent altitude;

Their ſum, rejecting 20 in the index, will be the proportional log. of the ſecond correction.

Fourthly. When the angle A is leſs than half the apparent diſtance, the firſt correction muſt be added to, and the ſecond ſubtracted from the apparent diſtance; but, when the angle A is greateſt, their ſum muſt be added to the apparent diſtance, when the ☉'s or ✱'s altitude is leſs than the ☽'s; but when the ☽'s altitude is leaſt, their ſum muſt be ſubtracted to give the corrected diſtance.

Fifthly. In Table XIX. look for the corrected diſtance in the top column, and the correction of ☽'s alt. in the left-hand ſide column; take out the number of ſeconds that ſtand under the former and oppoſite to the latter. Look again in the ſame table for the corrected diſtance in top column, and the ſecond correction in the left hand ſide column; take out the number of ſeconds that ſtand under the former and oppoſite the latter; the difference between theſe two numbers will be the third correction, which muſt be added to the corrected diſtance if leſs than 90°, but ſubtracted from it if more than 90°, the ſum, or difference, will be the true diſtance.

To illuſtrate this method, we ſhall add a few examples, of which the firſt and ſecond are the ſame as Ex. I. and II. preceding.

EXAMPLE I. (See Example I. page 183.)

Given the apparent altitude of the moon's centre 86° 40′; app. alt. of Regulus 14° 9′; diſtance of the centres of the ☽ and Regulus 76° 19′ 42″; the moon's horizontal parallax 58′ 51″. Required the true diſtance.

Find the correction of the moon's altitude 3′ 22″, and the correction of ✱'s alt. 3′ 43″, as in Example I, preceding; then proceed as follows.

☽'s app. alt.	86°	40′						
✱'s app. alt.	14	9						
Sum	100	49	Half ſum	50°	24′		Co-tan.	9.9176
Difference	72	31	Half diff.	36	15		Tang.	9.8652
			Half app. diſt.	38	10		Co-tan.	10.1046
			Angle A =	37	39		Tang.	9.8874
			Sum	75	49		Co-tan.	9.4027
			✱'s alt.	14	9		Co-tan.	10.5984
			Cor. ✱'s alt.		3	43″	P. L.	1.6851
			Firſt correction		3	42	P. L.	1.6862
			Difference	0	31		Co-tan.	12.0449
			☽'s app. alt.	86	40		Co-tan.	8.7652
			Cor. ☽'s alt.		3	22	P. L.	1.7281
			Second correction		0	31	P. L.	2.5382

As the angle A is leſs than half the apparent diſtance, the firſt correction is additive, the ſecond ſubtractive;

Apparent diſtance		76°	19′	42″
Firſt correction	add		3	42
		76	23	24
Second correction	ſubtract			31
		76	22	53
Correction Tab. XIX.				0
Correct diſtance		76	22	53

Hence we may deduce the longitude as in Example I. preceding.

EXAMPLE II. (See Example II. page 184.)

Given the apparent altitude of the moon's centre 52° 13′; the apparent altitude of the ſun's centre 28° 7′; apparent diſtance of their centres 70° 58′ 49″; moon's horizontal parallax 59′ 15″. Required the true diſtance.

Find, as in Example II. preceding, the correction of the ſun's altitude 1′ 39″, and the correction of the moon's altitude 35′ 35″.

☽'s App. alt.	52°	13′						
☉'s app. alt.	28	7						
Sum	80	20	Half ſum	40°	10′		Cotan.	10.0736
Difference	24	6	Half diff.	12	3		Tang.	9.3293
			Half app. diſt.	35	29		Co-tan.	10.1470
			Angle A	19	32		Tang.	9.5499
			Sum	55	1		Co-tan.	9.8450
			☉'s alt.	28	7		Co-tan.	10.2722
			Cor. ☉'s alt.		1	39″	P. L.	2.0378
			Firſt correction		1	16	P. L.	2.1550
			Difference	15	57		Co-tan.	10.5439
			☽'s alt.	52	13		Co-tan.	9.8894
			Cor. ☽'s alt.		35	35	P. L.	7040
			Second correction		13	7	P. L.	1.1373

As the angle A is leſs than half the apparent diſtance, the firſt correction is additive, and the ſecond ſubtractive:

Apparent diſtance		70°	58′	49″
Firſt correction	add		1	16
		71	0	5
Second correction	ſubtract		13	7
		70	46	58
Correction Tab. XIX. {4 / 1}	add			3
Correct diſtance		70	47	1

Hence we may deduce the longitude as in Example II. preceding.

EXAMPLE III.

Given the apparent altitude of the moon's centre 40° 12′; apparent altitude of Regulus 34° 26′; apparent distance of their centres 23° 29′ 9″; Moon's hor. par. 54′ 58″. Required the true distance.

Find the correction of the moon's altitude 40′ 52″, and correction of the star's altitude 1′ 23″, as in the preceding Examples.

☽'s app. alt.	40° 12′				
✱'s app. alt.	34 26				
Sum	74 38	Half sum	37° 19′	Co-tan.	10.1179
Diff.	5 46	Half diff.	2 53	Tang.	8.7021
		Half dist.	11 45	Co-tan.	10.6819
		Angle A	17 37	Tang.	9.5019
		Sum	29 22	Co-tan.	10.2497
		✱'s app. alt.	34 26	Co-tan.	10.1639
		Cor. ✱'s alt.	1 23″	P. L.	2.1143
		First correction	0 32	P. L.	2.5279
		Diff.	5 52	Co-tan.	10.9882
		☽'s app. alt.	40 12	Co-tan.	10.0731
		Cor. ☽'s alt.	40 52	P. L.	6439
		Second correction	3 33	P. L.	1.7052

As the angle A is greater than half the apparent distance, and the star's altitude is less than the moon's, both corrections are additive:

Apparent distance		23°	29′	9″
First correction	add		0	32
Second correction	add		3	33
Tab. XIX. correction				33
Correct distance		23	33	47

Method of taking a Lunar Observation when you have only one observer.

Three observers are required to make the necessary observations for determining the longitude; one to measure the distance of the bodies, and two others to take their altitudes. If the altitudes were not observed, on account of not having a sufficient number of instruments or observers, it has been customary to calculate them; there being given the latitude of the place, apparent time, right ascensions and declinations of the objects. These calculations are lengthy for the stars, and more so for the moon; and a considerable degree of accuracy is required in finding the moon's right ascension and declination from the Ephemeris, which must be liable to some error on account of the uncertainty of the ship's longitude. The following method for obtaining those altitudes is far more simple; it depends on the ſuppoſition that the altitudes increaſe or decreaſe uniformly, which will give them ſufficiently near for any nautical purpoſes.

Before you meaſure the diſtance of the bodies, take their altitudes, and note the time by a watch, then meaſure the diſtance and note the time (or you may meaſure a number of diſtances and note the correſponding times, and take the mean of all the times and diſtances for the true diſtance and time;) after you have meaſured the diſtances, again meaſure the altitudes, and note the times; Then

Add together the proportional logarithm (Tab. XXIII.) of the variation of altitude of either of the objects between the two times of obſerving the altitudes and the prop. log. of the time elapſed between taking the firſt altitude and meaſuring the diſtance; from the ſum ſubtract the prop. log. of the time elapſed between obſerving the two altitudes; the remainder will be the prop. log. of the correction to be applied to the firſt altitude, additive or ſubtractive, according as the altitude was increaſing or decreaſing; to the altitude thus corrected we muſt apply the correction for dip of the horizon and ſemidiameter as uſual.

EXAMPLE.

Suppoſe the diſtances and altitudes of the bodies were obſerved as follows: It is required to find the altitudes at the time of meaſuring the mean diſtance?

	Time.	Diſt. ☉ & ☽ N. L.
	2h. 3m. 20s.	40° 0′ 00″
	4 20	0 30
	5 50	1 30
Mean.	2 4 30	40 0 40

Time.	Obſerved Alt. ☽'s L. L.	Time.	Obſerved Alt. ☉'s L. L.
2h. 2m. 0s.	20° 46′	2h. 2m. 30s.	40° 20′
6 10	21 20	7 0	39 12
4 10	34	4 30	1 8

Var. ☽'s alt.	34′	P. L.	7238
Time 1ſt obſ.	2h. 2′ 0″		
Mean obſ.	2 4 30		
Difference	2 30	P. L.	1.8573
			2.5811
Elapſed time between the two obſervations	4′ 10″	P.L.	1.6355
Correction in alt.	0° 20′	P.L.	9456
1ſt alt. of Moon	20 46	add	
☽'s alt. at time of obſ.	21 6		

Variation ☉'s alt.	1° 8′	P. L.	4228
Time 1ſt obſ. ſun	2h. 2′ 30″		
Time mean obſ.	2 4 30		
Difference	2 0	P. L.	1.9542
Sum			2.3770
Elapſed time between the two obſervations	4′ 30″	P.L.	1.6021
Correction of alt.	0° 30′	P.L.	7749
Sub. from ſun's 1ſt alt.	40 20		
Sun's true alt. at time of obſ.	39 50		

Thus, at the time 2h. 4′ 30″, the mean obſerved diſtance is 40° 0′ 40″, the altitude of the moon 21° 6′, alt. of the ſun 39° 50′; theſe altitudes muſt be corrected for dip and ſemi-diameter.

In this manner I have often obtained the altitudes in much leſs time than I could have obtained them by other calculations.

I have made uſe of the ſame method of finding the ſun's altitude, when taking an azimuth, noting the times of taking the obſervations by a watch, and taking two altitudes, one before, the other after the obſervation, and proportioning the altitudes as above.

If any person wishes to calculate strictly the altitudes, it may be done by the following rules.

The apparent time, the ship's latitude, longitude, and sun's declination given, to find the true altitude of his centre.

RULE.

If the ship's co-latitude and the sun's declination be both north or both south,* take their sum; but if one be north and the other south, their difference is the sun's meridian altitude.

With the apparent time from noon, enter Table XXI. and from the column of rising take out the logarithm corresponding to it, to which add the log. co-sine of the latitude, and the log. co-sine of the sun's declination; their sum, rejecting 20 in the index, will be the logarithm of a natural number, which being subtracted from the natural sine of the sun's meridian altitude, will leave the natural sine of his true altitude at the given time.

EXAMPLE I.

Required the true altitude of the sun's centre, in lat. 49° 57′ N. and long. 125° W. July 26, 1804, at 6h. 56m. 30s. in the morning, sea account?

	h. m. s.		
	12 0 0		
App. time	6 56 30		
Time from noon	5 3 30	Its log. in col. of rising	4.87850
Latitude	49 57 N.	Its log. co-sine	9.80852
Decl. at that time	19 26 N.	Its log. co-sine	9.97453
Co-lat.	40 3 N.	Reject 20 N. N. 45872 its log.=	4.66155
Mer. alt.	59 29	Nat. sine 86148	
		Nat. sine true alt. 40276=23° 45′	

EXAMPLE II.

What will be the true altitude of the sun's centre at Baltimore, November 26, 1804, at 3h. 21m. 30s. apparent time in the afternoon, sea account?

	h. m. s.		
App. time from noon	3 21 30	Its log. in col. of rising	4.55900
Latitude	39° 20′ N.	Log. co-sine	9.88844
Decl. at that time	20 52 S.	Log. co-sine	9.97054
Co. lat.	50 40 N.	Nat. numb. 26181 its log.=	4.41798
Mer. alt.	29 48	Nat. sine 49697	
Nat. sine true alt.	13 36	Nat. sine 23516	

The apparent time, the latitude and longitude given, to find the Altitude of any of the known fixed stars.

RULE.

Turn the longitude into time, and add it to, or subtract it from, the time at the ship, according as it is west or east, the sum or difference will be the time at Greenwich.

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* The complement of latitude is called by the same name as the latitude; and if the sum exceeds 90° take it from 180°, and the remainder is the meridian altitude.

Take the ſun's right aſcenſion from the Nautical Almanac and proportion it to the time at Greenwich, by means of Table XXIX. and add it to the apparent time at the ſhip, which will give the right aſcenſion of the meridian, or mid-heaven.

Find the ✱'s right aſcenſion and declination in Table IX. and take the difference between its right aſcenſion and the right aſcenſion of the meridian, which will be the diſtance of the ✱ from the meridian.

Having the ✱'s diſtance from the meridian, with its declination, and the ſhip's latitude, the true altitude is found in the ſame manner as has been ſhewn in the laſt examples of finding the true altitude of the ſun.

EXAMPLE.

What will be the true altitude of Aldebaran at Philadelphia, April 12, 1804, ſea account, at 5h. 57m. 12s. in the afternoon, apparent time?

In Table IX. the right aſcenſion of Aldebaran for 1800 is 4h. 24m. 27s. its variation for 4⅓ years is 15″, which added, gives the right aſcenſion at the given time 4h. 24m. 42s. The declination of the ſtar for 1800 is 16° 6′ N. its variation for 4⅓ years is + 36″, which makes the declination nearly 16° 7′ N.

	h.	m.	s.
Apparent time by N. A. April 11,	5	57	12
Longitude 75° 19′ W.	5	1	16
Time at Greenwich April 11,	10	58	28
☉'s R.A. Apr. 11 at noon by N.A.	1	19	2
Var. for 10h. 58′ 28″ by Tab. XXIX.		1	41
☉'s R. A. at time of obſ.	1	20	43
Apparent time *	5	57	12
R. A. Mer.	7	17	55
✱'s R. A.	4	24	42

✱'s diſt. from merid.	2 53 13	its log. in col. riſing		4.43501
Latitude of Philadelphia	39° 57′ N.	Co-ſine		9.88457
✱'s declination	16 7 N.	Co-ſine		9.98259
Co-latitude	50 3 N.	Nat. numb.	20053 its log.	4.30217
Mer. altitude	66 10	Nat. ſine	91472	
True altitude	45 35	Nat. ſine	71419	

The apparent time, the latitude and longitude of the ſhip being given, to find the true altitude of the moon's centre.

RULE.

By Table XX. turn the longitude into time, and if it be weſt add it to, but if it be eaſt ſubtract it from the apparent time at the ſhip, and it will give the time at Greenwich.

Take the ☉'s Right Aſcenſion out of N. A. and proportion it to Greenwich time, by means of Table XXIX, and add it the apparent time at the ſhip, the ſum will be the right aſcenſion of the meridian or mid-heaven.

* In the example given in page [illegible]. Ed. 14, of Moore's Epitome, the time at Greenwich is erroneouſly added to the ſun's right aſcenſion, inſtead of adding the apparent time at the place of obſervation

Take out of the N. A. the ☽'s Rt. Afcen. and declination, and proportion them to the time at Greenwich, by means of Table XXVIII. Turn the ☽'s Rt. Afcen. into time, and take the difference between it and the Rt. Afcen. of the mid-heaven, which will be the diftance in time of the ☽ from the meridian.

Having the fhip's latitude, together with the ☽'s declination and diftance from the meridian, the true altitude is found, in the fame manner as has been fhewn in finding the true altitude of the ⊙ and ✻.

EXAMPLE.

What will be the moon's true altitude April 14, fea account at 6h. 20′ 8″ P.M. at Salem, in lat. 42° 34′ N. long. 70° 55′ W. of Greenwich?

April 14, fea account is April 13, by N. A. at				6h. 20′ 8″
Long. 70° 55′ W. in time				4 43 40
App. time at Greenwich				11 3 48
Sun's Rt. Afcen. April 13, at 11h. 3′ 48″ P.M. by N.A.				1h. 28′ 5″
Apparent time at the fhip				6 20 8
Right afcenfion of the meridian				7 48 13
☽'s right afcenfion in time				4 51 36
☽'s diftance from the meridian				2 56 37
Correfponding to which in the col. log. rifing is				4.45107
Latitude 42° 34′			Co-fine	9.86717
☽'s declination	26° 45′ N.		Co-fine	9.95084
Co-latitude	47 26 N.	Nat.num. 18581	log.	4.26908
Merid. altitude	74 11	Nat.fine 96214		
☽'s merid. alt.	50 56	Nat.fine 77633		

By the preceding calculations the true altitudes of the objects are found; if the apparent altitudes be wanted (as is the cafe in working a lunar obfervation) the difference between the ⊙'s parallax and refraction muft be added to the ⊙'s true altitude, the refraction muft be added to the true altitude of a ftar, and the difference between the ☽'s refraction and parallax in altitude muft be fubtracted from the true altitude of the ☽ thus found, to obtain the refpective apparent altitudes of their centres.

To find the longitude by the eclipfes of Jupiter's Satellites.

Find in page 3d. of the Nautical Almanac, the time at Greenwich, of an *immerfion* (or inftant of the difappearance of the fatellite by entering into the fhadow of Jupiter) or an *emerfion* (which is the inftant of its appearance in coming from the fame)—turn the longitude of the place from Greenwich into time, and add it thereto, if in eaft longitude; but fubtract it, if in weft; the fum or difference will be nearly the time when the eclipfe is to be obferved at the given place; if there is any uncertainty in the longitude of the place of obfervation, you muft begin to look out for the eclipfe at an earlier period.

The watch being well regulated, you muft obferve the inftant of immerfion or emerfion, the difference between this time and that fhewn by the Nautical Almanac, turned into degrees, will be the difference of longitude from Greenwich.

The immersions and emersions generally happen when the satellite is at some distance from the body of Jupiter, except near the opposition of Jupiter to the sun, when the satellite approaches nearer to his body. Before the opposition they happen on the west side of Jupiter, and after the opposition to the east side; but if an astronomical telescope is used, which reverses the objects, the appearance will be directly the contrary. The configurations, or the positions in which Jupiter's satellites appear at Greenwich, are laid down every night when visible, in page 12th of the month of the Nautical Almanac.

EXAMPLE.

Suppose that on the 19th of August, 1804, sea account in long. 137° 55' west by account, an immersion of Jupiter's first satellite was observed at 12h. 29m. 20s. apparent time. Required the longitude?

	H.	M.	S.
At Greenwich the immersion of 1st satellite that day will be	21	50	0
Observed immersion at	12	29	20
Difference in time	9	20	40

Turned into longitude gives 140° 10', and is west, because the time at Greenwich is more than at the place of observation. Therefore the error in longitude by account is 2° 15'.

As these eclipses happen almost daily, they afford the most ready means of determining the longitude of places on land; they might also be applied at sea, could they be observed with sufficient accuracy in a ship under sail; which can hardly be done, since the least motion of a telescope that magnifies sufficiently to make these observations, would throw the objects out of the field of view.

The eclipses of Jupiter's satellites may be well observed by one of Dolland's achromatic telescopes of three feet in length, or by a reflecting telescope of 18 or 20 inches focal length.

To find the longitude by the eclipses of the moon.

This is performed by comparing the times of the beginning or ending, as also the times when any number of digits are eclipsed, or when the earth's shadow begins to touch or leave any remarkable spot on the moon's face; the difference of time between the like observations made at different places, turned into degrees, will be their difference of longitude.

When the beginning or end of an eclipse of the moon is observed at any place, the longitude of that place may be easily found by comparing the time of observation with the time given in the N. A.—for the difference between the observed time of beginning or ending and the time given in the Nautical Almanac will be the ship's longitude in time, which may be turned into degrees by Table XX. Thus if the beginning of an eclipse of the moon was observed Jan. 27, 1804, sea account at 9h. 59½m. P. M. the time by the N. A. being Jan. 26, or Jan. 27, sea account at 7h. 57½', their difference 2h. 2m. is the longitude of the place of observation = 30° 30', which is east of Greenwich, because the time at the place of observation is greatest.

The longitude may also be obtained in a very accurate manner, by observing the beginning and end of a solar eclipse; and the calculations necessary for the purpose, are explained in most books of astronomy. But the eclipses of the sun and moon happen too seldom to be of general use at sea.

To find the longitude by a perfect time-keeper.

If a clock or watch was so contrived, as to go uniformly in all seasons, and in all places, the longitude might easily be deduced therefrom, by comparing the time shewn by the watch, regulated to some given meridian, to the mean time at the place of observation; for the difference would be the difference of longitude between that meridian and the place of observation.

When you mean to use a time-keeper, you must examine its rate of going before you leave the land, and adjust it to the meridian of the place from which you reckon your longitude. To do this, you must ascertain the apparent time by the sun's altitude (or by some other method) and apply to it the equation of time, taken from page 2d of the Nautical Almanac, according to its title of *add* or *subtract*; the sum or difference will give the mean time of observation; this, compared with the watch, will shew how much it is too fast or too slow; and by observing for several days successively, you may ascertain its rate of going: if you find it gains or loses a few seconds per day, you must make that allowance on all future observations at sea. Instead of comparing the time shewn by the watch, to the mean time at the place of observation, found as above, you may compare it with that mean time reduced to Greenwich time, by adding to that mean time the difference of longitude between Greenwich and the place of observation, when it is to the westward of Greenwich, but subtracting it when to the eastward; and by this means you will find how much your watch differs from Greenwich time. Having thus regulated your watch, the longitude at sea is easily found by it, as will evidently appear by the following examples.

EXAMPLE I.

Suppose that, July 26, 1804, sea account, the apparent time was found by an altitude of the sun to be 1h. 5′ 9″ P. M. when by a watch, well regulated to mean Greenwich time, it was 4h. 3′ 6″ P. M. Required the longitude?

Apparent time	1h.	5′	9″
Equation of time add		6	5
Mean time	1	11	14
Time per watch	4	3	6
Difference is long.	2	51	52 = 42° 58′ W.;

the longitude being west, because the time at Greenwich is the greatest.

EXAMPLE II.

Suppose that, May 15, 1804, sea account, the apparent time was found by an altitude of the sun to be 4h. 3′ 6″ P. M. when the time by the watch was 2h. P. M. the watch being too slow for mean Greenwich time 11′ 9″. Required the longitude?

Apparent time	4h.	3′	6″	
Equation of time sub.		3	57	
Mean time	3	59	9	P. M.
Time at Greenwich	2	11	9	
Diff. is longitude	1	48	0	= 27° 0′ E.

Time per watch	2h.	0′	0″
Watch error add		11	9
Time at Greenwich	2	11	9 P.M.

EXAMPLE III.

Suppoſe that June 14, 1804, ſea account, in a place whoſe longitude from Greenwich was known, a number of obſervations were taken, to aſcertain the going of the watch; and it was found that on that day it was 10″ too ſlow for mean Greenwich time, and that it loſt time 2″ per day; and that July 14, 1804, ſea account, the time per watch was 6h. 0′ 6″ P. M. when, by an obſerved altitude of the ſun, the apparent time was 1h. 16′ 14″ P. M. Required the longitude.

	h.	′	″
Apparent time	1h.	16′	14″
Equation of time add		5	18
Mean time	1	21	32
Cor. time per watch	6	1	16
Longitude	4	39	44 = 69° 56′ W.

	h.	′	″
Error of watch, June 14,		0′	10″
30 days at 2″		1	0
Error, July 14,		1	10
Time per watch	6	0	6
Correct time per watch	6	1	16

To find the longitude by a variation chart.

In the year 1700, Dr. Halley propoſed to find the longitude by a chart on which the lines of the variation of the compaſs were drawn; this method is ſimple, but is not ſo accurate as could be wiſhed.

The method of uſing this chart is as follows: On the parallel of latitude which you are in, find the obſerved variation, and that point will be the place of obſervation.

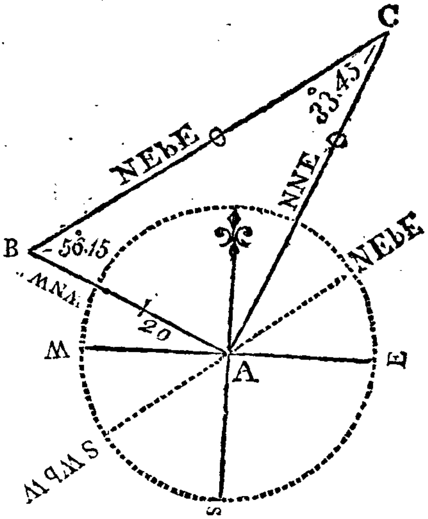
PROBLEMS USEFUL IN NAVIGATION.

PROBLEM I.

COASTING *along ſhore, I ſaw a cape of land bearing N. N. E. and after ſailing W. N. W.* 20 *miles, it bore N. E. by E.—required the diſtance of the ſhip from the cape at both ſtations?*

By PROJECTION.

Deſcribe the compaſs ESW, and let its centre A repreſent the place of the ſhip at the firſt ſtation; draw the W.N.W. line AB equal to 20 miles, and B will repreſent the ſecond ſtation. Draw the N. N.E. line AC, of an indefinite length, and the line BC parallel to the N. E. by E. line of the compaſs; the point of interſection C, will repreſent the place of the cape; and the diſtance BC being meaſured will be found 36 miles, and AC 30 miles.



By LOGARITHMS—(by Caſe I. Obl. Trig.)

The difference between N. N. E. and W. N. W. is 8 points or 90°, therefore BAC is a right angle; alſo the difference between the N. E. by E. and N. N. E. is 3 points = angle ACB, and the difference between the N. E. by E. points and the point oppoſite to W. N. W. is 5 points, equal to the angle ABC.

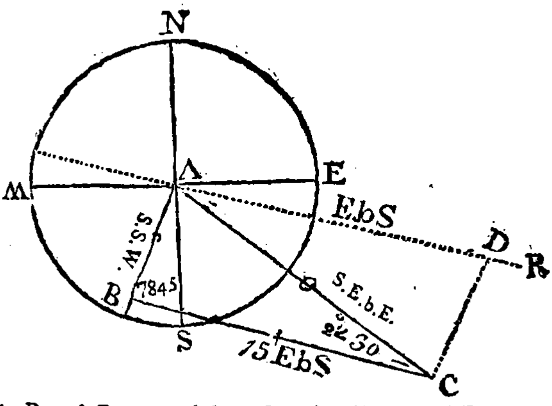
To find the diſtance BC.		To find the diſtance AC.	
As ſi. angle ACB 3 pts. ar.co.	0.25526	As ſine ACB 3 pts. ar.co.	0.25526
Is to the diſtance AB 20	1.30103	Is to the diſtance AB 20	1.30103
So is ſine angle BAC 8 pts.	10.00000	So is ſine angle ABC 5 pts.	9.91985
To the diſtance BC 36.0	1.55629	To the diſtance AC, 29.93	1.47614

The above ſolutions are by Caſe I. Oblique Trigonometry, though they might have been done in this example by Caſe II. of Right-Angled Trigonometry, becauſe the angle BAC is a right angle.

PROBLEM II.

Being at ſea, I ſaw two head lands whoſe bearing from one another by the Chart was W. by N. and E. by S. diſtance 15 *miles; the weſternmoſt bore from me S. S. W. and the eaſternmoſt S. E. by E.—required my diſtance from each of thoſe head lands?*

By PROJECTION.



Draw the compass NESW, and through the centre A, draw the E. by S. line AR, the S. S. W. line AB, and the S. E. by E. line AC; and continue the two latter indefinitely, but upon the former AR take AD = 15 miles; through D draw DC parallel to AB, meeting AC in C, draw CB parallel to AD and it is done; for A will be the place where the headlands B and C were observed; the distance AB of the westernmost head land being measured will be found to be 5,8 miles, and the distance AC of the easternmost head land 15 miles.

By LOGARITHMS.

Between the S. S. W. line AB and the S. E. by E. line AC are 7 points, = ∠BAC; and between the S. E. by E. line AC and the E. by S. line A D are two points = ∠CAD = ∠ACB (because AD, BC are parallel)—therefore ACB + BAC = 9 points, and since all three angles ACB, BAC, ABC are equal to 16 points, the angle ABC is also equal to 7 points, therefore *(by art.* 41 *Geom.)* the sides AC, CB are equal, being opposite to the equal angles ABC, BAC. If these angles had not been equal, the side AC might have been calculated in the same manner as we shall now calculate the side AB.

To find the side AB.

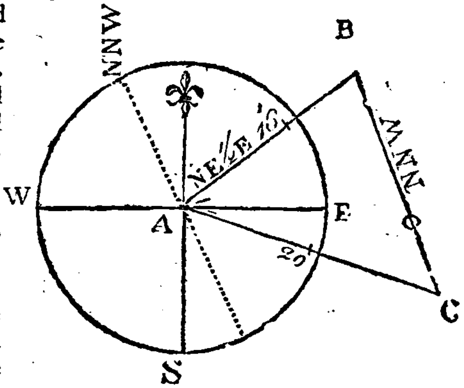
As sine BAC 7 points, co. ar.	0.00843
Is to BC 15 miles	1.17609
So is sine ACB 2 points	9.58284
To AB 5,85	0.76736

This problem and the first may be used for finding the distance of a ship from any head land, &c. when taking her departure from the land.

PROBLEM III.

Two ships sail from the same port, one sails N. E. ½ E. 16 miles, the other sails easterly 20 miles, and then finds that the first bears N. N. W.—required the other ship's course, and the distance between the two ships?

By PROJECTION.



Draw the compaſs ESW, and let its centre A repreſent the port failed from; draw the N. E. ½ E. line AB=16 miles, and through B, the line BC parallel to the N. N. W. line, and continue it indefinitely; take 20 miles in your compaſſes, and putting one foot in A, ſweep with the other the line BC in C, join AC and it is done; for A C is the courſe ſteered by the ſecond ſhip, which is nearly E. S. E. ½ E. and BC is the diſtance of the ſhips 17½ miles.

By LOGARITHMS.

The courſe from B to C is S. S. E. (oppoſite to N. N. W.) and from B to A is S. W. ½ W. (oppoſite to N. E. ½ E.) the difference between theſe bearings is 6½ points=73° 7′=the angle ABC; having this angle and the ſides AB, AC, the other angles and ſide are found by Caſes II. and III. of Oblique Trigonometry as follows:

To find the angle C.

As the ſide AC 20 miles	1.30103
Is to ſine ABC 73° 7′	9.98087
So is ſide AB 16 miles	1.20412
	11.18499
Subtract	1.30103
To ſine angle C 49° 57′	9.88396
For N.N.W. add 22 30	

Sum makes N. 72 27 W. the bearing of A from C, whence the courſe of the ſhip from A towards C is S. 72° 27′ E. or E. S. E. ½ E. nearly.

To find the diſtance of the ſhips BC.

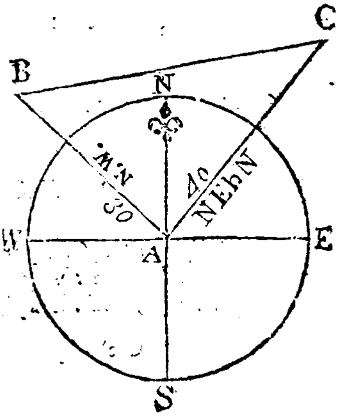
Add the angle C=49° 57′ to the angle B 73° 7′, the ſum 123° 4′ being ſubtracted from 180° leaves the angle CAB 56° 56′.

As ſi. ang. ABC 73° 7′ ar. co.	0.01913
Is to the ſide AC 20 miles	1.30103
So is ſine CAB 56° 56′	9.92326
To the ſide BC 17.5 miles	1.24342

PROBLEM IV.

Two ſhips ſail from the ſame port, one N. W. 30 miles, and the other N. E. by N. 40 miles; required their bearing and diſtance from each other?

By PROJECTION.



Draw the compaſs NESW, and let its centre A repreſent the port ſailed from; draw the N. W. line AB=30 miles, and the N. E. by N. line AC=40 miles, join BC, which will be the bearing and diſtance of the two ſhips, which being meaſured will be found W. S. W. ½ W. 45.1 miles nearly.

By LOGARITHMS, (by Cases IV. V. Ob. Trig.)

Between the N. W. line AB and the N. E. by N. line AC, there are 7 points = angle BAC, half the supplement of which to 180° is 50° 37½′ = half sum of the angles C and B.

To find the angles.			To find the distance BC.		
As sum of AB & AC	70 log.ar.co.	8.15490	As sine angle B	60° 30′ ar. co.	0.06030
Is to their difference	10	1.00000	Is to side AC	40	1.60206
So is tang. ½ sum angles	50 37½	10.08583	So is sine angle A	78° 45′	9.99157
To tang. ½ diff.	9 52½	9.24073	To the distance BC	45,1	1.65393
Sum = angle B	60 30				
Diff. = angle C	40 45				

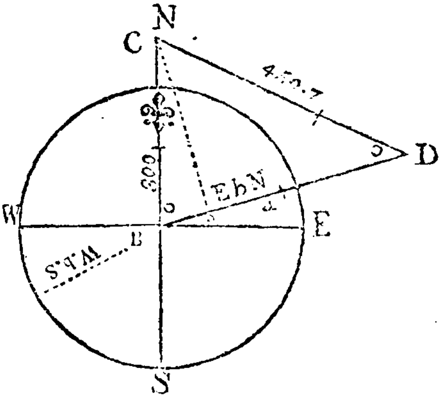
To the angle C = 40° 45′, add the course from C to A = 33° 45′, the sum is 74° 30′, which is the bearing of B from C, viz. S. 74° 30′ W. or W. S. W. ½ W. nearly.

PROBLEM V.

Two ports bear from each other E. by N. and W. by S. distant 400 miles; a ship from the easternmost sails northerly 450,7 miles, another from the westernmost sails 300 miles and meets the first; required the course steered by each ship?

By PROJECTION.

Draw the compass ESW, and let the centre B represent the westernmost port, draw the E. by N. line BD=400 miles, and D will be the easternmost port; with 300 in your compasses, and one foot in B, describe an arch; with 450,7 in your compasses, and one foot in D, describe another arch cutting the former in C; join DC, BC and it is done; for BC will be the course sailed by the westernmost ship, and DC the course sailed by the easternmost.



By LOGARITHMS.

To find the angle CBD.

By Theo. IV. Trig.

Divide the triangle BCD into two right angled triangles by means of the perpendicular CA, and bisect BD in a, then

As the base BD	400	ar. co.	7.39794
Is to the sum of BC, CD,	750.7		2.87547
So is diff. of BC, CD,	150.7		2.17811
To twice A a	282. 8		2.45152
Half or A a	141. 4		
½ BD=Ba=	200		
Diff. is BA	58. 6		

Then in the triangle ACB.

As hypot. DC	300	2.47712
Is to radius	90°	10.00000
So is AB	58.6	1.76790
To co-sine CBD	78° 44′	9.29078

By Theo. V. Trig.

CD = 450.7			
BD = 400		Log. ar. co.	7.39794
BC = 300		Log. ar. co.	7.52288
Sum	1150.7		
½ Sum	575.35	Log.	2.75993
½ sum less CD	124.65	Log.	2.09569
		Sum	19.77644
Half sum	39° 22′	Co-sine	9.88822
	2		

Doubled is 78 44 = Angle CBD. Having found this angle, we may find either of the others thus,

To find the angle CDB.

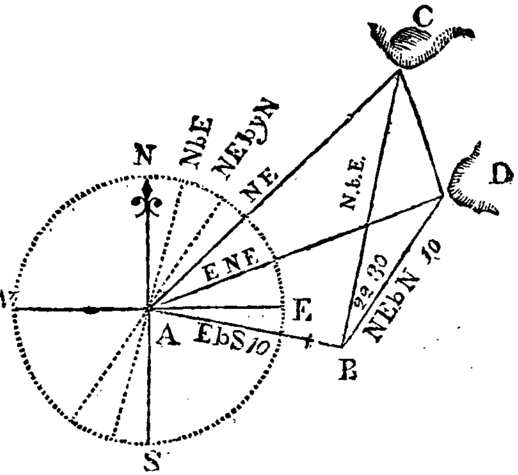
As CD 450.7 ar. co.		7.34611
Is to sine CBD	78° 44′	9.99155
So is BC	300	2.47712
To sine CDB	40° 45′	9.81478

As the angle CBD is 78° 44′ or 7 points nearly, and the course from B to D is E. by N. the course from B to C must be north. The course from D to B being W. by S. or W. 11° 15′ S. and the angle BDC=40° 45′, the bearing of C from D must be W. 29° 30′ N. because 40° 45′—11° 15′ =29° 30′.

PROBLEM VI.

Coasting along shore, I saw two head lands, the first bore from me N. E. the second E. N. E. after sailing E. by S. 10 miles, the first bore N. by E. and the second N. E. by N.—required the bearing of the two head lands from each other and their distance.

Draw the compass NESW, and let its centre A represent the place of the ship at the first station, draw the E. by S. line AB=10 miles, and B will be the place of the ship at the second station; draw the N. E. line AC, and the E. N. E. line AD; through the point B draw the lines BC, BD, parallel to the N. by E. and N. E. by N. lines, and the points C and D where they intersect the lines drawn from A to the same headlands, will be the points representing them respectively; join the points C and D; then will CD be the distance of the two head lands, and a line drawn through A parallel to CD will represent the bearing of those places from each other on the compass.



By LOGARITHMS.

In the triangle ABC, we have all the angles and the side AB to find BC. For the bearings of B and C from A are E. by S. and N. E. the difference being 5 points=BAC; and the bearings of B and A from C, are S. by W. and S. W. the difference being 3 points equal to the angle ACB.

To find the side BC.

As sine of ACB 3 pts. ar.co.	0.25526
Is to the side AB 10	1.00000
So is sine angle BAC 5 pts.	9.91985
To BC 14.97	1.17511

In the triangle ABD, we have all the angles and the side AB to find BD. For the bearings of B and A from D are S. W. by S. and W. S. W. the difference being 3 points=BDA; and the bearings of B and D from A, are E. by S. and E. N. E. the difference being also 3 points, equal to the angle BAD; therefore the angle BAD= BDA, and *(by art.* 41 *Geo.)* BD= AB=10 miles. If these angles had not been equal, you might have calculated the side BD in the same manner as BC.

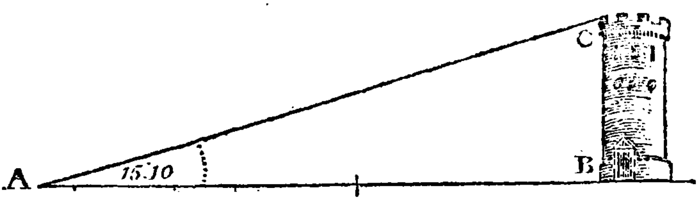
Now in the triangle CBD we have, BD=10, BC=14.97 and the angle CBD=22° 30′; for the bearings of C and D from B are N. by E. and N. E. by N. differing 2 points or 22° 30′; hence we have the other angles and side CD as in Case IV. Obl. Trig.

To find the angles BCD, BDC.				To find the distance CD.			
As sum of BC, BD	24,97	ar.co.	8.60258	As sine angle BCD	33° 44′	ar.co.	0.25545
Is to their diff.	4,97		0.69636	Is to side BD	10		1.00000
So is tang. ½ sum op.angles	78° 45′		10.70134	So is sine angle CBD	22° 30′		9.58284
To tang. ½ diff.	45 1		10.00028	To the distance CD	6,89		0.83829

Sum is angle BDC = 123 46
Diff. is angle BCD = 33 44 or nearly 3 points, and as the bearing of B from C is S. by W. the bearing of D from C must be S. S. E.

PROBLEM VII.

Being 96 fathoms from the bottom of a tower, I find its altitude above the horizontal line drawn from my eye is 15° 10′; required the elevation above that line?



By PROJECTION.	By LOGARITHMS.	
Draw the horizontal line AB=96 fathoms, and perpendicular thereto, the line BC; make the angle BAC= 15° 10′, and draw AC to cut BC in C, then will BC be the height of the tower 26 fathoms.	As radius 90°	10.00000
	Is to the dist. AB 96 fath.	1.98227
	So is tang. angle A 15° 10′	9.43308
	To the height BC 26,0 fath.	1.41535

PROBLEM VIII.

Sailing towards Cape-Cod, I discovered the light-house just appearing in the horizon, my eye being elevated 20 feet above the sea; it is required to find the distance of the light-house, supposing it to be elevated 200 feet above the surface of the sea?

The solution of this problem depends on the uniform curvature of the sea, by means of which all terrestrial objects disappear at certain distances from the observer. These distances may be computed by means of Table XI. in which the elevation in feet is given in one column, and the distance at which it is visible is expressed in statute miles in the other column. If the place from which you view the object be elevated above the horizon, you must *add together the distances corresponding to the height of the observer and the height of the object,* the sum will be the greatest distance at which that object is visible from the observer.

In the present example the height of the observer is 20 feet, and the height of the object 200 feet.

In Table XI. opposite 20 feet is 5,92 miles.
200 feet 18,71

Distance 24,63 statute miles of about 69½ to a degree, the distance in nautical leagues of 20 to a degree being about 7.

PROBLEM IX.

A man being on the main-top-gallant-maſt of a man of war 200 feet above the water, ſees an 100 gun ſhip ſhe had engaged the day before, hull-to; how far were thoſe ſhips diſtant from one another.

A ſhip of 100 guns, or a firſt-rate man of war, is about 60 feet from the keel to the rails, from which deduct about 20, leaves 40 for the height of her quarter-deck above water. Now a ſhip is ſeen to hull to when her upper works juſt appear.

In Table XI. oppoſite	200 feet ſtand	18.71
	40 feet	8.37
	Diſtance	27.08 miles.

PROBLEM X.

Upon ſeeing the flaſh of a gun, I counted 30 ſeconds by a watch before I heard the report; how far was that gun from me, ſuppoſing that ſound moves at the rate 1142 feet per ſecond?

The velocity of light is ſo great, that the ſeeing of any act done at even a number of miles diſtance is inſtantaneous; but by obſervation it is found that ſound moves at the rate of 1142 feet per ſecond, or about one ſtatute mile in 4,6 ſeconds; conſequently the number of ſeconds elapſed between ſeeing the flaſh and hearing the report, being divided by 4,6 will give the diſtance in ſtatute miles. In the preſent example the diſtance is about $6\frac{1}{2}$ miles, becauſe 30 divided by 4,6 quotes $6\frac{1}{2}$ nearly.

MENSURATION.

PROBLEM I.

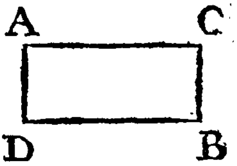
To find the Area of a Parallelogram.

RULE.

MULTIPLY the base by the perpendicular height, the product is the area.

NOTE. If both dimensions are given in feet, inches, &c. the product will be the area expressed in square feet, square inches, &c. respectively; if one of the dimensions be given in feet and the other in inches, the product divided by 12 will be the answer in square feet; if both dimensions are given in inches, the product will be square inches, which divided by 144 will be the answer in square feet. The same is to be understood in finding the area of other surfaces.

EXAMPLE I. Suppose the base DB of the rectangular parallelogram ACBD is 7 feet, and the perpendicular BC 3 feet; required the area?



Multiply 7
By 3

Product 21 square feet, the area required.

EXAMPLE II. Suppose ACBD is a board whose length DB is 22 feet and breadth BC is 14 inches; required the number of square feet?

Multiply 22
By 14

88
22

Div. by 12)308

$25\frac{2}{3}$ square feet the area required.

EXAMPLE III. If DB be 25 inches and BC 20 inches; required the area in square feet?

Multiply 25
By 20

144)500(3,47, so that the area is $3\frac{47}{100}$ feet.
432

680
576

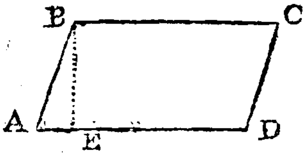
1040
1008

32

Example IV. Given the base AD of the oblique angular parallelogram ABCD, equal to 30 feet, and the perpendicular height BE 15 feet; required the area of the parallelogram?

Multiply 15
By 30

Product 450 square feet.



PROBLEM II.

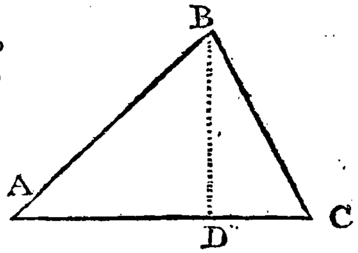
To find the area of a Triangle.

Rule. Multiply the base by half the perpendicular height, and the product is the area required.

Example. Given the base AC 30 feet, and the perpendicular DB 20 feet, required the area of the triangle?

Multiply the base 30 feet
By half the perpendicular 10 feet

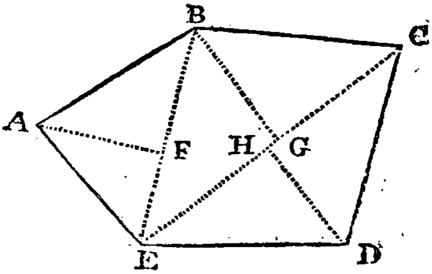
Product 300 square feet is the area required.



PROBLEM III.

To find the area of any irregular right-lined figure.

Rule. Reduce the figure to triangles by drawing diagonals therein; then find the area of each triangle, and the sum of them is the area of the proposed figure. Or, instead of finding the area of each triangle separately, you may find at one operation the area of two triangles having the same diagonal, by multiplying the diagonal by half the sum of the perpendiculars let fall thereon.



Example. Required the area of the figure ABCDE, in which EC=33 feet, EB=22 feet, and the perpendicular AF=13 feet, BG=14 feet, and DH=12 feet?

EB=22
Half of AF = 6,5

11,0
132

Area EAB 143

BG=14
DH=12

Sum 26

Half sum 13
EC 33

39
39

Area BCDE 429
EAB 143

Area of the figure 572

PROBLEM IV.

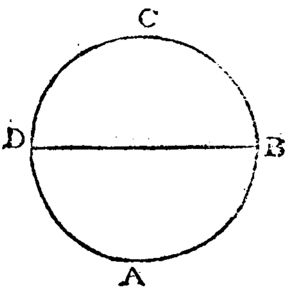
To find the area of a circle.

Rule. Multiply the diameter of the circle by itself, then multiply this product by the quantity 0.7854, and you will have the sought area.

Note. Instead of multiplying by 0.7854 you may multiply by 11 and divide by 14, the quotient will be the area nearly. This quantity .7854 represents the area of a circle whose diameter is 1. The circumference of the same circle being 3.1416 nearly. The proportion of the diameter to the circumference is expressed in whole numbers by the ratio of 7 to 22 nearly; or more exactly by 113 to 355.

Example. Required the area of a circle ABCD, whose diameter BD is 10,6 feet?

Diameter 10,6 feet
10,6
6,36
106,0
112,36 product.
.7854
44944
56180
89888
78652
88.247544 area in feet.



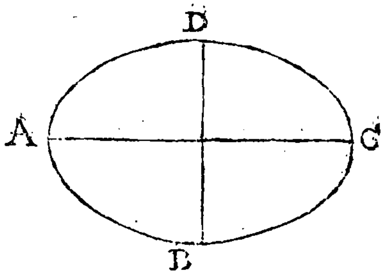
PROBLEM V.

To find the area of an Ellipsis or Oval.

Rule. Multiply the longest diameter by the least; and the product by .7854, this last product is the area required.

Example. Required the area of an Ellipsis or Oval ABCD, whose longest diameter AC is 12 feet, and the shortest diameter BD 10 feet?

Multiply 12 feet
By 10
Product 120
.7854
480
600
960
840
94.2480 area in sq. feet.



The area of a sector of a circle is found by means of the whole area of the circle obtained in Problem IV. by saying, as 360 degrees is to the angle contained between the two legs of the sector, so is the whole area of the circle to the area of the sector.

There are various regular solids, the most noted are the following.—(1) A *Cube*, which is a figure bounded by six equal squares. (2) A *Pa-*

rallelepiped, which is a folid terminated by fix quadrilateral figures, of which the oppofite ones are equal and parallel. (3) A *Cylinder*, which is a figure formed by the revolution of a rectangular parallelogram about one of its fides. (4) A *Pyramid*, which is a folid decreafing gradually from the bafe, till it comes to a point; there are various kinds of Pyramids according to the figure of their bafes. Thus if the bafe be a triangle, it is called a *triangular Pyramid*; if the bafe be a parallelogram, it is called a *parallelogramic Pyramid*; and if the bafe be a circle, it is called a circular Pyramid, or fimply a *Cone*. The point in which the Pyramid ends, is called the *Vertex*, and a line drawn from the vertex perpendicular to the bafe is called the height of the Pyramid.

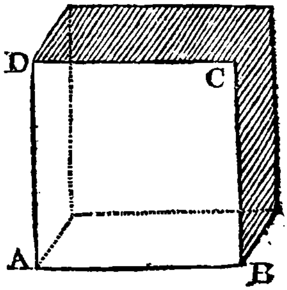
PROBLEM VI.

To find the folidity of a Cube.

RULE. Multiply the length of a fide of the Cube by itfelf, and that product by the fame fide, and you will have the folidity required; which will be expreffed in cubic feet if the dimenfions are given in feet; but in cubic inches if the dimenfions were given in inches, &c.

EXAMPLE. If the fide AB of the Cube be 6,3 feet, it is required to determine its folidity?

```
     6,3
     6,3
    ----
    1,89
   37,8
   -----
   39,69
     6,3
  ------
  11,907
 238,14
 -------
 250,047 folidity in cubic feet.
```



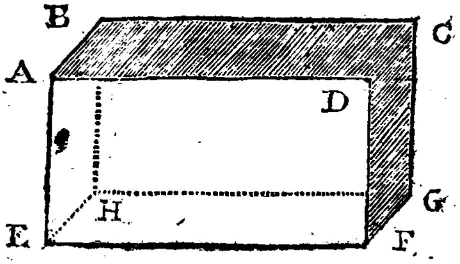
PROBLEM VII.

To find the folidity of a Parallelepiped.

RULE. Multiply the length, breadth and depth, into each other; and the product is the folidity required.

EXAMPLE. Suppofe in the parallelepiped ABCDFGHE, the length EF is 36 feet, the breadth GF 16 feet, and the depth FD 12 feet; it is required to find the folidity?

```
 EF=36 feet
 GF=16
    ---
    216
    36
    ---
    576
 FD= 12
    ---
Solidity 6912 cubic feet.
```

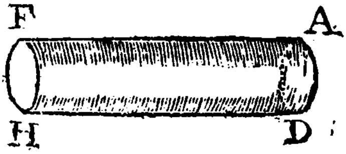


PROBLEM VIII.

To find the solidity of a Cylinder.

Rule. Multiply the diameter of the base by itself, and this product by the length, and by the constant quantity .7854 ; this last product will be the solidity required.

Example. Required the solidity of a cylinder ADHF, whose length HD is 13 feet, and diameter of the base AD is 11 feet ?




```
AD = 11
     11
    ----
    121
HD = 13
    ----
    363
   121
   ----
   1573
  .7854
  ------
   6292
  7865
 12584
11011
---------
1235.4342 solidity in cubic feet.
```

PROBLEM IX.

To find the solidity of a Grindstone.

Grindstones in the form of cylinders are sold by the stone of 24 inches diameter and 4 inches thick ; the number of stones that any one contains may be obtained by the following rule.

Rule. Multiply the diameter in inches by itself and that product by the thickness in inches, divide this last product by 2304, and you will have the number of stones required.

Example. Required the number of stones in a Grindstone whose diameter is 36 inches and thickness 8 inches ?

```
          36
          36
         ---
         216
        108
        ----
        1296
           8
        -----
2304)10368.(4,5
      9216
      -----
      1152.0
      1152.0
      ------
```

The ans. is 4 stones and $\frac{5}{10}$ or $4\frac{1}{2}$ stones.

This problem may be solved by means of the line of numbers on Gunter's Scale, in a very expeditious manner, by the following rule.

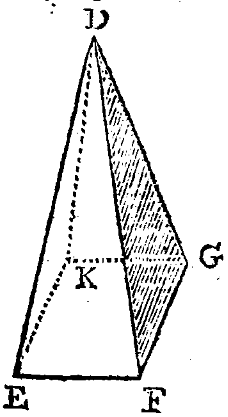
Rule. Extend from 48 to the diameter, that extent turned over twice, the same way, from the thickness, will reach to the number of stones required.

Thus in the preceding example, the extent from 48 to the diameter 36, turned over twice, from the thickness 8, will reach to 4.5, or $4\frac{1}{2}$, which is the number of stones sought.

PROBLEM X.

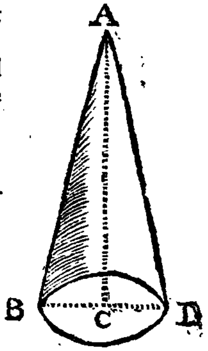
To find the solidity of any Pyramid or Cone.

Rule. Multiply the area of the base by one third of the perpendicular height of the Pyramid or Cone, the product is the solidity required.



Example I. If the Pyramid hath a square base, the side of which is 4 feet, and the perpendicular height is 6 feet; it is required to determine its solidity?

The area of the base is $4 \times 4 = 16$ square feet; this multiplied by one third of the height or 2 feet, gives 32 feet the solidity required.



Example II. If a cone hath a diameter at the base of 10,6 feet, and a perpendicular height of 30 feet; it is required to find its solidity?

The area of this base was found in Problem IV. equal to 88.247544; this multiplied by one third of the height or 10 feet, gives the solidity required equal to 882,47544 cubic feet.

Having obtained, by the foregoing rules, the number of cubic feet in any body, you may find the number of tons it measures, by dividing the number of cubic feet by 40, which is the cubic feet contained in one ton. Thus the solidity of the abovementioned cone 882,47544, being divided by 40, quotes 22,061886, which is the number of tons in that cone.

PROBLEM XI.

To find the tonnage of a ship.

By a law of the Congress of the United States of America, the tonnage of a ship is to be found in the following manner.

If the vessel be double-decked, take the length thereof from the fore part of the main stem to the after part of the stern post above the upper deck; the breadth thereof at the broadest part above the main wales, half of which breadth shall be accounted the depth of such vessel; then deduct from the length three fifths of the breadth, multiply the remainder by the breadth, and the product by the depth; divide this last product by ninety-five, and the quotient is the true content or tonnage of such vessel.

If the vessel be single-decked, take the length and breadth as above directed, in respect to a double-decked vessel, and deduct from the length three fifths of the breadth, and taking the depth from the under side of the deck plank to the cieling in the hold; multiply and divide as aforesaid, the quotient is the true content or tonnage of such vessel.

EXAMPLE. Suppose the length of a double-decked vessel is 80 feet, and the breadth 24 feet; what is her tonnage?

```
Length                          80   feet
Subtract 3/5 of the breadth     14.4
                               -----
                                65.6
Multiply by the breadth           24
                               ------
                               262.4
                              1312
                              ------
                              1574.4
Multiply by the depth             12
                             --------
Divide by                 95)18892.8(198.8
                             95
                             ---
                             939
                             855
                             ---
                              842
                              760
                              ---
                               828
                               760
                               ---
                                68
```

Carpenters, in finding the tonnage, multiply the length of the keel by the breadth of the main beam and the depth of the hold in feet, and divide the product by 95; the quotient is the number of tons. In double-decked vessels, half the breadth is taken for the depth.

GAUGING.

HAVING found the number of cubic inches in any body by the preceding rules, you may from thence determine the number of gallons, buſhels, &c. it will hold, by dividing that number of cubic inches by the number of cubic inches in a gallon, buſhel, &c.

A *wine gallon*, by which moſt liquors are meaſured, contains 231 cubic inches. A *beer gallon*, by which beer, ale, and a few other liquors are meaſured, contains 282 cubic inches. A *buſhel* of corn, malt, &c. contains 2150.4 cubic inches; this meaſure is ſubdivided into 8 gallons, each of which contains 268.8 cubic inches.

In all the following rules, it will be ſuppoſed that the dimenſions of the body are given in inches, and decimal parts of an inch.

PROBLEM I.

To find the number of gallons in a body of a cubic form.

RULE. Divide the cube of the ſide AB (ſee the fig. Prob. VI. of Menſuration) by 231, the quotient will be the anſwer in wine gallons; if we divide it by 282, the quotient will be the anſwer in beer gallons; and if we divide it by 2150.4 the quotient will be the number of buſhels.

EXAMPLE. Required the number of wine gallons contained in a cubic ciſtern, the length of whoſe ſide is 62 inches.

```
    62
    62
   ---
   124
  372
  ----
  3844
    62
 -----
  7688
23064
------
231)238328(1031 wine gallons; the remainder of the diviſion
    231          167 being about 3/4 of 231, ſhews that the
    ---          ciſtern contains 3/4 of a gallon more than
     732         1031.
     693
     ---
      398
      231
      ---
      167
```

PROBLEM II.

To find the number of gallons contained in a body of the form of a Parallelopiped. (See the figure of Problem VII. of Menſuration.)

Rule. Multiply the length, breadth, and depth together; divide this laſt product by 231, for wine gallons; by 282 for beer gallons; and by 2150.4 for to find the number of buſhels.

Example. Required the number of wine gallons contained in a ciſtern ABCDFGHE (ſee fig. Prob. VII. of Menſuration) of the form of a parallelopiped, whoſe length EF is 66 inches, its breadth GF 35 inches, and its depth FD 24 inches.

```
Length EF   =   66
Breadth GF  =   35
              ----
               330
              198
              ----
              2310
Depth FD    =   24
              ----
              9240
             4620
            ------
      231)55440(240  wine gallons.
           462
           ---
           924
           924
           ---
             0
```

PROBLEM III.

To find the number of gallons contained in a body of a cylindrical form.

Rule. Multiply the diameter by itſelf and that product by the height of the cylinder, divide this laſt product by 294.12 and the quotient will be the number of wine gallons; if you divide it by 359.05 the quotient will be the number of ale gallons; and if you divide it by 2738 you will have the number of buſhels.

Note. Theſe diviſors are found by dividing 231, 282, and 2150.4 by .7854.

EXAMPLE. Required the number of wine gallons contained in the cylinder AFHD (see the Fig. of Prob. VIII. of Mensuration), the diameter AD of its base being 26 inches, and length HD 18 inches?

```
Diameter AD = 26
              26
             ----
             156
             52
             ----
             676
Length, HD = 18
             ----
             5408
             676
             -----
294.12)12168.00(41 gallons
       117648
       ------
         40320
         29412
         -----
         10908
```

I have affixed two ciphers to the product 12168, which makes the same number of decimals in the divisor and dividend, and consequently the quotient is the number of gallons.

PROBLEM IV.

To find the number of gallons contained in a body of the form of a pyramid or cone. (See figures of Prob. X. of Mensuration.)

RULE. Multiply the area of the base of the pyramid or cone by one third of its perpendicular height; the product divided by 231 gives the answer in wine gallons; if divided by 282, the quotient is the number of beer gallons; and if divided by 2150.4, the quotient is the number of bushels.

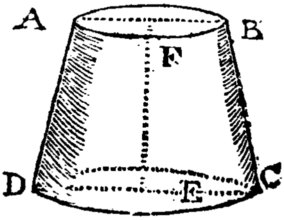
EXAMPLE. Required the number of beer gallons contained in a pyramid DEFGK (see Fig. Prob. X. Exam. 1.) whose base is a square EFGK, a side of which, as EF, is equal to 30 inches, and the perpendicular height of the pyramid is 60 inches?

```
        Base EF=30
                30
               ----
               900
One third of 60 = 20
               -----
282)18000(63.8 Ale gallons
    1692
    ----
    1080
     846
    -----
    234.0
    225.6
    -----
      8.4
```

PROBLEM V.

To find the number of gallons contained in a body of the form of a frustum of a cone. (See the Figure below.)

Rule. Multiply the top and bottom diameters together, and to the product add one third of the square of the difference of the same diameters; multiply this sum by the perpendicular height; and divide the product by 294.12 for wine gallons, by 359.05 for ale gallons, and by 2738 for bushels.



Example. Given the diameter DC of the bottom of a frustum of a cone 36 inches, the top diameter AB = 27 inches, and the perpendicular height, FE, 50 inches. Required the number of wine gallons it will hold?

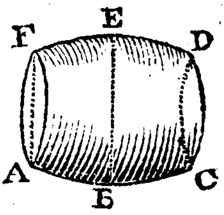
Multiply AB = 27
by DC = 36
162
81
Product 972
Add 27
999
Multiply by FE = 50

294.12)49950.00(169 wine gallons
29412
205380
176472
289080
264708
24372

DC = 36
AB = 27
Difference 9
Multiplied by 9
Divided by 3)81
27

PROBLEM VI.

To gauge a cask.



To gauge a cask, you must measure the head diameters FA, DC, and take a mean of their measures when they differ; measure also the diameter EB at the bung, (taking the measure within the cask); then measure the length of the cask, making due allowance for the thickness of the heads. Having these dimensions you may calculate the number of gallons it will hold by the following rule.

Rule. Take the difference between the head and bung diameter, multiply this by .62, and add the product to the head diameter, the sum will be the mean diameter; multiply this by itself and by the length of the cask, and divide the product by 294.12 for wine gallons, by 359.05 for beer gallons, and by 2738 for bushels.

The quantity .62 is generally used by gaugers in finding the mean diameter of a cask; but if the staves are nearly straight, it would be more accurate to take .60 or less; if on the contrary the cask is full on the quarter, it would be best to take .64 or .65.

Example. Given the bung diameter EB=34.5 inches, the head diameter FA=30.7 inches and the length 59.3 inches; required the number of wine gallons this cask will hold?

Bung diameter	34.5
Head diameter	30.7
Difference	3.8
Multiply by	.62
	76
	2.28
	2.356
Add head diameter	30.7
Mean diameter	33.056 or 33.1

Mean diameter	33.1
	33.1
	3.31
	99.3
	993
	1095.61
Length	59.3
	328.683
	9860.49
	54780.5
	294.12)64969.673(220.8 Galls.
	58824
	61456
	58824
	263273
	235296
	27977

To gauge a cask by means of the line of numbers, on Gunter's Scale, or on the calipers used by gaugers.

Make marks on the scale at the points 17.15, 18.95, and 52.33 which numbers are the square roots of 294.12, 359.05, and 2738. A brass pin is generally fixed on the calipers at each of these points, which are called the gauge points. Having prepared the scale in this manner, you may calculate the number of gallons or bushels by the following rule.

Rule. Extend from 1 towards the left hand to .62; that extent will reach from the difference between the head and bung diameters, to a number which added to the head diameter will give the mean diameter; then put one foot of the compasses upon the gauge point—which is 17.15 for wine gallons, 18.95 for ale gallons, and 52.33 for bushels—and extend the other to the mean diameter; this extent turned over twice the same way, from the length of the cask, will give the number of gallons or bushels respectively.

In the preceding example the extent from 1 to .62 will reach from 3.8 to 2.4 nearly, which added to 30.7 gives the mean diameter 33.1.

Then the extent from the gauge point 17.15 to 33,1, turned over twice from the length 59.3, will reach to 220.8, wine gallons.

If you had used the gauge point 18.95 the answer would have been in ale gallons; and if you had used 52.33 the answer would have been in bushels.

SURVEYING.

LAND is generally measured by a chain of 66 feet in length, which is divided into 100 equal parts called links, each *link* being 7.92 inches.

A *pole* or *rod* is $16\frac{1}{2}$ feet, or 25 links, in length; hence a square pole contains $272\frac{1}{4}$ square feet, or 625 square links.

An *acre* of land is equal to 160 square poles, and therefore contains 43560 square feet, or 100000 square links.

To find the number of square poles in any piece of land, you may take the dimensions of it in feet, and find its area in square feet, as in the preceding Problems; divide this area by 43560, the quotient will be the number of acres; or dividing it by 272,25 the quotient will be the number of square poles. If the dimensions be taken in links, and the area be found in square links, we may obtain the number of acres by dividing by 100000 (that is, by crossing off the five right hand figures); and the number of square poles may be obtained by dividing by 625.

PROBLEM I.

To find the number of acres and poles in a piece of land in the form of a rectangular parallelogram.

RULE. Multiply the base by the perpendicular height, and divide by 625 if the dimensions were taken in links, but by 272.25 if they were taken in feet; the quotient will be the number of poles, which, divided by 160, gives the number of acres.

EXAMPLE I. Suppose the base DB (see the figure of Ex. I. Prob. I. of Mensuration) of the rectangular parallelogram ACBD is 60 feet, and the perpendicular BC 25 feet; required the area in poles.

```
Multiply      25
By            60
           ---------
Divide by  272.25)1500.000(5.5
                  136125
                  ------
                  138750
                  136125
                  ------
                    2625
```

To the product 1500, I have affixed three ciphers to the right, in order to obtain the area in poles and decimal parts of a pole; hence the sought area is 5 poles and 5 tenths.

PROBLEM II.

To find the number of acres and poles in a piece of land in the form of an obl[illegible]r parallelogram. (See the figure of Prob. I. Ex. IV. of M[illegible].)

Ru[illegible]s area is found in exactly the same manner as in the preceding [illegible]y multiplying the base AD by the perpendicular height BE, and [illegible] by 625 when the dimensions are taken in links, but by 272.25 when [illegible] taken in feet; the quotient is the answer in poles, which divide[illegible] 160 gives the answer in acres.

EXAMPLE. Suppose the base AD is 632 links, and the perpendicular BE 326 links; required the number of poles.

Multiply 632
By 326

3792
1264
1896

625)206032(329 poles.
1875

1853
1250

6032
5625

407

PROBLEM III.

To find the number of acres and poles in a piece of land of a triangular form.

RULE. Multiply the base by the perpendicular height, and divide the product by 1250 when the dimensions are given in links, but by 544.5 when they are given in feet; the quotient is the answer in poles.

NOTE. Instead of dividing by 1250, you may multiply by 8, and cross off the four right hand figures.

EXAMPLE. Given the base AC (see fig. of Prob. II. of Mensuration) equal to 300 feet, and the perpendicular BD 150 feet; required the area in poles.

Multiply 150
By 300

544.5)45000.00(82.6 poles.
43560

14400
10890

35100
32670

2430

PROBLEM IV.

To find the number of acres and poles in a piece of land of any irregular right-lined figure.

RULE. Find the area as in Problem III. of Mensuration, by drawing diagonals, and reducing the figure to triangles: the base of each triangle being multiplied by the perpendicular, (or by the sum of the perpendiculars falling on it) and the sum of all these products divided by 1250 when the dimensions are given in links, but by 544.5 when in feet, will give the area of the figure in poles.

Example. Suppoſe that the piece of land is of the ſame form as the figure in Problem III. of Menſuration, and that EB = 22 feet, EC = 33 feet, AF = 13 feet, BG = 14 feet, and DH = 12 feet; it is required to find the area in poles.

EB = 22	BG = 14
AF = 13	DH = 12
66	Sum 26
22	EC = 33
EAB = 286	78
	78
	BCDE = 858
	EAB = 286

544.5)1144.00(2.1 Anſ. $2\frac{1}{10}$ poles.
10890
5500
5445
55

*The manner of ſurveying Coaſts and Harbours.**

From what has been already ſaid, an intelligent reader would ſee how the buſineſs of taking the bearings of part of a coaſt, and of plotting or delineating it might be done. But as there are ſome particulars which can be gained only by experience in the art of ſurveying, it will not be improper to apprize the learner concerning them to qualify him to go more readily to work.

To take a draught of a coaſt in ſailing along ſhore.

Having brought the ſhip to a convenient place, from which the principal points of the coaſt, or bay, may be ſeen, either caſt anchor, if it is convenient, or lie too as ſteady as poſſible; or if the coaſt is too ſhoal, let the obſervations and meaſures be done in a boat. Then while the veſſel is ſtationary, take with the azimuth compaſs the bearings in degrees of ſuch points of the coaſt as form the moſt material projections or hollows; write down theſe bearings and make a rough ſketch of the coaſt, obſerving carefully to mark the points whoſe bearings were taken, with letters, for the ſake of reference.

Then let the ſhip or boat run in a direct line, which muſt be very carefully meaſured by the log, or otherwiſe, one, two or three miles, until ſhe comes to a ſituation from which the ſame points before obſerved can be ſeen again with quite different bearings: then let the veſſel lie ſteady as at the former ſtation, and obſerve again the bearings of the ſame points, and make a rough ſketch of the coaſt; this ſketch may be made more accurately while the veſſel is running the baſe line.

* Moſt of this piece is from Robertſon's Navigation.

To defcribe the chart from thefe obfervations, you muft in fome convenient part of a fheet of paper draw the magnetic meridian, and lay off the feveral bearings taken at the firft ftation, marking them with their proper letters ; lay down alfo the bearings taken from the fecond ftation. Draw a line to reprefent the fhip's run both in length and courfe, and from that end of it expreffing the firft ftation, draw lines parallel to the refpective bearings taken from that end ; alfo from the other end draw lines parallel to the bearings taken at that end, and note the interfection of each pair of lines directed to the fame point ; and through thefe interfections, draw by hand, a curved line, obferving to wave it in and out as near as can be like the bending of the coaft itfelf. Then mark off the variation of the compafs from the north end of the magnetic meridian, towards the right hand, if it be weft, or towards the left hand, if it be eaft, and draw the true meridian through that point and the centre of the circle.

Againft each part draw the appearance of the land marked in the fketches, diftinguifhing rocks, cliffs, high-lands, fand-hills, &c. If there are any currents, exprefs them in their proper places by darts or arrows, the points being turned that way the current fets. Put in the feveral foundings at low water, in fmall figures, diftinguifhing whether they are fathoms or feet ; fhew the time of high water on the full and change days by roman figures, and tell the rife in feet. Put in a compafs, and a fcale of miles or leagues, fuch as the veffels run was laid down by ; add the name of the place, and the latitude and longitude as true as can be obtained.

If there are fhoals or fands on the coaft, let them be taken by a boat failing round them, keeping account of the courfes, diftances, and foundings. But to put them in the draught, the boat muft take the bearings of two points on the coaft ; the bearings of which have been taken from the fhip, from fome part of each fand or fhoal fo failed round ; or, the bearing of the boat at fome part of the fhoal, or of fome beacon in that place, muft be taken by the fhip at each of the ftations where fhe took the bearings of the fhore ; for by either of thefe means, one point of the fand being obtained, the reft of it can be laid down from the boat's account.

If the coaft to be drawn is a bay or harbour winding in fuch manner that all its parts cannot be feen at two ftations, let as many bafes or lines be run and meafured exactly as may be found neceffary, obferving that the feveral diftances run fhould join to one another, in the nature of a traverfe ; that each new fet of objects, or points obferved, fhould be taken from two ftations at the end of a known diftance, and that the objects whofe bearings are taken do not fo much extend beyond the limits of the bafe as to make angles with it lefs than about $\frac{1}{2}$ or $\frac{3}{4}$ of a point, but rather referve fuch objects for the next meafured bafe line ; for when lines lie very obliquely to one another their interfections are not eafily afcertained.

If any particular parts of the harbour cannot be conveniently feen from either of the ftations, take the boat into thofe places, and having well examined them, make fketches thereof, eftimating the lengths and breadths of the feveral inlets, either by the rowing or failing of the boat, take as many bearings, foundings, and other notes, as may be thought neceffary ; then annex thefe particular views in their proper places in the general draught.

If there are any dangerous fands or rocks, befides inferting them in their proper places, you muft fee if there be any two objects afhore (fuch as a church, mill, houfe, noted cliff, &c.) which appear in the fame right line when on the fhoal ; and thefe objects muft be noted on your chart. If none can be found, you muft take the bearings of fome remarkable points, and note them on your chart ; by which means a fhip will know how to avoid the danger.

It ſhould be remarked in the draught what places are unfit for anchorage, and what fit, by writing *rocky ground, foul anchorage, good anchorage,* &c. and in the latter to draw the figure of an anchor. Alſo, if there is any particular channel more convenient than another, it is to be pointed out by lines drawn to its entrance from two or more noted marks aſhore.

The poſitions of objects taken by a magnetic compaſs being liable to great uncertainties, as is well known to thoſe who have had any experience, eſpecially at ſea; an obſerver would therefore do well to obſerve only the bearings of the ſtation lines by the compaſs, and then meaſure the angles which the other objects make with theſe lines, by a quadrant or ſextant, which for this purpoſe muſt be held in an horizontal poſition.

EXAMPLE I. (See Fig. 1. adjoined plate.)

Suppoſe a ſhip at A, obſerves the bearings of the moſt remarkable points of a bay, C, D, E, F, G, H, and I, and ſails S. 63° E. $1\frac{1}{2}$ miles to B; at B ſhe alſo obſerves the bearings of the ſame points; from hence it is required to conſtruct the chart.

Bearing of C from A	S. 38° W.		Bearing of C from B	S. 89° W.
D	N. 9° W.		D	N. 48° W.
E	N. 26° E.		E	N. 24° W.
F	N. 55° E.		F	N. 13° E.
G	Eaſt.		G	N. 47° E.
H	S. 40° E.		H	S. 38° W.
I	S. 19° E.		I	S. 46° W.

Draw the line AB, S. 63° E. $1\frac{1}{2}$ miles. Through the points A and B draw the lines AC, AD, AE, AF, AG, AH, AI, BC, BD, BE, BF, BG, BH, and BI, at their reſpective bearings, and where the correſponding lines cut each other, will be the points C, D, E, F, G, H, and I, required; through which the different curvatures of the land muſt be drawn, correſponding with your eye-draught. In this manner may a chart be conſtructed by obſervations taken upon the water. The manner of ſurveying upon land is exactly ſimilar.

To ſurvey a harbour by obſervations on ſhore.

Make an eye-draught of the place to be ſurveyed, and in going round its coaſt fix ſtation ſtaves, or ſtraight poles, tall enough to be ſeen at a conſiderable diſtance, in the moſt remarkable points and bendings of the ſhore; but if at any of thoſe places there is a noted tree, houſe, or any other remarkable thing, that object may ſerve inſtead of a ſtation ſtaff; and it will be convenient to black the ſtaves, and tie a piece of white bunting at the top of each; then in the eye-draught put letters at the noted points or marks, for diſtinction ſake.

Chooſe the moſt extenſive and level ſpot of ground you can meet with to meaſure your baſe line upon, which ſhould not be leſs than a tenth part of the diſtance of the two extreme objects which are to be obſerved; and let the direction of the meaſured baſe line be ſuch that as many of the ſtation ſtaves as poſſible may be ſeen from each end of it. The bearing or poſition of this baſe muſt be well determined in degrees and minutes, and its length accurately meaſured, either by a meaſuring chain or a piece of log-line.

From each end of the baſe obſerve, with the azimuth compaſs, the bearings of each of the ſtation ſtaves; or elſe with a ſextant meaſure the angles contained between these staves or remarkable objects, and the other end of the station line, and write them down in order in your book. These measures and agles being plotted down, as before directed, will give the most conspicuous points of the shore; the intermediate spaces are to be filled up from the sketches made on the spot.

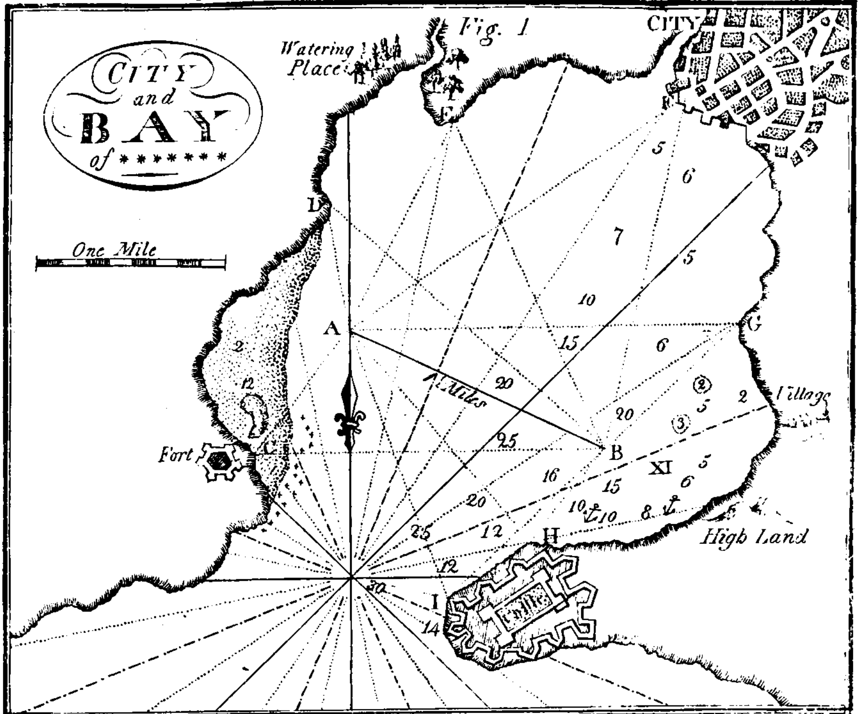
But if either of these objects should spread on either hand so far beyond the limits of the base, that at either end thereof the other end and those objects should appear nearly in the same direction, or to make angles not exceeding 10°; or, if some of the remarkable objects can be seen only from one end of the base; then let the bearings of such objects be taken from a place whose position has been determined from both ends of the measured base; or, if there are several remarked objects which cannot be seen from either end of the base lines, let the bearings of such objects be taken from each of the two points whose position has been taken from both ends of the base, or it may on some occasions be proper to choose another place on which another base of a convenient length may be measured, and from the extremities of which the ends of the first base may be seen; and also as many as can be of the remaining objects which lay too obliquely for the first base, or which could not be seen from it. In such manner proceed until the bearings are taken of all the points judged necessary for completing the survey of the limits of the harbour.

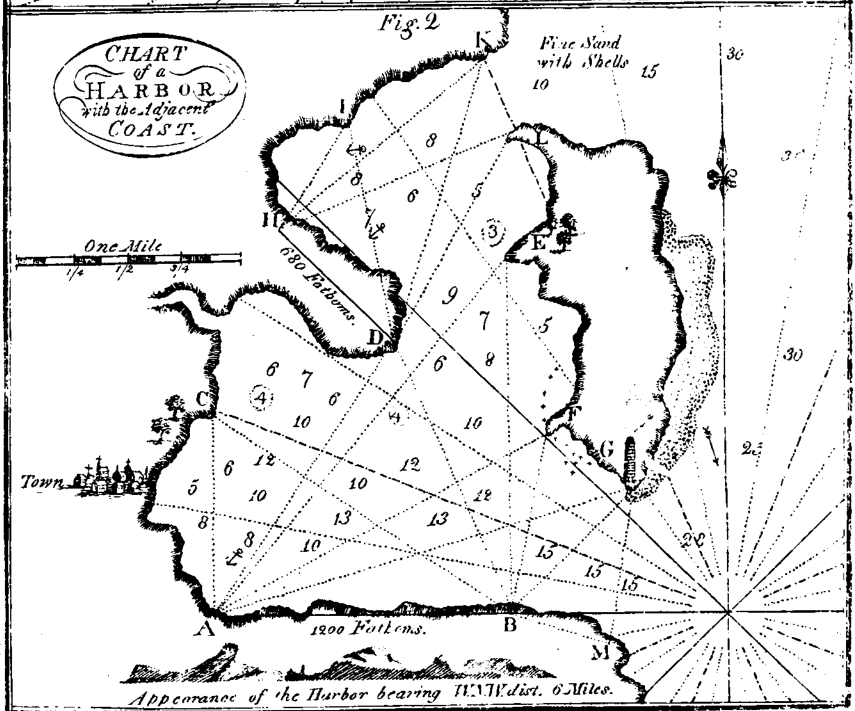
If a base line of a sufficient length cannot be measured in one right line, it may be taken in two adjoining lines as the two sides of a triangle, the included angle being accurately taken, and the bearing of either line.

When the outlines or limits of a harbour, bay, road, &c. are delineated by the preceding precepts, let a small vessel go out to sea to take drawings of the appearance of the land, and its bearings; sail likewise into the harbour, and draw the appearance of its entrance; take particular notice if there be any false resemblance of the entrance, by which ships may be deceived and run into danger; or when any two objects being brought in a line, or in one, will lead into the harbour without danger; search for the best anchoring places, and if possible, denote those place by bringing two objects in one, if not take the exact bearings of two or three other objects, so that the places may be easily determined. The chart being correctly drawn, a compass, with the variation, and scale properly fitted to the plan, the isles, rocks, sands, &c. marked in their proper places, with their soundings at low water, and the winds open to them, the best track with the soundings all the way to those anchoring places; the proper sailing marks to avoid dangers; the winds, if any troublesome ones, which prevail, and at what seasons; the places where fresh water can be got; the name of the place, the country in, on what sea; the latitude and longitude; a sketch of the appearance the place makes at sea upon a known thumb, and at an estimated distance; and whatever else a judicious seaman shall think proper to insert. Then is the plan fit for all nautical purposes, and may be embellished with proper colours if necessary.

EXAMPLE II. (See Fig. 2. of the Plate.)

From each end of a base line AB of 1200 fathoms, were observed the points C, D, E, F, and G; and as the points I, K, and L were not visible from the extremities of the base line, another base line was measured from the point D to H of 680 fathoms, from which points the bearings of I, K, and L were observed: from hence it is required to construct a chart of the place.





Newburyport Published by Edmund M. Blunt, 1802.

Bearing of B from A	East.	Bearing of C from B	N. W. b. W.
C	North.	D	N. N. W.
D	N. E. b. N.	E	North.
E	N. E. ½ N.	F	N. b. E.
F	N.E.b.E. ½ E.	G	N. E.
G	E. b. N. ½ N.		
Bearing of H from D	N. W.	Bearing of I from H	N. E. b. N.
I	N. b. W.	K	N. E. ½ E.
K	N. b. E. ½ E.	L	E. N. E.
L	N. N. E. ½ E.		

Draw the east line AB=1200 fathoms; from each end of this line draw the lines AC, AD, AE, AF, AG, BC, &c. at their respective bearings; the points of intersection will give the points C, D, E, F, and G. From the point D (which was found in this manner) draw the N. W. line DH = 680 fathoms; and through these points draw the lines DI, DK, DL, HI, &c. at their respective bearings; the points of intersection of the corresponding lines will be the situation of the points I, K, L. Between these remarkable points draw the outlines of the land conformable to your rough draught.

In order to determine the situation of the point M, which is seen too obliquely from the bases AB, DH, you may take the bearing of that point from B and then from G (whose situation has been determined by bearings taken from the points A, B), the intersection of the lines BM, GM, will determine the situation of M.

To reduce a Draught to a smaller scale.

With a black-lead pencil draw the draught to be reduced all over with cross lines, forming exact squares; draw the clean paper for the copy all over with the same number of squares, but their sides larger or smaller in proportion to the intended size of the scale such as ½, ¼, &c. length of the other; distinguish by a stronger mark, every fifth or sixth row of squares in both, so that the several corresponding squares may be readily perceived; then, in each of the squares of the draught, draw, by the eye, a curve on the paper, similar to that in the square of your copying draught, till the whole is copied; when the black-lead lines may be rubbed out with bread or India rubber.

A chart may also be reduced in the following manner: thus, suppose you would reduce a chart in the ratio of the line MN (figure plate fronting page 45) to HI. Draw the line AC, which make equal to HI; upon A as a centre sweep the arch CE, and make the chord CE=MN, join AE; then if you take any distance, AB you want to reduce, and upon A, as a centre, sweep an arch BD; the chord BD intercepted by the lines AC, AE, will be the reduced distance corresponding to AB. This reduced distance can also be obtained by another method, which is more simple than the former: Take any extent from the large chart which is to be reduced to a smaller scale, and apply it from A to O (see figure of same plate); take in your compasses the corresponding distance on the small chart, and with one foot in O sweep an arch P; draw the line AP just touching the arch in P; then if you take any distance from the great chart, and apply it from A to R, and at the point R sweep an arch S to touch the line AE; the extent RS will be the reduced distance of the line AR.

OF WINDS.

THE earth is ſurrounded by a fine inviſible fluid, called Air, extending ſome miles above its ſurface. By its weight it is capable of ſupporting the vapours raiſed by the ſun; and by its elaſticity it is capable of expanding or ſpreading itſelf, ſo as to fill up a larger ſpace. When the elaſticity of any portion of the air is changed, by the heat of the ſun or by other cauſes, the neighbouring parts are put in motion to reſtore the equilibrium; in this manner a current of air is formed, called the Wind, which is diſtinguiſhed by ſeveral names, viz. trade-wind, monſoon, variable wind, &c. The *trade winds* blow conſtantly from the ſame part; the *monſoons* blow half the year one way, and half the other; and the *variable winds* are ſuch as blow without any regularity either as to time, place, or direction. The following obſervations on the wind have been made by Doctor Halley, and others.

There is a conſtant trade wind, blowing from the eaſt, in moſt parts of the Atlantic and Pacific Oceans, between the latitudes of 30° N. and 30° S. Near their northern limits, they blow between the north and eaſt; and near their ſouthern limits they blow between ſouth and eaſt.

In the Atlantic Ocean, at about 100 leagues from the coaſts of Africa, between the latitudes of 28° and 10° north, there is generally a freſh gale of wind blowing from the N. E.

Thoſe bound to the Carribee Iſlands acroſs the Atlantic, find, as they approach the American ſide, that the N. E. wind becomes eaſterly, or ſeldom blows more than a point from the eaſt, either to the Northward or Southward.

Theſe trade winds on the American ſide are extended to 30°, 31°, or even to 32° of north latitude, which is about 4° further than what they extend to on the African ſide; alſo to the ſouthward of the equator, the trade winds extend 3 or 4 degrees further towards the coaſt of Brazil on the American ſide, than they do near the Cape of Good Hope on the African ſide.

Between the latitudes of 4° north and 4° ſouth, the wind always blows between the ſouth and eaſt: on the African ſide the winds are neareſt the ſouth, and on the American ſide neareſt the eaſt. In theſe ſeas, Dr. Halley obſerved, that when the wind was eaſtward, the weather was gloomy, dark, and rainy, with hard gales of wind; but when the wind veered to the ſouthward, the weather generally became ſerene, with gentle breezes next to a calm.

Theſe winds are ſomewhat changed by the ſeaſons of the year: when the ſun is far northward, the Brazil S. E. wind gets to the ſouth, and the N. E. wind to the eaſt; and when the ſun is far ſouth, the S. E. wind gets to the eaſt, and the N. E. wind on this ſide of the equator veers more to the north.

Along the coaſt of Guinea, from Sierra Leon to the iſland of St. Thomas, under the equator, the ſoutherly and S. W. winds blow perpetually; for the S. E. trade wind having paſſed the equator, and approaching the Guinea coast, within 80 or 100 leagues, inclines toward the shore, and becomes S. S. E. then south, and by degrees, as it comes near the land, it veers about to S. S. W. and within the land it is S. W. and sometimes W. S. W. This track is troubled with frequent calms, and violent sudden gusts of wind, called Tornadoes, blowing from all points of the horizon.

The reason of the wind setting in west on the coast of Guinea is, in all probability, owing to the nature of the coast, which being greatly heated by the sun, rarefies the air exceedingly, and consequently the cool air from off the sea will keep rushing in, to restore the equilibrium.

Between the 4th and 10th degrees of north latitude, and between the longitude of Cape Verd and the easternmost of the Cape Verd Islands, there is a track of sea, which seems to be condemned to perpetual calms, attended with terrible thunder and lightning, and frequent rains.

The cause of this seems to be, that the westerly winds setting in on this coast, and meeting the general easterly winds in this tract, balance each other, and so cause the calms; and the vapours, carried thither by each wind, meeting and condensing, occasion the almost constant rains.

These observations shew the reason of the difficulty which ships find in sailing to the southward, between the coasts of Guinea and Brazil, particularly in the months of July and August, notwithstanding the width of the sea is more than 500 leagues. For the S. E. winds at that time of the year commonly extend some degrees beyond the ordinary limits of 4° N. latitude, besides coming so much southerly as to be sometimes south, sometimes a point or two to the west; it then only remains to ply to windward: And if on the one side they steer W. S. W. they get a wind more and more easterly, but then there is danger of falling in with the Brazilian coast or shoals; and if they steer E. S. E. they fall into the neighbourhood of the coast of Guinea, from whence they cannot depart without running easterly as far as the island of St. Thomas; and this is the constant practice of all the Guinea ships.

All ships departing from Guinea for Europe, their direct course is northward; but on this course they cannot go, because the coast trending nearly east and west, the land is to the northward; therefore, as the winds on this coast are generally between the south and W. S. W. they are obliged to steer S. S. E. or south, and with these courses they run off the shore; but in so doing they always find the wind more and more contrary; so that when near the shore they can lie south; at a great distance they can make no better than S. E. and afterwards E. S. E. with which courses they generally fetch the island of St. Thomas, and Cape Lopez, where finding the winds to the eastward of the south, they sail westerly with it, till coming to the latitude of four degrees south, where they find the S. E. wind blowing perpetually.

On account of these general winds, all bound from Europe to the West-Indies, or to the southern states of America, reckon it their best course to get as soon as they can to the southward, that so they may be certain of a fair and fresh gale, to run before it to the westward. For the same reason those bound from America to Europe endeavour to gain the latitude of 30 degrees, where they first find the wind begin to be variable, though the most ordinary winds in the North Atlantic Ocean come between the south and west.

And for the same reason, those bound to India from America run to the eastward in the variable winds, so as to be in the longitude of 35° or 38° W.

when in the latitude of 30° N. From thence they steer south-easterly towards the Cape de Verds, passing 2° or 3° to the westward of them, unless they want to stop for supplies, or to correct their longitude. Being then in the common route of the European Indiamen, they steer south-easterly to cross the equator between the longitude of 18° W. and 25° W. where, meeting the S. E. winds, they must brace up and sail upon a-wind till they get through them, and come into the variable winds, where they may steer to the eastward. Near the equator, the trade-wind is generally stronger to the westward than to the eastward; and were it not for the fear of falling in with the Brazil coast, a ship might cross the line further to the westward than what we have recommended above. When homeward bound, from the Cape of Good-Hope towards America, they might deviate a little to the westward of their straight course, in order to take advantage of this fresher trade-wind.

Between the southern latitudes of 10° and 30° in the Indian Ocean, the general trade-wind about S. E. by S. is found to blow all the year round, in the same manner as in the like latitudes in the Ethiopic Ocean; and during the six months, from May to December, these winds reach to within 2 degrees of the equator; but during the other six months, from November to June, a N. W. wind, called the little monsoon, blows in the track lying between the 3d and 10th degrees of south latitude, in the meridian of the north end of Madagascar, and between the 2d and 12th degrees of south latitude, near the longitude of Sumatra and Java.

In the track between Sumatra and the African coast, and from 3° of south latitude, quite northward to the Asiatic coast, including the Arabian sea and the bay of Bengal, the monsoons blow from September to April on the N. E. and from March to October on the S. W. In the former half year, the wind is more steady and gentle, and the weather clearer than in the latter six months; and the wind is more strong and steady in the Arabian sea than in the bay of Bengal.

Between the island of Madagascar and the coast of Africa, and thence northward as far as the equator, there is a track, wherein, from April to October, there is a constant fresh S. S. W. wind, which, to the northward, changes into the W. S. W. wind, blowing at that time in the Arabian sea.

To the eastward of Sumatra and Malacca, on the north of the equator, and along the coasts of Cambodia and China, quite through the Philippines as far as Japan, the monsoons blow northerly and southerly; the northern setting in about October or November, and the southern about May. These winds are not quite so certain as those in the Arabian sea.

Between Sumatra and Java to the west, and New-Guinea to the east, the same northerly and southerly winds are observed; but the first half year the monsoons incline to the N. W. and the latter to the S. E. These winds begin a month or six weeks after those in the Chinese seas set in, and are quite as variable.

These contrary winds do not shift from one point to its opposite all at once: in some places, the time of the change is attended with calms, in others by variable winds; and it often happens, on the shores of Coromandel and China, towards the end of the monsoons, that there are most violent storms, called Tuffons, greatly resembling the hurricanes in the West-Indies, wherein the wind is so vastly strong, that hardly any thing can resist its force.

TIDES.

TIDE is a periodical motion of the water of the sea, by which it ebbs and flows twice in a day. The *flow* continues about 6 hours, during which the water gradually rises till it has arrived at its greatest height; then it begins to *ebb* or decrease, and continues to do so for about 6 more, till it has fallen to nearly its former level; then the flow begins again as before.

The cause of the tides is the unequal attraction of the sun and moon upon different parts of the earth. For they attract the parts of the earth's surface nearest to them, with a greater force than they do its centre; and attract the centre more than they do the opposite surface. To restore this equilibrium the waters take a spheriodical figure, whose longer axis is directed towards the attracting luminary. If the moon only acted upon the water, the time of high water would be when the moon was upon the meridian, above or below the horizon; or rather at an hour or two after, (because the moon continues to act with considerable force for some time after passing the meridian.) But the moon passes the meridian about 49′ later every day; of course, if she only acted on the tides, they would be retarded every day 49′, and it would be high water at the same distance from her passing the meridian: and it is upon this principle that the time of high water is calculated in most books of navigation, although it will sometimes differ an hour from the truth, owing to the neglect of the disturbing force of the sun. The effect of the moon upon the tides is greater than that of sun, notwithstanding the quantity of matter in the latter is vastly greater than in the former; but the sun being at a much greater distance from the earth than the moon, it attracts the different parts of the earth in a more uniform manner. According to the latest observations, the mean force of the sun for raising the tides is to the mean force of the moon as 1 to 2½. By the combined effect of these two forces, the tides come on *sooner* when the moon is in her *first* and *third* quarters, and later in the *second* and *fourth* quarters, than they would do if caused only by the moon's attraction. The quantity of this acceleration and retardation is given in the Table B, adjoined; the use of which will be explained hereafter.

The tides are greater than ordinary about three days after the new and full moon; these are called *spring-tides*. And they are lower than common about three days after the first and last quarters; these are called the *neap-tides*. In the former case the sun and moon concur to raise the tide in the same place, but in the latter the sun raises the water where the moon depresses it. When the moon is in her *perigee*, or nearest approach to the earth, the tides rise higher than they do, under the same circumstances, at other times; and are lowest when she is in her *apogee*, or farthest distance from the earth. The spring-tides are greatest about the time of the equinoxes, in March and September, and the neap-tides are less. The morning tides generally differ in their rise from the evening tides. All these things would obtain exactly, were the whole surface of the earth covered with sea; but the interruptions caused by the continents, islands, shoals, &c. entirely alter the state of the tides in many cases. A small inland sea, such as the Mediterranean or Baltic, is little subject to tides; because the action of the ſun and moon is always nearly equal at the extremities of ſuch ſeas. In very high latitudes the tides are inconſiderable.

From the obſervations of many perſons, the times when it is high-water on the days of new and full moon, in the moſt noted places of the globe, have been collected. Theſe times are uſually put in a table againſt the names of the places, arranged in an alphabetical order; this is generally called a Tide Table. We have here given one for the moſt remarkable places of the coaſts of America and Europe, by means of which the times of high-water may be found, by various methods. The moſt common rule preſcribed for this purpoſe, in books of navigation, is that depending on the golden number and epact; in which the tide is ſuppoſed to be uniformly retarded every day. This method will ſometimes differ 2 hours from the truth, for which reaſon I ſhall not inſert it; but ſhall proceed to explain the calculation by the adjoined tables A and B, and the Nautical Almanac; by means of which the time of high-water may be obtained to a greater degree of exactneſs than from our common almanacs.

RULE.

Find the time of the moon's coming to the meridian of Greenwich on the given day, in page 6th. of the Nautical Almanac. Enter the Table A, and find the longitude of the given place, in the left hand column, correſponding to which is a number of minutes to be applied to the time of paſſing the meridian of Greenwich, by *adding* when in *weſt* longitude, but *ſubtracting* when in *eaſt* longitude; the ſum or difference will be nearly the time that the moon paſſes the meridian of the given place. With this time enter Table B, and take out the correſponding correction, which is to be applied to the time of paſſing the meridian of the place of obſervation, by adding or ſubtracting, according to the directions of the table.

To this corrected time add the time of full ſea on the full and change days; the ſum will be the time of high-water at the given place, reckoning from the noon of the given day. If this ſum be greater than 12h. 24m. you muſt ſubtract 12h. 24m.* from it, and the remainder will be the time of high water nearly, reckoning from the ſame noon; or if it exceed 24h. 48m. you muſt ſubtract 24h. 48m. from that ſum, and the remainder will be the time of high-water, reckoning from the ſame noon, nearly.

EXAMPLE I.

Required the time of high-water at Charleſton light-houſe (S.C.) March 15, 1804, in the afternoon, civil account?

By the Nautical Almanac I find that the moon paſſes the meridian of Greenwich at 3h. 6m.; to this I add 11m. taken from Table A, correſponding to the longitude of Charleſton light-houſe. With the ſum 3h. 17m. I enter Table B, and find (by taking proportional parts) that the correction is 54m. which is to be ſubtracted from 3h. 17m. (becauſe immediately over it in the table it is marked Sub.); to the remainder 2h. 23m. I add the time of high-water on the full and change days 7h. 0m. (which is found in the tide table following); the ſum 9h. 23m. is the time of high-water on the afternoon of March 15, 1804, civil account.

* Inſtead of ſubtracting 12h. 24m. you may, when great accuracy is required, ſubtract 12 hours increaſed by half the daily variation of the moon's paſſing the meridian found in the Nautical Almanac; with this enter Table B, and correct it, and find the time of high-water from noon as above. And inſtead of ſubtracting 24h. 48m. you may ſubtract 24h. increaſed by the daily variation of the moon's paſſing the meridian; then find the correction of Table B, and the time of high-water from noon as above.

EXAMPLE II.

Required the time of high-water at Portland light-house, May 20, 1804, in the afternoon, civil account ?

By the Nautical Almanac the moon passes the meridian of Greenwich at 9h. 14m. The correction from Table A, corresponding to 70°, the longitude of Portland light-house, is 9m. which added to 9h. 14m. gives the time of the moon's southing at Portland 9h. 23m. nearly. The number in Table B corresponding to 9h. 23m. is 23m. which is to be added to 9h. 23m. (because immediately over it, in the table, is marked Add). To the sum 9h. 46m. I add the time of high-water on the full and change days 10h. 45m. and the sum is 20h. 31m. consequently the high-water happens at 20h. 31m. past noon of May 20, that is at 8h. 31m. A. M. of May 21. And by subtracting 12h. 24m. from 20h. 31m. we have 8h. 7m. which is nearly the time of high-water on the afternoon of May 20, 1804.

In this manner we may obtain the time of high-water at any place, to a considerable degree of accuracy. But the tides are so much influenced by the winds, freshets, &c. that the calculated times will sometimes differ a little from the truth.

Many pilots reckon the time of high-water by the point of the compass the moon is upon at that time, allowing 45 minutes for each point. Thus on the full and change days, if it is high-water at noon, they say a north and south moon makes full sea ; if at 11h. 15m. they say a S. by E. or N. by W. moon makes full sea ; and in like manner for any other time. But it is a very inaccurate way of finding the time of full sea by the bearing of the moon, except in places where it is high-water about noon on the full and change days.

When you have not a Nautical Almanac, you may find the time of high water by means of the following Tables C and D ; and although this method is not so exact as the former, yet it may be useful in many cases. To calculate the time of full sea by this method, observe the following

RULE.

Enter Table C, and take out the number which stands opposite to the year, and under the month for which the tide is to be calculated ; this number, added to the day of the month, gives the moon's age, taking care to reject 30 when it exceeds that number. Against her age found in the left hand column of Table D, is a certain number of hours and minutes in the adjoined column, which, being added to the time of high water at the given place on the full and change days, will give the time of high water required ; which will be on the afternoon of that day, civil account, if less than 12 hours ; but if above 12 hours, and less than 24 hours, subtract 12 hours, and the remainder will be the time of high water on the next morning : if above 24 hours, subtract 24 hours, and the remainder will be the time of high water in the following afternoon. And the time of the preceding high water may be obtained nearly, by subtracting 12h. 24m.

By this rule I shall work the two preceding Examples.

EXAMPLE III.

Required the time of high water at Charleston light-house (S. C.) March 15, 1804, in the afternoon, civil account ?

In the Table C, opposite 1804, and under March, stand 19, which, added to the day of the month 15, gives 34, and by subtracting 30, leaves 4, the moon's age: opposite 4 in Table D, is 2h. 22m. which added to 7h. the time of high water on the full and change days, gives 9h. 22m. for the time of high water; differing only one minute from the former method.

EXAMPLE IV.

Required the time of high water at Portland light-house, May 20, 1804, in the afternoon, civil account?

In the Table C, opposite 1804, and under May, stand 21, which added to the day of the month 20, and 30 subtracted from the sum leaves the moon's age 11; opposite to this, in Table D, is 9h, 19m. which added to 10h. 45m. the time of high water on the full and change days, gives 20h. 4m. or 8h. 4m. A. M. of May 21; or by subtracting 12h. 24m. from 20h. 4m. we have 7h. 40m. for the time of full sea on the afternoon of May 20, 1804; this differs 27 minutes from the former method.

In the third column of Table D is given the time of the moon's coming to the meridian, for every day of her age: thus, opposite 11 days stand 8h. 57m. which is the time of her coming to the meridian on that day. This table may be of some use when a Nautical Almanac cannot be procured, but as it is calculated upon the supposition that the moon moves uniformly in the equator, it cannot be very accurate. The numbers in this Table are reckoned from noon to noon; thus, 1h. A. M. is denoted by 13h.; 2h. A. M. by 14h. &c.

The time of new moon is easily found, by subtracting the number taken from Table C, from 30. Ex. Suppose it was required to find the time of new moon for May, 1804. By examining the table, we find the number corresponding to that time is 21; this subtracted from 30 leaves 9; therefore it is new moon the 9th May, 1804. This table is calculated to give the *true* time of new moon, and not the *mean* time.

When the time of high water is known for any day of the moon's age, we may from thence find the time of high water on the full and change days, by the following

RULE.

Find the time of the moon's coming to the meridian of Greenwich, in the 6th page of the Nautical Almanac; to this time apply the corrections taken from the tables A and B, (in the same manner as directed in the preceding rule for finding the time of high water)—subtract this corrected time from the observed time of high water, and the remainder will be the time of high water on the change and full days.

NOTE. If the time to be subtracted be greater than the observed time of full sea, you must increase the latter by 12h, 24m. or by 24h. 48m. nearly.*

EXAMPLE.

On the 15th March, 1804, the time of high water at Charleston light-house, was found to be at 9h. 23m. P. M. required the time of high water on the full and change days?

I find, as in example 1st preceding, that the number to be subtracted is 2h. 23m.—taking this from 9h. 23m. leaves 7h. which is the time of high water on the full and change days.

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* Or instead of subtracting 12h. 24' and 24h. 48'—you may make the calculation accurately by a method similar to that on page 232.

When you have not a Nautical Almanac, you may find this time by means of the Tables C and D. For in the present example, I find by Table C, that the moon's age was 4, corresponding to which in the second column of Table D, is 2h. 22m. this subtracted from 9h. 23m. leaves 7h. 1m. for the time of high-water on the full and change days.

TAB. A.

Long of the place	Cor. of ☽'s passi. the mer.
Deg.	Min.
0	0
10	1
20	3
30	4
40	5
50	7
60	8
70	9
80	11
90	12
100	14
110	15
120	16
130	18
140	19
150	20
160	22
170	23
180	24

TAB. B.

Time of Moon's passing the merid.	Cor.	
HOURS.	H.	M.
	Sub.	
0	0	0
1	0	17
2	0	34
3	0	50
4	1	3
5	1	9
6	1	3
7	0	35
	Add.	
8	0	2
9	0	23
10	0	24
11	0	14
12	0	0
	Sub.	
13	0	17
14	0	34
15	0	50
16	1	3
17	1	9
18	1	3
19	0	35
	Add.	
20	0	2
21	0	23
22	0	24
23	0	14
24	0	0

TABLE C.

A TABLE for finding the Moon's Age.

Add the number taken from this table to the day of the month; the sum (rejecting 30 if necessary) is the moon's age.

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
1800	6	7	5	7	7	8	9	10	12	12	14	14
1801	16	18	16	18	18	19	20	21	22	23	24	25
1802	26	28	26	28	29	1	1	2	4	4	5	6
1803	7	9	7	9	10	11	12	13	15	15	16	17
1804	18	19	19	20	21	23	23	25	27	27	28	28
1805	0	1	0	1	2	4	4	6	8	8	9	10
1806	11	12	10	12	12	14	15	16	18	19	20	21
1807	22	23	21	23	23	24	25	27	28	29 0	1	2
1808	3	4	4	5	5	7	7	9	10	11	13	13
1809	15	15	14	16	16	18	18	19	21	21	23	24
1810	25	27	25	27	27	28	29	1	2	2	4	4

TABLE D.

Moon's Age.	High Water.		Moon passes Merid.	
Days	H.	M.	H.	M.
0	0	0	0	0
1	0	35	0	49
2	1	10	1	38
3	1	46	2	26
4	2	22	3	15
5	3	1	4	4
6	3	44	4	53
7	4	35	5	42
8	5	39	6	30
9	6	57	7	19
10	8	15	8	8
11	9	19	8	57
12	10	10	9	46
13	10	54	10	34
14	11	33	11	23
15	12	9	12	12
16	12	44	13	1
17	13	19	13	50
18	13	54	14	38
19	14	31	15	27
20	15	11	16	16
21	15	56	17	5
22	16	49	17	54
23	17	57	18	42
24	19	17	19	31
25	20	32	20	20
26	21	33	21	9
27	22	22	21	58
28	23	4	22	46
29	23	42	23	35
29½	24	0	24	0

TIDE TABLE,

Shewing the time of high water at the full and change of the moon at various places on the coast of the UNITED STATES OF AMERICA, *and in* EUROPE; *with the usual rise of the tide expressed in feet.*

Places on the Coast of the United States of America.	Time of High Water. H. M.	Elevation in Feet.	Places in various parts of the world.	Time of H. Water. H. M.
Block Island	7 37	5	Aberdeen (Scotland)	0 45
Boston Light-House	11 30	12	Amazon's River (Am.)	6 0
Broad Bay	10 45	9	Amsterdam (Holland)	3 0
Cape Ann	11 30	12	Amsterdam, Isl. of (South seas)	8 30
Cape Charles	7 0		Anholt (Denmark)	0 0
Cape Cod	11 30	6½	Antwerp (Flanders)	6 0
Cape Henlopen	8 54	5	Archangel (Russia)	6 0
Cape Henry	7 0	4	Bayonne (France)	3 30
Charleston	7 0	6	Beachy-Head (England)	10 15
Elizabeth-Town-Point	8 54	5	Belfast (Ireland)	10 0
Florida Keys	8 50		Bermudas Island	7 0
Fox Island (Mass.)	10 45	10	Blanco Cape (Negroland)	9 45
Gay Head	7 37	7	Bordeaux (France)	3 0
George's River	10 45	9	Bremen (Germany)	6 0
Goulsborough	11 0	12	Bristol (England)	6 45
Kennebeck	10 45	9	Cadiz (Spain)	3 30
Machias	11 0	12	Canaria Island	3 0
Manomy Point	11 30	6½	Q. Charlotte's Sound (N. Zeal.)	9 0
Marblehead	11 30	12	Cape Clear (Ireland)	3 0
Moose Island (Mass.)	11 30	25	Dort (Holland)	3 0
Mount Desert (Mass.)	11 0	12	Dunkirk (France)	0 0
Nantucket	12 3	6	Gibraltar (Spain)	0 0
New Bedford	7 37	5	Gravesend (Eng.)	1 30
Newburyport	11 15	10	Hague (Holland)	8 15
New-Haven	11 0	8	Havre de Grace (France)	9 0
New-London	8 54	5	Lisbon (Portugal)	2 15
New-York	8 54	5	Loire River (France)	3 0
Passamaquoddy-River	11 30	25	London (England)	3 0
Penobscot-River	10 45	10	Madeira Island	12 4
Plymouth	11 30	6½	Naze (Norway)	11 15
Portland	10 45	9	Ostend (Flanders)	12 0
Port-Royal	8 15		Port Praya (Cape de Verd)	11 0
Portsmouth	11 15	10	Portsmouth (Eng.)	11 15
Race-Point (Cape-Cod)	10 45		Quebec (Canada)	7 30
Rhode-Island-Harbours	7 37	5	Rochelle (France)	3 45
St. Anastatia's-Island	7 30		Rotterdam (Holland)	3 0
St. Simon's Bar	7 30		Rouen (France)	1 15
St. Simon's Offing	6 45		Sierra Leona (Guinea)	8 15
St. Simon's Sound	9 0		Shetland I. (Scotland)	3 0
Salem	11 30	12	Ushant (France)	4 30
Sandy Hook (New-York)	6 37	5		
Sheepscut	10 45	9		
Tarpaulin Cove (Mass.)	9 52	5		
Townsend (Mass.)	10 45	9		

In the Table of latitudes and longitudes (Tab. IV.) there is also given the time of high-water at a number of places, on the day of full or change of the moon.

CURRENTS.

A CURRENT is a progreſſive motion of the water, cauſing all floating bodies to move that way towards which the ſtream is directed. The *ſet of a current*, is that point of the compaſs towards which the waters run, and its *drift* is the rate it runs per hour. The moſt uſual way of diſcovering the ſet and drift of an unknown current, is thus:

Let three or four men take a boat a little way from the ſhip: and by a rope faſtened to her ſtern, let down a heavy iron pot or loaded kettle into the ſea to the depth of 80 or 100 fathoms; then heave the log, and the number of knots run out in half a minute will give the miles the current ſets per hour, and the bearing of the log ſhows the ſet of it.

There is a very remarkable current, called the GULF STREAM, which ſets in a north-eaſt direction along the coaſt of America, from Cape Florida towards the Iſle of Sables, at unequal diſtances from the land, being about 75 miles from the ſhores of the ſouthern ſtates, but is more diſtant as it proceeds to the northward; the width of it is about 40 or 50 miles, widening towards the north; its velocity is various, from one to three knots per hour, or more; being greateſt in the channel between Florida and the Bahamas, and gradually decreaſing as it paſſes to the northward; but is greatly influenced by the winds both in its drift and ſet.

We are chiefly indebted to Doctor Franklin, Commodore Truxton, and Mr. Jonathan Williams, for the knowledge we poſſeſs of the direction and velocity of this ſtream; whoſe general courſe, as given by them, is marked on the chart affixed to this work. They all concur in recommending the uſe of the thermometer, as the beſt means of diſcovering when you are in or near the ſtream. For, it appears by their obſervations, that the water is warmer than the air when in the ſtream; and that at leaving it, and approaching towards the land, the water will be found ſix or eight degrees colder than in the ſtream, and ſix or eight degrees colder ſtill when on ſoundings. Veſſels coming from Europe to America, by the northern paſſage, ſhould keep a little to the northward of the ſtream, where they may probably be aſſiſted by a counter current, as is obſerved by Commodore Truxton. When bound from America to Europe, a ſhip may generally ſhorten her paſſage by keeping in it. By ſteering N. W. you will generally croſs the gulf in the ſhorteſt time, as its direction is nearly N. E. Thoſe who wiſh for further information on this ſubject, may conſult an ingenious treatiſe on "Thermometrical Navigation," publiſhed by Mr. Jonathan Williams, at Philadelphia, in 1799.

In the other parts of the Atlantic ocean the currents are variable, but are generally ſouth-eaſterly, along the coaſt of Spain, Portugal and Africa, from the bay of Biſcay towards Madeira and the Cape de Verds. Between the tropics there is generally a current ſetting to the weſtward.

There is alſo a remarkable current which ſets through the Mozambique channel, between the Iſland of Madagaſcar and the main continent of Africa, in a ſouth-weſterly direction; as it proceeds towards Cape Lagullas it takes a more weſterly courſe, and then tends round the Cape towards St. Helena. Ships bound to the weſtward from India, may generally ſhorten their paſſage, by taking advantage of this current.—On the contrary, when bound to the eaſtward, round the Cape of Good Hope, they ought to keep far to the ſouthward of it. However there appears to be a great difference in the velocity of this current at different times; for ſome ſhips have been off this Cape ſeveral days endeavouring to get to the weſtward, and have found no current;—others have experienced it ſetting conſtantly to the weſtward during their paſſage from the Cape towards St. Helena, Aſcenſion and the Weſt-India Iſlands.

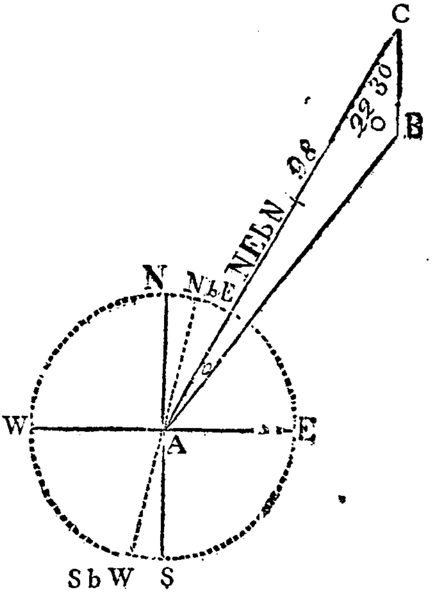
All caſes of ſailing in a current are calculated upon the principle, that the ſhip is affected in the ſame manner by the current, as if ſhe had ſailed in ſtill water, with an additional courſe and diſtance exactly equal to the courſe and ſet of the current; on this principle the projection and calculation of any problem may be eaſily made.

EXAMPLE.

If a ſhip ſails 98 miles N. E. by N. in a current which ſets S. by W. 27 miles in the ſame time; required her true courſe and diſtance?

By PROJECTION.

Deſcribe the compaſs NESW, through the centre A draw the N. E. by N. line AC=98 miles, through C draw the line CB parallel to the S. by W. line, and on it ſet off CB=27 miles; join AB, and it is done: for AB will be the courſe and diſtance made good, which by meaſuring is N. E. ¼ N. 74 miles.



By CALCULATION.

The ſhorteſt method of calculating this problem is by the adjoined Traverſe Table; putting in it the courſe ſailed by the ſhip, and the ſet of the current, and finding the difference of latitude and departure, by Table I.; then find the courſe and diſtance made good, as in Caſe VI. Plane Sailing.—In the preſent example the courſe is N. E. ¼ N. and the diſtance 74 miles nearly.

TRAVERSE TABLE.

Courſes.	Diſt.	N.	S.	E.	W.
N. E. by N.	98	81.5		54.4	
S. by W.	27		26.5		5.3
		81.5 26.5	26.5	54.4 5.3	5.3
Diff. Lat.		55.0	Dep.	49.1	

Method of keeping a ſhip's Reckoning, or Journal, at Sea.

A SHIP'S RECKONING is that account, by which it can be known at any time where the ſhip is, and on what courſe or courſes ſhe muſt ſteer to gain her port. DEAD RECKONING is that account deduced from the ſhip's run from the laſt obſervation.

THE LOG-BOARD.

H.	K.	F.	Courſes.	Winds.	Lee-way.	Tranſactions.
2	6		S. W.	N. E.		
4	5	5				
6	5			N. W. by W.		
8	5					Moderate gales
10	4	5	E. N. E.	N. W.		& fair weather;
12	4	5				at 8 A.M. ſaw
2	4	5				a ſhip to the
4	4	5				northward.
6	4	5				
8	5		S. W.	W. N. W.	1	
10	4	5				No obſervation.
12	4					

The daily occurrences on board a ſhip are marked on a board or ſlate, called the log-board, or log-ſlate, kept in the ſteerage for that purpoſe, which is uſually divided into ſeven columns; the firſt contains the hours from noon to noon, being marked by ſome for every two hours, but by others for every ſingle hour; in the ſecond and third columns are the knots and fathoms the ſhip is found to run per hour, ſet againſt the hours when the log was hove. Some navigators do not divide the knot into ten fathoms, but into half knots only, marking the third column H. F. The fourth column contains the courſes ſteered by compaſs; the fifth, the winds; the ſixth, the leeway; and in the ſeventh, the alteration of the ſails, the buſineſs done a-board, and what other remarks the officer of the watch thinks proper to inſert. For it ſhould be obſerved, that it is uſual to divide a ſhip's company into two parts, called the ſtarboard and larboard watches, who do the duty of the ſhip for four hours and four hours, alternately, except from 4 to 8 P. M. which is divided into two watches.— The remarks made on the log-board are daily copied into a book called the LOG-BOOK, which is ruled like the log-board. This book contains the only authentic record of the ſhip's tranſactions, and the perſons who keep a reckoning tranſcribe them into their *journals*, and from thence make the neceſſary deductions relative to the ſhip's place. There are various ways of keeping theſe journals, according to the different taſtes of navigators. Some keep only an abſtract of each day's tranſactions, ſpecifying the weather, what ſhips or lands were ſeen, accidents on board, the latitude, longitude, courſe, and run: theſe particulars being drawn from the ſhip's log-book. Others keep a full copy of the log-book, and the deductions drawn therefrom, arranged in proper columns at the bottom of it: this is the moſt ſatisfactory method to thoſe who may have occaſion to inſpect it, and we have adopted it in the following journal, but ſhall give an abſtract at the end conformable to the former method.

When a ſhip is about loſing ſight of the land, the bearing of ſome noted place (whoſe latitude and longitude is known) is obſerved, and its diſtance eſtimated and marked on the log-book: this is called *taking a departure*. In working this firſt day's work, the calculation is made in the ſame manner as if the ſhip had ſailed that diſtance, from that place, upon a courſe oppoſite to its bearing; and it is entered accordingly into the Traverſe Table, after correcting it for the variation. The other courſes ſailed, till the following noon (which ends the ſea day, as we have before obſerved), corrected for the variation, are alſo put in the Traverſe Table, with their correſponding diſtances. From hence the latitude and longitude of the ſhip are found, as in the Example page 125, and are marked in the journal. The next and following days' works are calculated in a ſimilar manner; finding the latitude and longitude of the ſhip by means of her latitude and longitude at the preceding noon.

Having thus explained the general manner of keeping a ſhip's journal, we ſhall now give a number of examples—Of allowing for the variation; of the eſtimation and allowance for leeway; of the rules for correcting the dead reckoning by an obſervation—and then will follow a number of ſingle days works, and a continued journal of a voyage from Boſton to Madeira, in which the various rules of Navigation will be exemplified.

To allow for the Variation.

We have already taught the methods of finding the variation, which muſt be allowed on all courſes ſteered, and on all bearings taken with the compaſs; *to the right hand, if the variation be eaſt; but to the left hand, if it be weſt*; the obſerver being ſuppoſed to be placed in the centre of the compaſs, looking towards the point on which the variation is to be allowed.

EXAMPLES.

			Points.		
Courſe by compaſs	N. E. by E.	Variation	2 W.	True courſe	N. E. by N.
	N. E.		$1\frac{1}{4}$ E.		N. E. by E. $\frac{1}{4}$ E.
	N. W.		3 W.		W. by N.
	S. E.		3 E.		S. by E.
	S. S. W.		$1\frac{1}{2}$ W.		S. $\frac{1}{2}$ W.
	E. S. E.		$1\frac{1}{4}$ W.		E. $\frac{3}{4}$ S.
	S. W. $\frac{1}{4}$ W.		$\frac{1}{2}$ W.		S. W. $\frac{1}{4}$ S.
	N. N. E. $\frac{3}{4}$ E.		$1\frac{1}{2}$ E.		N. E. $\frac{1}{4}$ E.

To find the Leeway and allow for it.

Leeway is the angle the ſhip's real courſe makes with her intended courſe, occaſioned by contrary winds or a rough ſea; and may be eſtimated by obſerving the angle which the wake of the ſhip makes with the point right a-ſtern, or in the direction of her keel. This may be done by a compaſs cut in lead (or other metal) on the poop, or ſome other convenient part of the ſhip's ſtern. It would be very conducive to the accuracy of a ſhip's reckoning, if the leeway was marked on the log-board every watch, according to an eſtimation made at the time, inſtead of leaving it till the day's work is calculating, and then gueſſing at it, as is the general practice.

Lee-way is to be allowed on all courſes ſteered, in the following manner: Count the neareſt way of the compaſs from the wind to the courſe ſet, and as many points and parts beyond as the lee-way amounts to, and it gives the correct courſe: or, allow it *to the right hand of the courſe ſteered when the larboard tacks* are aboard, and on the left hand when the ſtarboard tacks are aboard,* the perſon making the allowance being ſuppoſed to be looking towards the point of the compaſs the ſhip is ſailing upon.

The lee-way made by different ſhips, under the ſame circumſtances of wind and ſails, will be different; and even the ſame ſhip, when differently laden, and having more or leſs ſail abroad, will make more or leſs lee-way. However, the following precepts for allowing for lee-way are generally given by writers: they were firſt publiſhed by W. Jones, Eſq. who had them from Mr. John Buckler.

1ſt. When a ſhip is cloſe-hauled, with all her ſails ſet, the, water ſmooth, and a moderate gale of wind, ſhe is then ſuppoſed to make little or no lee-way.

2d. Allow 1 point, when the top-gallant-ſails are taken in.

3d. Allow 2 points, when the top-ſails muſt be cloſe-reefed.

4th. Allow 2½ points, when one top-ſail muſt be handed.

5th. Allow 3½ points, when both topſails muſt be taken in.

6th. Allow 4 points, when the fore courſe is handed.

7th. Allow 5 points, when trying under the main-ſail only.

8th. Allow 6 points, when both main and fore courſes are taken in.

9th. Allow 7 points, when the ſhip tries a-hull, or all ſails handed.

10th. When a ſhip is lying-to, under her main-ſail, mizen, &c. then obſerve how ſhe comes up and falls off, and take the middle between the two points, and from that allow the lee-way and variation.

When the wind has blown hard on any point of the compaſs, and ſhifts to the oppoſite point, the ſhip will make leſs lee-way than ſhe did before. But in all theſe caſes reſpect muſt be had to the roughneſs of the ſea, and the trim of the ſhip.

EXAMPLES.

Courſe ſteered.	Wind	Lee-way.	True courſe.
N. W.	N. N. E.	1 point.	N. W. by W.
E. N. E.	North.	2	Eaſt.
E. S. E.	South.	1	E. by S.
W. by N.	N. by W.	½	W. ½ N.
E. N. E. ½ E.	S. E.	3	N. E. ½ N.

When variation and lee-way are both to be allowed on a courſe, you may do it at once, by allowing their ſum when they are both the ſame way, and their difference when the allowance is to be made in different ways, taking care to make the allowance in the ſame way as the greater quantity ought to be, whether it be the variation or lee-way.

EXAMPLE I.

A ſhip ſteers W. by N. with her larboard tacks aboard, and makes one point lee-way, there being two points weſterly variation; required the true courſe.

Lee-way to the right hand	1 pt.
Variation to the left	2 pts.
Difference allowed to the left	1 pt.

Whence the courſe is Weſt.

EXAMPLE II.

A ſhip ſteers E. S. E. with her ſtarboard tacks aboard, and makes two points lee-way, there being one point weſterly variation; required the true courſe.

Lee-way to the left	2 pts.
Variation to the left	1 pt.
Sum allowed to the left	3 pts.

Whence the courſe is E. by N.

* See the note at the bottom of page 156.

EXAMPLE III.

A ſhip lying-to under her main-ſail, with her ſtarboard tacks aboard, comes up E. by S. and falls off N. E. by E. there being one point weſterly variation, and ſhe makes 5 points lee-way; what courſe does ſhe make good?

The middle between E. by S. and N. E. by E. is E. by N.; and by allowing 6 points to the left hand (viz. 5 for lee-way and 1 for variation) the true courſe will be obtained N. by E.

To exerciſe the learner, we ſhall add the examples contained in the following Table.

THE TABLE.

Courſes ſteered	Winds.	Lee-way. point	Vari-ation. Points	Courſes corrected.
N. W. $\frac{1}{2}$ W.	N. N. E.	$\frac{1}{2}$	$\frac{3}{4}$ W.	N. $5\frac{3}{4}$ W.
W.	N. N. W.	$\frac{3}{4}$	$\frac{3}{4}$ W.	S. $6\frac{1}{2}$ W.
W. S. W.	S.	1	$\frac{3}{4}$ W.	S. $6\frac{1}{4}$ W.
W.	S. S. W.	$\frac{3}{4}$	$\frac{3}{4}$ W.	W.
W. by N.	N. by W.	$1\frac{1}{4}$	$\frac{3}{4}$ W.	S. 7 W.
S. W.	W. N. W.	$1\frac{1}{2}$	$\frac{3}{4}$ W.	S. $1\frac{1}{2}$ W.
S.	W. S. W.	$\frac{3}{4}$	$1\frac{1}{4}$ W.	S. S. E.
S. S. W.	W.	1	$1\frac{1}{4}$ W.	S. $\frac{1}{4}$ E.
S. W.	N. W. by W.	$\frac{1}{2}$	$1\frac{1}{4}$ W.	S. S. W. $\frac{1}{4}$ W.
W.	S. S. W.	$1\frac{3}{4}$	$1\frac{1}{4}$ W.	W. $\frac{1}{2}$ N.
W. by N.	N. by W.	1	$1\frac{1}{4}$ W.	W. S. W. $\frac{3}{4}$ W.
S.	E. S. E.	2	$1\frac{1}{4}$ W.	S. $\frac{3}{4}$ W.
E. by S.	S. $\frac{1}{2}$ E.	$\frac{3}{4}$	$1\frac{1}{4}$ W.	E. by N.
E. N. E.	N.	$1\frac{3}{4}$	$1\frac{1}{4}$ W.	E. N. E. $\frac{1}{2}$ E.
E.	N.	$\frac{3}{4}$	$1\frac{1}{4}$ W.	E. $\frac{1}{2}$ N.
E.	S.	0	$1\frac{1}{4}$ W.	E. N. E. $\frac{3}{4}$ E.
S.	E. S. E.	$\frac{1}{2}$	$1\frac{3}{4}$ W.	S. by E. $\frac{1}{4}$ E.
E. S. E.	N. E.	$\frac{1}{2}$	$1\frac{1}{4}$ W.	E. $\frac{3}{4}$ S.
W. S. W.	S.	$\frac{3}{4}$	$1\frac{3}{4}$ W.	S. W. by W.
W. by N.	S. W. by S.	1	$1\frac{3}{4}$ W.	W. $\frac{1}{4}$ N.
N. W.	W. S. W.	1	$1\frac{3}{4}$ W.	N. W. $\frac{3}{4}$ W.
S.	W. S. W.	1	$\frac{3}{4}$ E.	S. $\frac{1}{4}$ E.
N. by E.	N. W. by W.	$\frac{3}{4}$	1 E.	N. N. E. $\frac{3}{4}$ E.
N. W. by N.	W. by S.	$1\frac{1}{4}$	1 E.	N. $\frac{3}{4}$ W.
N. W. by W.	N. by E.	$1\frac{1}{2}$	$1\frac{1}{4}$ E.	N. W. by W. $\frac{1}{4}$ W.
W. b. S.	N. W. by N.	$1\frac{3}{4}$	$2\frac{1}{4}$ E.	W. $\frac{1}{2}$ S.

If the ſhip has been acted upon by a current or a heave of the ſea, you muſt allow the ſet and drift as a courſe and diſtance in your traverſe table, as directed in page 236, where we have already treated on this ſubject.

To correct the dead reckoning.

After having calculated your day's-work, you muſt compare the latitude by dead reckoning with the latitude by obſervation; if they agree your day's-work is probably correct, but if they differ you muſt try to diſcover the cauſes of it. Examine your log-line and half-minute-glaſs, to find whether the diſtance is given exactly by the log; inquire whether the ſhip came-to or fell-off her courſe, by bad ſteerage or ſudden ſqualls, &c.; ſee if you have made ſufficient allowance for variation and lee-way; but above all, you ought to diſcover (if poſſible) whether there is a current, with its ſetting and drift. If, after making proper allowance for theſe things, there is ſtill a difference between the latitude by dead reckoning and by obſervation, and you feel confident that the error does not ariſe from an unknown current, you may make a further correction, depending on the following principles: When the courſe is within three points of the meridian, the error is probably in the diſtance, becauſe it would require a greater error in the courſe, to cauſe that difference of latitude, than can be ſuppoſed probable to have been committed.—When the courſe is above five points from the meridian, the error is probably in the courſe, becauſe a ſmall error in the courſe would cauſe a conſiderable error in the difference of latitude, but an error in the diſtance would affect it but little. When the courſe is between three and five points, the error may be either in the courſe, or in the diſtance, or in both; and an allowance ought to be made on both of them. The method of making this correction is therefore naturally divided into three different caſes, each of which we ſhall explain by proper examples.

CASE I.

If the courſe found by dead reckoning is leſs than three points, or 33° 45′.

RULE. With the difference of latitude and departure by account, find the courſe, by Caſe VI. Plane Sailing; with this courſe, and the difference of latitude by obſervation, find the difference of longitude, by Caſe IV. of Middle Latitude or Mercator's Sailing.

EXAMPLE.

Yeſterday at noon we were in the latitude of 39° 18′ N.; by an obſervation this noon we are in the latitude of 37° 48′ N. and our dead reckoning gives 107 miles ſouthing, and 64 miles weſting; required the true difference of longitude.

To the difference of latitude 107, and departure 64, I find the courſe $2\frac{3}{4}$ points; with which, and the difference of latitude by obſervation 90 miles (which is the difference between 37° 48′ and 39° 18′) I find the departure 54 miles; with this departure and the middle latitude 38° 33′, I find the difference of longitude 69 miles.

CASE II.

If the courſe by dead reckoning be more than three points, or 33° 45′, and leſs than five points, or 56° 15′.

RULE. With the difference of latitude and departure by account, find the diſtance (by Caſe VI. Plane Sailing); with this diſtance, and the difference of latitude by obſervation, find another departure, by Caſe IV. Plane Sailing; take half the ſum of this departure, and the departure by account, for the true departure, with which, and the difference of latitude by obſervation, find the difference of longitude by Caſe II. of Middle Latitude or Mercator's Sailing.

EXAMPLE.

Yeſterday at noon we were in the latitude of 52° 40′ N. and this noon are in the latitude of 54° 22′ N. having made by account 84 miles northing, and 76 miles weſting; required the true difference of longitude?

With the difference of latitude 84, and departure 76, I find the courſe 42°, and diſtance 113 miles; with this diſtance, and the difference of latitude by obſervation 102 miles, I find the departure 47.8, which added to 76, and divided by 2, gives the true departure 61.9; with this departure 61.9, and the middle latitude 53° 31′, I find the difference of longitude 105 miles.

CASE III.

If the courſe by dead reckoning be more than five points, or 56° 15′.

RULE. With the difference of latitude and departure find the diſtance, by Caſe VI. Plane Sailing; with this diſtance, and the difference of latitude by obſervation, find the difference of longitude, by Caſe V. of Middle Latitude or Mercator's Sailing.

EXAMPLE.

Yeſterday at noon we were in the latitude of 38° 52′ N.; this day at noon we were in the latitude of 40° 18′ N. and by account have made 68 miles northing, and 113 miles of weſting; required the true diff. of longitude.

With the difference of latitude 68, and departure 113, I find the courſe 59°, and the diſtance 132 miles, with which, and the difference of latitude by obſervation 86 miles, I find the courſe 49° nearly, and the departure 99.6 ; with this departure, and the middle latitude 39° 35′, the difference of longitude is found equal to 130 miles nearly.

To correct for ſeveral days.

The preceding rules will ſerve for correcting any ſingle day's work; but if an obſervation has been wanting for ſeveral days, you muſt proceed in the following manner.

Take the latitude by obſervation and longitude in at the time of laſt obſervation (or the latitude and longitude of the place you took your departure from, if you have had no obſervation ſince) and alſo the latitude in by obſervation, and the longitude by account ; find the differences of theſe latitudes and longitudes, and the middle latitude ; with the middle latitude and difference of longitude, find the departure ; with this departure, and the difference of latitude by account (which is found by taking the difference between the latitude left by obſervation and the latitude in by account) find the courſe and diſtance correſponding, and ſee what caſe this courſe falls under, and correct the departure by it ; then having the correct departure, you may find the true difference of longitude and longitude in.

EXAMPLE.

Three days ago, I was in the latitude of 40° 0′ N. and longitude of 58° 20′ W. This day by account my latitude is 38° 10′ N. and my longitude 57° 20′ W. but my latitude by obſervation is 38° 0′ N. what is my true longitude in ?

Latitude left	40° 0′ N.	Latitude left	40° 0′ N.	Long. left	58° 20′ W.
Lat. by obſ.	38 0 N.	Lat. by acc.	38 10 N.	Lo. in by acc.	57 20 W.
Diff. lat. by obſ.	2 0	Dif. lat. by acc.	1 50	Dif. of long.	1 0
	60		60		60
In miles	120	In miles	110	In miles	60
Sum of latitudes	78 0				
Mid. latitude	39 0				

With the middle latitude 39° and difference of longitude 60 miles, I find the departure 46,6 ; with the difference of latitude by account 110 and the departure 46,6, I find the courſe 23° ; therefore it muſt be corrected by Caſe I. by finding the departure 50,8 correſponding to the courſe 23° and the difference of latitude by obſervation 120 ; and then with the middle latitude 39°, and the correct departure 50,8, I find the correct difference of longitude 65 miles or 1° 5′, which ſubtracted from the longitude left 58° 20′, leaves the correct longitude in 57° 15′ W. In the preceding examples we have taken the courſes and mid. lat. to the neareſt degree ; a ſmall difference would be found if we had taken them to minutes.

A journal being kept in the preceding manner, the ſituation of the ſhip may be known nearly at any time, and the bearing and diſtance of the place of deſtination may be found. When the mariner is fearful that his longitude by account is inaccurate, and he has no lunar obſervations to correct it ; he muſt get into the latitude of the place, and (if poſſible) run eaſt or weſt according to his ſituation and the prevailing ſtate of the winds. To illuſtrate what has been ſaid on theſe ſubjects we ſhall now add examples of a number of ſeparate day's works, and then proceed to a connected journal.

EXAMPLE I.

Yesterday, at noon, we were in the latitude of 48° 21′ N. and the longitude of 36° 28′ W. and have sailed till this day at noon, as per log-board; required the course and distance made good, with the latitude and longitude in.

LOG-BOARD.						
H	K	F	Courses.	Winds.	Leeway.	REMARKS.
2	6		S.W. by W. $\frac{3}{4}$ W.	N.		These 24 hours moderate gales
4	5	5				and cloudy weather.
6	5			N. W.		At 4 P.M. spoke the ship Wash-
8	5					ington from New-York bound
10	3	6	S. W. $\frac{3}{4}$ W.			to Cork.
12	3	4				
2	3	4				
4	4	5				At 6 A. M. got the bower an-
6	4	6				chors on the gunnel, and un-
8	5		S.W. by S. $\frac{3}{4}$ W.	W.N.W.		bent the cables and stowed
10	4	5				them.
12	4					Variation $2\frac{1}{4}$ points westerly.†

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
S.W. by S. $\frac{1}{2}$ W.	43		33.2		27.3
S. S. W. $\frac{1}{2}$ W.	39		34.4		18.4
S. by W. $\frac{1}{2}$ W.	27		25.8		7.8
		Diff. Lat.	93.4	Dep.	53.5

By examining the log-board, it appears that the ship goes large, and makes no leeway; therefore, by allowing the variation on each of the courses, they will stand as in the adjoined traverse table. Then the distances marked on the log-board must be summed up, and doubled, because marked only for every two hours.* In allowing for the knots, you must reckon 10 to a mile; and when the tenths are above 5, you must add 1 mile to the distance. Having found the distances, you must find the corresponding differences of latitude and departures, in Table I. or II. and then with the whole difference of latitude and departure, find the course and distance made good, and the difference of longitude, by Case II. Mercator's Sailing.

In the present example, the difference of latitude is 93′ = 1° 33′ S.

Yesterday's latitude	48	21	N.
The difference is the latitude in	46	48	N.
Sum of latitudes	95	9	
Middle latitude	47	34	

With the difference of latitude made good 93.4 S. and the departure 53.5 W. I enter Table II. and find they correspond nearly to a course of S. 30° W. and distance 108 miles. Then with the middle latitude 47° 34′ or 48°, I enter Table II. and find the departure 53.5 in the Lat. column, opposite to which in the distance column, is the difference of longitude 80′ = 1° 20′ W.

Longitude left	36	28	W.
Sum is the longitude in	37	48	W.

* In India voyages, it is customary to mark the log-board every hour; in that case, the distances marked on the log being summed up, will be the true distance sailed.

† As these examples were given only to illustrate the rules, we have not been attentive to mark the true variation.

EXAMPLE II.

Yesterday at noon we were in the latitude of 35° 46′ N. and the longitude of 17° 36′ W. and have sailed till this noon as per log-board; required the latitude and longitude in, and the bearing and distance of Cape St. Vincent?

LOG-BOARD.

H.	K	F.	Courses.	Winds.	Lee-Way	REMARKS.
2	6	6	S.b.E.½E.	S. W. ½ W.	1½	These 24 hours moderate gales and clear weather.
4	5	8				
6	5	8				
8	5	8				
10	5		S. S. E.	S. W.	1½	At 8 A. M. saw a ship to windward, steering east.
12	5	2				
2	5	3				
4	5	5	S.S.E.½E.	S.W.b.S.½W.	1½	
6	5	5				
8	5	5				
10	5	6	S. E. b. S.	S. W. b. S.	1½	
12	5	4				Variation ¼ point easterly.

The courses being corrected for lee-way and variation, and the distances summed up and doubled, will stand as in the adjoined Traverse Table. Hence the difference of latitude made good is 105.4 S. and the departure 81.7 E.; consequently the course is S. 38° E. and the distance 133 miles nearly.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S.S.E.¾E.	48		41.2	24.7	
S. E. ¾ S.	31		24.9	18.5	
S. E. ¼ S.	33		24.5	22.2	
S. E. ¼ E.	22		14.8	16.3	
	Diff.	Lat.	105.4	81.7	Dep.

Latitude left	35° 46′ N.
Diff. of lat.	1 45 S.
Latitude in	34 1 N.
Sum of lat.	69 47
Middle lat.	34 53

With the middle latitude 34° 53′ or 35°, and the departure 81.7, the difference of long. is found to be 100 miles, = 1° 40′ E.

Longitude left	17 36 W.
Longitude in	15 56 W.

To find the bearing and distance of Cape St. Vincents.

Latitude in	34° 1′ N.	Mer. parts	2173	Long. in	15° 56′ W.
C.St.Vincent's lat.	37 2 N.	Mer. parts	2395	C.St.V. lon.	8 56 W.
Diff. of lat.	3 1 = 181′	M.dif.lat.	222	Diff. long.	7 0 = 420′

By LOGARITHMS.

To find the bearing.

As Mer. diff. lat.	222	log. 2.34635
Is to radius	45°	10.00000
So is diff. long.	420	log. 2.62325
To tang. course	62° 8′	10.27690

To find the distance.

As radius	45°	10.00000
Is to prop. diff. lat.	181	2.25768
So is secant course	62° 8′	10.33030
To the distance	387.2	2.58798

Hence the bearing of Cape St. Vincent is N. 62° 8′ E. and distant 387.2 miles.

EXAMPLE III.

Suppofe that at the end of the fea-day, March 10, 1804, we were in the latitude of 43° 34′ N. and the longitude of 35° 16′ W. and have failed till next noon as per log-board; required the latitude and longitude in, and the variation of the compafs,

Log-Board.

H	K	F	Courfes.	Winds.	L W.	Remarks.
2	4	5	W. S. W.	South.		Thefe 24 hours moderate gales, found a fmall current fetting N. E. at the rate of 1 mile in 4 hours.
4	4	5				
6	4	5				
8	4					
10	4					
12	4					
2	3	5				
4	3	5	S. W. by W.	S. by E.		
6	3					At 8 A. M. fun's magnetic azimuth N. 125° 19′ E. Alt. of ☉'s L. L. 18° 40′; correction for dip and femi-diameter 12′ additive.
8	3					
10	3					
12	3	5				

In calculating the variation from the above obfervation it is neceffary to find the declination and latitude at the time of obfervation. The former at noon ending the fea-day March 11, 1804, is 3° 40′ S. by Table V.; the correction for the long. 35°. W. is — 2′ 14″, and for the time from noon 4h. is +35′ 1″, therefore the whole correction is +1′ 37″ or nearly 2′, which added to 3° 40′ gives the declination at the time of obfervation 3° 42′ S. confequently the polar diftance 93° 42′. To find the latitude we muft fee by the log-board what courfes and diftances the fhip has failed from noon to the time of obfervation 8 A. M. viz. W. S. W. 58 miles, and S. W. by W. 19 miles; the current fetting in the fame time N. E. 5 miles; thefe courfes muft be corrected for 1 point wefterly variation, which is found to be nearly its value, by a rough calculation made with the latitude in at the preceding noon; and by arranging them in a traverfe table we find that the difference of latitude made good at 8 A. M. is about 41 miles, confequently the latitude in at the time of obfervation is nearly 42° 53′ N. and the co-latitude 47° 7′; the obferved altitude of the fun's L. L. is 18° 40′: the correction for dip and femi-diameter being +12′, and the refraction by table XIII.—3′ nearly, confequently the fun's correct altitude is 18° 49′ and its co-altitude 71° 11′. With thefe data, the true azimuth is calculated as in page 146.

Co-lat.	47° 7′	Co-fecant	0.13505
Co-alt.	71 11	Co-fecant	0.02385
Pol.dift.	93 42		
Sum	212 00		
H. fum	106 00	Sine	9.98284
Pol-dift.	93 42		
Rem.	12 18	Sine	9.32844
		Sum	19.47018
Half fum log. co-fine	57° 5′ 2		9.73509
True azimuth	N. 114 10 E.		
Mag. azimuth	N. 125 19 E.		
Variation	11 9 W. or nearly 1 point.		

The variation being allowed on all the courfes and current, and the diftances fummed up, the traverfe table will be as adjoined; and the difference of latitude made good =49,8 S. departure=67,5 W. hence the courfe made good S. 53½° W. and diftance =84 miles. And by fubtracting the difference of latitude 50′ from latitude left 43° 34′, there remains the latitude in 42° 44′ N. Hence we have the middle latitude 43° 9′, with which and the departure 67,5, the difference of longitude is 92′ or 1° 32′ W. nearly; and by adding it to the longitude left 35° 16′ W. we have the longitude in 36° 48′ W.

Traverse Table.

Courfes.	Dift.	N.	S.	E.	W.
S.W.b.W.	58		32.2		48.2
S. W.	32		22.6		22.6
N.E.b.N.	6	5.0		3.3	
		5.0	54.8	3.3	70.8
			5.0		3.3
	Diff. Lat.		49.8	Dep.	67.5

EXAMPLE IV.

Yesterday at noon we were in the lat. of 40° 19′ N. and in the long. of 68° 8′ W. and have sailed till this noon as per log-book; required the bearing and distance of Cape Cod?

Log-Board.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks.
1	1		W. N. W.	North.	1	First part of these 24 hours light breezes and fine weather; latter part pleasant gales and cloudy.
2	1					
3	1					
4	1					
5	2	5				
6	3					
7	1	5				
8	1	5				
9	1	5				
10	1					
11	1		N. W.	N. N. E.	1	Saw great quantities of gulf-weed, and rock-weed.
12	1					
1	2	5	N.W.½N.	N. N. E.½E.	1	
2	2	5				
3	2	5				
4	2	5				At 7 A. M. water discoloured, sounded no bottom.
5	3		N. N. W.	N. E. by E.	0	
6	3					
7	3					
8	3					
9	4					
10	4					
11	4	5		E. N. E.		Latitude by observation 40° 52′ N. Variation ¾ point W.
12	4	5				

The distances are summed up, and marked in the Traverse Table without doubling, because the log-board is marked for every hour. By working this day's work like the others, we find the diff. of lat. made good=31,6m. N. & the dep. 40.3m. W.—hence the course N. 52° W. nearly, and distance 51 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
W. ¾ N.	15	0 7			15 0
N. W. by W. ¾ W.	2	0 9			1 8
N. W. by W. ¼ W.	10	5 1			8 6
N. N. W. ¾ W.	29	24 9			14 9
	D. Lat.	31 6		Dep.	40 3

Latitude left	40°	19′N.
Diff. of lat.		32 N.
Lat. in by D.R.	40	51 N.
Sum of lats.	81	10
Mid. lat.	40	35

With the mid. lat. 40½° and the departure 40,3, the diff. of long. is 0° 53′ W.

Long. left	68	8 W.
Long. in	69	1 W.

To find the bearing and distance of Cape-Cod.

Lat. in by obs.	40° 52′ N.		Long. in by D. R.	69° 1′ W.	
Lat. of Cape Cod	42 5 N.		Long. of Cape Cod	70 14 W.	
Diff. of lat.	1 13	=73 miles.	Diff. of long.	1 13	=73mi.
Mid. lat.	41 28				

With the difference of longitude 73 miles, and the middle-latitude 41° 28′, or 41½°, I find the depart. 54,6 nearly, with which and the diff. of lat. 73 miles, the bearing of Cape Cod is found N. 37° W. dist. 91 miles.

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OF A VOYAGE FROM BOSTON TO MADEIRA.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Wednesday, March 25, 1801.
2						At noon got under way, with a fine breeze from the N. W.
4						
6						
8						At 8 P. M. Cape Cod light-house bore S. S. E. distant 4 leagues; from which I take my departure.
10	6	5	E. by S.	N. W.		
12	6	5				
2	6	6				
4	6	4				
6	7					
8	7			North.		
10	7					
12	7					Variation ½ point westerly.

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and distance.
		N.	E.	N.		E.	W.	Funchal S.76°41'E
N.87° 11'E.	102	5	102	42° 10'		2° 17'	67° 57'	dist. 2485 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
N. N.W. ½ W.	12	10.3			6.2
E. ¼ S.	108		5.3	107.9	
		10.3	5.3	107.9	6.2
		5.3		6.2	
	D. Lat.	5.0	Dep.	101.7	

Cape Cod bearing from the ship S.S.E. dist. 4 leagues, is the same as if the ship had sailed from Cape Cod 4 leagues or 12 miles upon the opposite or N. N. W. point of the compass, and allowing for the variation, it becomes N. N. W. ½ W. dist. 12 miles, which is to be set in the traverse table as the first course and distance.

The ship sailed all day upon an E. by S. course by compass, which, by allowing the variation, becomes E. ¼ S. The sum of all the distances is 54 miles, which being doubled because the table is marked for every two hours, gives the whole distance sailed 108 miles. With these courses and distances, I find the corresponding differences of latitude and departures; and by subtracting the southing from the northing, and the westing from the easting, find that the difference of latitude made good is 5.0 N. and the departure 101.7 W. which correspond to a course of N. 87° 11' E. and distance 102 miles.

Lat. sailed from, or Cape Cod's lat.	42° 05'	N.
Diff. of lat.	0 05	N.
Latitude in	42 10	N.
Sum of lats.	84 15	
Middle latitude	42 7	

Then with the middle latitude 42° as a course, I enter Table II. and against the departure 101.7 (or 101.8 which is the nearest tabular number) found in the latitude column, is 137 = the difference of longitude in the distance column.

Long from, or C.Cod's long.	70° 14'	W.
Diff. long.	2 17	E.
Long. in	67 57	W.

To find the bearing and distance of Funchal.

Latitude in	42° 10' N.	Mer. parts	2795	Longitude in	67° 57' W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 5 W.
Diff. of lat.	9 32	Mer. diff. lat.	722	Diff. long.	50 52
	60				60
In miles	572			In miles	3052

With the merid. diff. of lat. 722 miles, and diff. of long. 3052 miles, the bearing is found S. 76° 41' E. and with that bearing taken as a course, and the proper difference of latitude 572 miles, the distance is found 2485 miles, as in Case I, of Mercator's Sailing.

H	K	F	Courses.	Winds.	Lee-Way	REMARKS on board, Thursday, March 26, 1801.
2	7		E. by S.	N. by E.		Fresh gales and pleasant weather.
4	7					
6	7					Saw a number of fishing vessels to the southward.
8	7		E. by S. ½ S.	N. N. E.		At noon observed the altitude of the sun's lower
10	7					limb to the southward of me 50° 17'
12	7					Add for semidiameter and dip 12 The refraction being small, is neglected
2	7		E. S. E.			Correct altitude 50 29
4	6	6				Subtract from 90 00
6	6	4				☉'s Zenith distance 39 31 N.
8	6	4				☉'s correct declination 2 12 N.
10	6	6				Latitude by observation 41 43 N.
12	6	5				Variation ¾ point westerly.

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Distance.
		S	E.	N.	N.	E.	W.	Funchal S. 76° 24' E.
S. 80° 15' E.	162	27	160	41° 43'	41° 43'	3° 35'	64° 22'	dist. 2319 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. ¼ S.	42		2.1	41.9	
E. ¾ S.	42		6.2	41.5	
E. by S. ¼ S.	79		19.2	76.6	
		D. Lat.	27.5	160.0	Dep.

The variation being allowed on each course, and the distances summed up, they will stand as in the adjoined traverse table; from hence, by means of Table I. I find the difference of latitude 27,5 and the departure 160,0 which correspond to the course S. 80° 15' E. and the distance 162 miles.

Yesterday's latitude	42°	10' N.
Diff. of latitude		27 S.
Latitude in	41	43 N.
Sum of latitudes	83	53
Middle latitude	41	56

With the middle latitude 41° 56' or 42° as a course, I enter Table II. and seek for the departure 160,0 in the latitude column; the nearest number to which is 159,8 corresponding to the distance 215, which is therefore the diff. of long. equal to 3° 35' E.

Yesterday's long.	67	57 W.
Long. in	64	22 W.

To find the bearing and distance of Funchal.

Latitude in	41°	43' N.	Mer parts	2759	Longitude in	64°	22' W.
Funchal's lat.	32	38 N.	Mer. parts	2073	Funchal's long.	17	5 W.
Diff. of lat.	9	5	Mer. diff. lat.	686	Diff. of long.	47	17
	60					60	
In miles	545				In miles	2837	

By Case I. of Mercator's Sailing, I find the bearing of Funchal S. 76° 24' E. and its distance 2319 miles.

When the sun was upon the meridian, the altitude of his lower limb was 50° 17', to which add 12 miles for his semidiameter and the dip of the horizon; the refraction (given in Table XIII.) for this altitude, being small, is neglected; hence his correct central altitude = 50° 29', which subtracted from 90° leaves his zenith distance 39° 31', which must be called north, because the sun bore south when on the meridian; then in Table V. I find the sun's declination at noon at Greenwich = 2° 8' N. to this add the correction 4 miles, taken from Table VI. corresponding to the ship's longitude; the sum is 2° 12' N. = his correct declination; and since the declination and zenith distance are both north, I add them together, and the sum is the latitude by observation = 41° 43' N. which agrees with the latitude by account.

H	K	F	Courses.	Winds.	Lee-Way	REMARKS on board, Friday, March 27, 1801.	
2	7		E. S. E.	N. by E.		All these 24 hours fresh breezes, and clear.	
4	8						
6	8						
8	8					Meridian alt. sun's lower limb	51° 38'
10	8					Add for semidiameter, dip, &c.	12
12	8					Sun's correct altitude	51 50
2	8	6		N. N. E.		Subtract from	90 00
4	8	6				Sun's zenith distance	38 10 N.
6	8	6				Sun's correct declination	2 36 N.
8	8	6				Latitude observed	40 46 N.
10	8	1					
12	8			N.E. by N.		Variation ¾ point westerly, per amplitude.	

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Distance.
S. 73° E.	195	S. 57	E. 186	N. 40° 56'	N. 40°46'	E. 4° 8'	W. 60° 14'	Funchal, S. 76° 45' E. dist. 2129 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. by S. ¼ S.	195	D. Lat.	47.4	189.2	Dep.

The ship sailed all day upon the same course, which, corrected for the variation, is E. by S. ¼ S. the whole distance sailed is 195 miles, and the difference of latitude is 47 miles. 0° 47' S.
Yesterday's latitude 41 43 N.

Latitude by D. R. 40 56 N.

Hence the latitude by account differs 10 miles from the latitude by observation; therefore I correct this day's work by Case III.

Latitude, yesterday, by obs.	41° 43' N.
Latitude obs. this day	40 46 N.
Diff. of lat. by obs.	57
Sum of latitudes	82 29
Middle latitude	41 14

With the distance 195, and difference of latitude 57, I find the course S. 73° E. and the departure 186.5; then with the middle latitude 41° 14′ as a course, and the departure 186.5 as difference of latitude, I find the corresponding distance 248, which is equal to the difference of longitude 4° 8' E.
Yesterday's long. 64 22 W.

Longitude in 60 14 W.

NOTE. As this journal is only designed to exemplify the rules of navigation, we have not endeavoured to give the true variation.

To find the bearing and distance of Funchal.

Latitude in	40° 46' N.	Mer. parts	2683	Longitude in	60° 14' W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 5 W.
Diff. of lat.	8 8	M. D. Lat.	610	Diff. long.	43 9
	60				60
In miles	488			In miles	2589

With the merid. diff. of lat. and diff. of long. the bearing is found S. 76° 45' E. With that and the proper diff. of lat. the distance is found to be 2129 miles,* by Case I. Mercator.

* If the course was calculated to seconds, and the meridional parts taken to one or two places of decimals, it would sometimes make a difference of a few miles in the calculated distance.

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H	K	F	Courses.	Winds.	Lee-Way
2	7		S. E. by E.	N.E.byE.	1
4	6	6			
6	6				
8	5	4			
10	5	6	S. E.	E. N. E.	1
12	5	6			
2	5	3			
4	5	5			
6	6		S. E. by S.	E. by N.	1
8	6				
10	6				
12	5				

REMARKS on board, Saturday, March 28, 1801.

Fresh gales, with rain.
At 4 P. M. spoke the ship Franklin, from Philadelphia, bound to Lisbon.

At noon, observed merid. alt. sun's lower limb	53°	43'
Add for semidiameter, &c.		12
Sun's correct altitude	53	55
Subtract from	90	00
Sun's Zenith distance	36	05 N.
Sun's correct declination	2	59 N
Latitude observed	39	4 N.

Variation ¾ point westerly.

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Distance.
S. 42° 29' E.	138	S. 102	E. 93	N. 39° 04'	N. 39° 04'	E. 2° 2'	W. 58° 12'	Funchal, S. 79° 4' E. dist. 2037 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. E. ¾ E.	50		29.8	40.2	
S. E. ¼ S.	44		32.6	29.5	
S. S. E. ¾ E.	46		39.5	23.6	
		D. Lat.	101.9	93.3	Dep.

The leeway and variation being allowed on the courses, they will stand as in the adjoined traverse table. Then with the difference of latitude and departure the course is found to be S. 42° 29' E. distance 138 miles.

Yesterday's latitude		40° 46'	N.
Diff. of latitude	102' =	1 42	S.
Latitude in		39 04	N.
Sum of lats.		79 50	
Middle lat.		39 55	

With the middle latitude 39° 55' or 40° as a course, and the departure 93.3 taken as difference of latitude, the difference of longitude is found 122 miles = 2° 2' E.

Yesterday's long.	60 14	W.
Longitude in	58 12	W.

The course made good each day is marked in the journal to degrees and minutes, as they were calculated by the logarithms; but for practical purposes, it is sufficiently exact to find it to the nearest degree by inspection of Table II.

To find the bearing and distance of Funchal.

By Case I. Middle Latitude Sailing.

Latitude in	39° 04' N.	Longitude in	58° 12' W.
Funchal's latitude	32 38 N.	Funchal's long.	17 05 W.
Diff. of lat.	6 26 = 386 miles.	Diff of long.	41 7
			60
Sum of latitudes	71 42		
Middle latitude	35 51	In miles	2467

With the middle latitude 35° 51' or 36° as a course, and the difference of longitude 2467 as a distance, I calculate the departure; with that and the difference of latitude I find the distance and course, by Case I. of Middle Latitude Sailing.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Sunday, March 29, 1801.
2	4		South.	E. S. E.	1	These 24 hours moderate, pleasant weather.
4	4					
6	4					
8	4					
10	4					Merid. Alt. ☉'s lower limb 55° 22'
12	4					Add for semidiameter, dip, &c 0 12
2	3	6	S. ½ E.	E.byS.½S.	1½	☉'s correct Altitude 55 34
4	3	4				Subtract from 90 00
6	3					☉'s Zenith distance 34 26 N.
8	3					☉'s correct declination 3 22 N.
10	3					Latitude observed 37 48 N.
12	3					Variation 1 point westerly.

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Distance.
South.	76	S. 76	0	N. 37° 38'	N. 37° 48'	0	W. 58° 12'	Funchal, S. 81° 15' E. Distance, 2038 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
South.	86		86.0	Diff. Lat.	

The leeway and variation being allowed on both courses, they become South; the whole distance sailed, or 86 miles, is therefore the difference of latitude by account; the departure being nothing; consequently the ship is in the same longitude as yesterday.

Yesterday's latitude			39° 04'N.
Difference of latitude	86	=	1 26 S.
Latitude in by D. R.			37 38 N.

The latitude by observation is 37° 48' N. differing 10 miles from the account; and this is probably an error in the distance marked in the log-book, I therefore take 10 miles from that distance, and reckon it 76 miles.

To find the bearing and distance of Funchal.

Latitude in	37° 48' N.	Mer. parts	2453	Longitude in	58° 12' W.
Funchal's latitude	32 38 N.	Mer. parts	2073	Funchal's longitude	17 5 W.
Diff. of lat.	5 10	Mer. diff. lat.	380	Diff. of long.	41 7
	60				60
In miles	310			In miles	2467

Hence the bearing is S. 81° 15' E. distance 2038 miles, by Case I. of Mercator's sailing; and the same may be found by middle latitude, which is the most exact method when the two latitudes differ but little; and it is the way in which the calculation will be made in the rest of the journal.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Monday, March 30, 1801.
2	3		East.	N. N. E.	3	These 24 hours fresh gales and squally.
4	3					Handed the Fore and Main Courses.
6	Lay too, up S. E. by E. off					
8	S.E. by S. Drift 1½ miles per hour.				5	
10	Up S. off S. W. Drift 1½ miles					At midnight more moderate; wore ship, and set
12	per hour.				5	the Courses close reefed.
2	2	5	E. by N.	S. E. by S.	1½	
4	3					
6	3	5				At 6 A. M. set the Topsails close reefed.
8	2	5				
10	2	5				
12	2					Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Dif. Long.	Long. in.	Bearing & Dist.
		N.	E.	N.		E.	W.	Fun. S. 80° 55'E.
N. 76° 17'E.	31	7	30	37° 55'		0° 38'	57° 34'	dist. 2008 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. S. E.	12		4. 6	11. 1	
South	6		6. 0		
W. S. W.	6		2. 3		5. 5
N. E. ½ E.	32	20. 3		24. 7	
		20. 3	12. 9	35. 8	5. 5
		12. 9		5. 5	
	D. Lat.	7. 4	Dep.	30. 3	

Taking the middle points (viz. S. E. and S. S. W.) between the point to which the ship comes to and falls off, as taught in the rules of lying too, and then allowing as before for the variation and leeway, the traverse table will stand as adjoined.

With the difference of latitude and departure the course is found N. 76° 17' E. distance 31 miles.

Yesterday's latitude	37° 48' N.
Difference of latitude	7 N.
Latitude in	37° 55 N.
Sum of latitudes	75 43
Middle latitude	37 51

With the middle latitude 37° 51' (or 38°) as a course, and the departure 30. 3 used as difference of latitude, I find the difference of longitude 0. 38 E.

Yesterday's longitude	58. 12 W.
Longitude in	57. 34 W.

To find the bearing and distance of Funchal.

Latitude in	37° 55' N.	Longitude in	57° 34' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 5 W.
Diff. of latitude	5 17=317 miles.	Diff. of longitude	40 29
			60
Sum of latitudes	70 33		
Middle latitude	35 16	In miles	2429

With the middle latitude 35° 16' and the difference of longitude 2429, the departure is found=1983; with that and the difference of latitude 317, the bearing of Funchal is found S. 80° 55' E. distance 2008 miles.

H	K	F	Courses.	Winds.	Lee-way.	Remarks on board, Tuesday, March 31, 1801.
2	5		E. S. E.	South.	1	Pleasant gales and fair weather.
4	5					
6	5	6				
8	5	4				
10	5	5	E. by S. ½ S.	S. ½ E.	½	
12	6					This day took a lunar observation, by measuring the distance of the moon from the star Antares; the longitude at noon, deduced from this observation, is 54° 23' W. which agrees with the longitude by account.
2	7					
4	7					
6	7					
8	7					
10	7					
12	8					Variation 1 point westerly, per azimuth.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Dif. Long.	Long. in	Bearing & Dist.
East.	151	0	E. 151	N. 37° 55'		E. 3° 11'	W. 54° 23'	Fun. S. 80° 9' E. dist. 1855 miles.

The variation and leeway being allowed on both courses, it appears, that the ship has made a due east course, the distance sailed 151 miles is the departure, and the difference of longitude is found by Case II. of Parallel Sailing. The latitude in, is the same as yesterday's latitude, 37° 55' N. Taking this as a course, and the departure 151 as difference of latitude, the distance which corresponds is the difference of longitude, 191 miles = 3° 11' E.

Yesterday's longitude	57 34 W.
Longitude in	54 23 W.

To find the bearing and distance of Funchal.

Latitude in	37° 55' N.	Longitude in	54° 23' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 05 W.
Diff. of latitude	5 17 = 317 miles	Diff. of longitude	37 18
			60
Sum of latitudes	70 33		
Middle latitude	35 16	In miles	2238

Hence by Case I. of middle latitude sailing, the departure is 1827 miles, the bearing of Funchal S. 80° 9' E. distance 1855 miles.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Wednesday, April 1, 1801.
2	8		E. S. E.	S. S. W.		Fresh gales and pleasant weather.
4	8					
6	8	4				
8	8	6				
10	8	5				Obs. mer. alt. sun's lower limb 56° 49'
12	8	5				Correct for semidiameter, dip, &c. 12
2	9		E. by S. ½ S.	S. by W.		Sun's correct altitude 57 01
4	9					Subtract from 90 00
6	8	6		South		Sun's Zenith distance 32 59N.
8	8	4				Sun's declination 4 31N.
10	8	5	East.	S. by E.	½	Latitude observed 37 30N.
12	9					Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D.R.	Lat. by Obs.	Diff. Long.	Long. in	Bearing & Distance
		S.	E.	N.	N.	E	W.	Fun. S. 79° 48′ E.
S. 85° 24′ E.	202	16	201	37° 39′	37° 30′	4° 15′	50° 8′	Dist. 1649 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. by S.	100		19. 5	98. 1	
E. ½ S.	70		6. 9	69. 7	
E. by N. ¾N.	35	10. 2		33. 5	
		10. 2	26. 4	201. 3	Dep.
			10. 2		
		Diff. Lat.	16. 2		

The courses being corrected for leeway and variation, the traverse table will be as here given.

Hence the course is S. 85° 24′E. distance 202 miles,

Yesterday's latitude	37°	55′N.
Diff. of latitude		16 S.
Lat. in by account	37	39. N
Sum of latitudes	75	34
Middle latitude	37	47

Yesterday's longitude 54° 23′ W.
With the middle lat. and the dep. 201.3 the difference of longitude is 255= 4 15 E.

Longitude in by account 50 8 W.

As the latitude by observation differs from the latitude by account, I correct as follows, it being three days since I had an observation.

Last obs. lat. Mar. 29,	37°	48′	Lat. obs. Mar. 29,	37°	48′	Long. in Mar. 29,	58°	12′W.
Lat. in by account	37	39	Lat. in by obs.	37	30	Long. in by acc.	50	8
Dif. of lat. by account		9	Dif. of lat. by obs.		18	Diff. of long.	8	4
Sum of latitudes	75	27					60	
Middle latitude	37	43						
						In miles	484	

With the middle latitude 37° 43′, and the difference of longitude by account 484, I find the departure 382. 9; with this departure and the difference of latitude by account 9, I find the course S. 88° 39′ E. and distance 383; with this distance 383, and the difference of latitude by observation 18, I find the true course S. 87° 18′ E. and the departure 382.5; with this departure and the middle latitude, I find the true difference of longitude 483.6 miles=8° 4′, this subtracted from 58° 12′ W. the longitude in March 29, gives the longitude in this day 50° 8′ W.* The preceding calculations were made by logarithms, to a greater exactness than is necessary at sea.

To find the bearing and distance of Funchal.

Latitude in	37°	30′ N.	Longitude in	50°	08′ W.
Funchal's latitude	32	38 N.	Funchal's longitude	17	5 W.
Sum of latitudes	70	8	Diff. of longitude	33	3
Middle latitude	35	4		60	
Diff. of latitude	4	52=292	In miles	1983	

Hence by Case I, middle latitude sailing, the bearing of Funchal is S. 79° 48′ E. and its distance 1649 miles.

* The course being nearly east makes the correction of longitude only 4 tenths of a mile, so that the longitude by dead reckoning is the same as the corrected longitude.

H	K	F	Courſes.	Winds.	Lee-Way	REMARKS on board, Thurſday, April 2, 1801.
2	6	5	E. S. E.	South.	½	Freſh gales, with rain.
4	7	5				
6	7					
8	8		E. S. E.	S. W.	0	
10	8	5				Saw a ſhip to the ſouthward.
12	8	5				
2	9					
4	9					
6	9					
8	9					
10	9	5				
12	9	5				Variation 1 point weſterly.

Courſe.	Diſt.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obſ.	Diff. Long.	Long. in.	Bearing and Diſtance.
		S.	E.	N.		E.	W.	Funchal, S. 79° 46' E.
S. 79° 56' E.	202	35	199	36° 55'		4° 9'	45° 59'	diſt. 1447 miles.

TRAVERSE TABLE.					
Courſes.	Diſt.	N.	S.	E.	W.
E. ½ S.	42		4.1	41.8	
E. by S.	160		31.2	156.9	
		D. Lat.	35.3	198.7	Dep.

The leeway and variation being corrected on the courſes, the traverſe table will be as here given; hence the courſe S. 79° 56' E. diſtance 202 miles.

Yeſterday's latitude	37° 30'	N.
Diff. of lat.	35	S.
Latitude in	36 55	N.
Sum of latitudes	74 25	
Middle latitude	37 12	

With the middle latitude 37° 12' and the departure 198.7, the difference of longitude is found 249 miles = 4° 9' E.

Yeſterday's longitude	50 8	W.
Longitude in	45 59	W.

To find the bearing and diſtance of Funchal.

Latitude in	36° 55'	N.	Longitude in	45° 59'	W.
Funchal's latitude	32 38	N.	Funchal's longitude	17 05	W.
Diff. of lat.	4 17 = 257 miles.		Diff. of long.	28 54	
				60	
Sum of latitudes	69 33				
Middle latitude	34 46		In miles	1734	

Hence, by Caſe I. of Middle Latitude Sailing, the bearing of Funchal is S. 79° 46' E. and its diſtance 1447 miles.

H	K	F	Courfes.	Winds.	Lee-Way	Remarks on board, Friday, April 3, 1801.
2	9	6	E. S. E.	Weft		Frefh gales and rainy weather; latter part clear.
4	9	4				A great fwell from the N.E. for which I allow 9 miles.
6	9					
8	9					
10	9	5				Obf. alt. fun's lower limb at noon 58° 48'
12	9	5				Correction for femidiameter, &c. add 0 12
2	9			N. W.		Sun's correct altitude 59 0
4	9					Subtract from 90 0
6	9					Sun's zenith diftance 31 0 N.
8	9					Sun's declination 5 17 N.
10	9			North		Latitude obferved 36 17 N.
12	9					Variation 1¾ points wefterly per azimuth.

Courfe.	Dift.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obf.	Diff. Long.	Long. in.	Bearing and Diftance.
		S.	E.	N.	N.	E.	W.	Funchal, S. 79° 45' E.
S. 79° 22' E.	217	40	213	36° 15'	36° 17'	4° 25.	41° 34'	diftance 1231 miles.

Traverse Table.					
Courfes.	Dift.	N.	S.	E.	W.
E. ¾ S.	220		32.3	217.6	
S.S.W. ¾ W.	9		7.7		4.6
		D. Lat.	40.0	217.6	4.6
				4.6	
			Dep.	213.0	

In this day's work the fwell is confidered as a current fetting the fhip 9 miles per day; and fince it comes from the N. E. it muft fet the fhip S. W. and allowing the variation S.S.W. ¾ W. 9 miles, this is placed as a courfe and diftance in the traverfe table.

With the difference of latitude and departure the courfe is found to be S. 79° 22' E. and diftance 217 miles.

Yefterday's lat.	36°	55' N.
Diff. of lat.		40 S.
Latitude in	36	15' N.
Sum of latitudes	73	10
Middle latitude	36	35

With the middle latitude 36° 35', and the departure 213 miles, the difference of longitude is found 265 miles = 4° 25' E.

Yefterday's long.	45	59	W.
Longitude in	41	34	W.

The latitude by obfervation is 36° 17' N. differing only 2 miles from the computed latitude; for that reafon, this day's work does not want any correction.

To find the bearing and diftance of Funchal.

Latitude in	36° 17' N.	Longitude in	41° 34' W.
Funchal's lat.	32 38 N.	Funchal's long.	17 5 W.
Diff. of latitude	3 39 = 219 miles.	Diff. of long.	24 29
			60
Sum of latitudes	68 55		
Middle latitude	34 27	In miles	1469

Hence, by Cafe I. of Middle Latitude Sailing, the bearing of Funchal is S. 79° 45' E. and diftance 1231 miles.

To find the bearing and diftance of Funchal by Mercator's Chart.

Having pricked off the place of the fhip at noon, lay a ruler from that point to Funchal; take the neareft diftance between the centre of the compafs and the ruler; then flide one foot of the compaffes along the edge of the ruler, keeping the other foot at the greateft diftance from it, and it will be found to run nearly upon the E. by S. line, which is therefore the bearing of Funchal; then take in your compaffes the extent from the place of the fhip to Funchal, and apply it to the graduated meridian, fetting one foot as much above one place as the other is below the other place, and it will be found to meafure 20½ degrees, or 1230 miles; which is the diftance of the fhip from Funchal nearly.

H	K	F	Courses.	Winds.	Lee-Way
2	7	4	E. S. E.	N. E.	1
4	6	6			
6	6				
8	5	4	S. E.	E. N. E.	1
10	4	6			
12	4		S. S. E.	East.	1
2	4		S. by E.	E. by S.	1¼
4	4				
6	4	5	S. by W.	S.E. by E.	1½
8	4				
10	4				
12	4				

REMARKS on board, Saturday, April 4, 1801.

First part fresh gales; latter part more moderate, a heavy sea running.

Mer. alt. sun's lower limb	65°	53'
Correction for semidiameter, &c.	0	12
Sun's correct altitude	61	05
Subtract from	90	00
Sun's zenith distance	28	55 N.
Sun's declination	5	40 N.
Latitude observed	34	35 N.

Variation 1¼ points westerly.

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and distance.
		S.	E.	N.	N.	E.	W.	Funchal, S. 84° 14' E.
S. 31° 57' E.	120	102	64	34° 55'	34° 35'	1° 18'	40° 16'	distance 1164 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. by S. ¾ S.	40		13.5	37.7	
S. E. ¼ E.	20		13.4	14.8	
S. S. E. ¼ E.	8		7.2	3.4	
S. by E.	16		15.7	3.1	
S. by W. ¼ W.	33		32.0		8.0
		D. Lat.	81.8	59.0	8.0
				8.0	
			Dep.	51.0	

The courses being corrected for lee-way and variation, will stand as in the adjoined traverse table.

Then with the difference of latitude 81.8, and the departure 51.0, I find the course S. 31° 57' E.

Yesterday's latitude	36°	17' N.
Difference of latitude	1	22 S.
Latitude by account	34	55 N.

But the latitude by observation being 34° 35' N. I correct by Case I.

Yesterday's latitude	36°	17' N.
Latitude in by obs.	34	35 N.
Diff. of lat. by obs.	1	42 = 102 miles.
Sum of latitudes	70	52
Middle latitude	35	26

With the course 31° 57' (or 32°) and the difference of latitude by observation 102 miles, I find the distance 120 miles, and the departure 63.6 miles; with this departure, and the middle latitude 35° 26', I find the difference of longitude 78 miles = 1° 18' E.

Yesterday's longitude	41	34 W.
Longitude in	40	16 W.

To find the bearing and distance of Funchal.

Latitude in	34°	35' N.	Longitude in	40°	16' W.
Funchal's latitude	32	38 N.	Funchal's long.	17	05 W.
Diff. of lat.	1	57 = 117 miles.	Diff. of long.	23	11
Middle latitude	33	36		60	
			In miles	1391	

Hence, by Case I. of Middle Latitude Sailing, the bearing of Funchal is S. 84° 14' E. distance 1164 miles.

H	K	F	Courses.	Winds.	Lee-Way
2	3		S. E.	E. N. E.	1
4	2				
6			Calm.		
8					
10					
12					
2	3	4	E. S. E.	N. N. E.	
4	4	6			
6	5	5			
8	6	5			
10	7				
12	8				

REMARKS on board, Sunday, April 5, 1801.

First part of these 24 hours small breezes, and calm; latter part fresh gales.

At 4 P. M. got out the boat and tried the current; found it running E. 1 mile per hour, and suppose it has been setting in that direction all these 24 hours.

Mer. alt. Sun's lower limb	61° 30'
Correction for semidiameter, &c.	0 12
Sun's correct altitude	61 42
Subtract from	90 00
Sun's zenith distance	28 18 N
Sun's declination	6 3 N.
Obs. latitude	34 21 N.

Variation 1 and one fourth of a point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in	Bearing & distance.
		S.	E.	N.	N.	E.	W.	Fun. S. 84° 27' E.
S. 83° 36' E.	101	11	100	34° 24'	34° 21'	2° 1'	38° 15'	dist. 1064 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. E. ¼ E.	10		6. 7	7. 4	
E. ¾ S.	70		10. 3	69. 2	
E. by N. ¼ N.	24	5. 8		23. 3	
		5. 8	17. 0	99. 9	Dep.
		Diff.	5. 8		
		Lat.	11. 2		

In addition to the courses sailed, I also allow 24 miles for the set of the current in the direction of east per compass or E. by N. ¼ N. true course.

With the difference of latitude 11. 2 and the departure 99. 9, the course is S. 83° 36' E. and the distance nearly 101 miles.

Yesterday's latitude	34° 35' N.
Difference of latitude	0 11 S.
Latitude in by account	34 24 N.

And as this differs only 3 miles from the observed latitude 34° 21' N. this day's work will not require any correction; therefore with the middle latitude 34° 28', and the departure 99. 9, I find the difference of longitude 121 miles = 2° 1' E.

Yesterday's longitude	40 16 W.
Longitude in	38 15 W.

To find the bearing and distance of Funchal.

Latitude in	34° 21' N.	Longitude in	38° 15' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 5 W.
Difference of latitude	1 43 = 103 miles.	Difference of longitude	21 10
Sum of latitudes	66 59		60
Middle latitude	33 30 nearly.	In miles	1270

Hence by Case 1 of middle latitude sailing, the bearing of Funchal is S. 84° 27' E. distance 1064 miles.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Monday, April 6, 1801.
2	9		E. S. E.	North.		Fine fresh gales and clear weather.
4	9					
6	9					
8	9					
10	9					Mer. alt. Sun's lower limb 62° 25' Correction for dip, &c. 0 12
12	9					
2	9					Sun's correct altitude 62 37 Subtract from 90 00
4	9					
6	9					Sun's zenith distance 27 23 N. Sun's declination 6 25 N.
8	9					
10	9					Observed latitude 33 48 N.
12	9					Variation per Amp. 1 $\frac{1}{4}$ point westerly.

Course.	Dist.	Diff. Lat.	Depart.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in	Bearing and Distance.
E. $\frac{3}{4}$ S.	216	S. 32	E. 214	N. 33° 49'	N. 33° 48'	E. 4° 18'	W. 33° 57'	Funch. S. 85° 16' E. distance 850 miles.

The course corrected for variation is E. $\frac{3}{4}$ S. distance 216 miles; hence the difference of latitude is 31. 7, and the departure 213. 7 miles.

Yesterday's latitude	34° 21'	N.
Difference of latitude	32	S.
Latitude in	33 49	N.
Sum of Latitudes	68 10	
Middle latitude	34 5	

With the middle latitude 34° 5' and the departure 213. 7 miles, I find the difference of longitude 258 miles =

	4° 18'	E.
Yesterday's longitude	38 15	W.
Longitude in	33 57	W.

To find the bearing and distance of Funchal.

Latitude in	33° 48' N.	Longitude in	33° 57' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 05 W.
Diff. of latitude	1 10=70 miles.	Diff. of longitude	16 52
Sum of latitudes	66 26		60
Middle latitude	33 13	In miles	1012

Hence the bearing of Funchal .85° 16' E. distance 850 miles.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Tuesday, April 7, 1801.
2	10		E. S. E.	N. N. W.		Fresh gales and pleasant weather, with a large sea.
4	10					
6	10					
8	8	4	E. S. E. ½ S.	North.		
10	8	6				
12	8	5				
2	8					
4	8	5				
6	8	4				
8	8	6				
10	8					
12	8					Variation per azimuth 1 ½ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in	Bearing and Distance.
		S.	E.	N.		E.	W.	
S. 80° 20' E.	210	35	207	33° 13'		4° 8'	29° 49'	Fun. S. 86° 53' E. distance 642 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. ½ S.	60		5. 9	59. 7	
E. by S.	150		29. 3	147. 1	
			35. 2	206. 8	

By the adjoined traverse table, the difference of latitude is 35. 2, and the departure 206. 8, hence the course S. 80° 20' E. and the distance 209. 8, or 210 miles.

Yesterday's latitude	33° 48' N.
Difference of latitude	35' S.
Latitude in by account	33 13' N.
Sum of latitudes	67 01
Middle latitude	33 30

With the middle latitude 33° 30' and the departure 206. 8, I find the difference of longitude 248 miles, or 4° 8' E.

Yesterday's longitude	33 57 W.
Longitude in	29 49 W.

To find the bearing and distance of Funchal.

Latitude in	33° 13' N.	Longitude in	29° 49' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 5 W.
Diff. of latitude	35	Diff. of longitude	12 44
Sum of latitudes	65 51		60
Middle latitude	32 55	In miles	764

Hence the bearing of Funchal is S. 86° 53' E. distance 642 miles.

H	K	F	Courses.	Winds.	Lee-way.	REMARKS on board, Wednesday, April 8, 1801.
2	8		E. by S. ½ S.	N. N. E.		First part fresh gales and clear. Latter part rainy weather.
4	8	5				
6	8	5				
8	8		S. E.	E. N. E.	½	
10	8					
12	8					
2	8					
4	8					At 6 A. M. the wind hauled suddenly to the S. S. E.
6	7	5	East.	S. S. E.	¼	
8	7	5				
10	7	5				
12	7	5				Variation 1 ½ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in	Bearing & Dist.
		S.	E.	N.		E.	W.	Fun. S. 88° 03' E.
S. 83° 45' E.	172	19	171	32° 54		3° 24'	26° 25'	Distance 471 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
East.	50			50. 0	
S. E. by E.	80		44. 4	66. 5	
E. N. E. ¼ N.	60	25. 7		54. 2	
		25. 7	44. 4	170. 7	Dep.
			25. 7		
		Diff. Lat.	18. 7		

The leeway and variation being allowed on the courses, they will stand as in the adjoined traverse table; then with the difference of latitude 18. 7, and the departure 170. 7, the course is found S. 83° 45' E. and the distance 172 miles.

Yesterday's latitude	33° 13' N.
Difference of latitude	19 S.
Latitude in	32 54 N.
Sum of latitudes	66 07
Middle latitude	33 03

With the middle latitude 33° 03', and the departure 170. 7, I find the difference of longitude is nearly 204 miles = 3 24 E.

Yesterday's longitude	29 49 W.
Longitude in	26 25 W.

To find the bearing and distance of Funchal.

Latitude in	32° 54' N.	Longitude in	26° 25' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 05 W.
Diff. of latitude	16	Diff. of longitude	9 20
Sum of latitudes	65 32		60
Middle latitude	32 46	In miles	560

Hence the bearing of Funchal is S. 88° 3' E. distance 471 miles.

H	K	F	Courſes.	Winds.	Lee-way.	REMARKS on board, Thurſday, April 9, 1801.
2	7	5	E. by S. ¾ S.	South.		Fine breezes, with variable weather.
4	8					
6	8	5				
8	9					
10	9					
12	9					
2	9					
4	9		E. by S.			
6	9					
8	9					
10	9					
12	9					Variation 1 ½ point weſterly.

Mer. alt. ſun's lower limb	63° 24'
Correction for dip, &c.	0 12
Sun's correct altitude	64 36
Subtract from	90 00
Sun's zenith diſtance	25 24 N.
Sun's declination	7 32 N.
Obſerved latitude	32 56 N.

Courſe.	Diſt.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in	Bearing & diſtance.
		N.	E.	N.	N.	E.	W.	Funch. S. 86° 3' E.
N. 89° 12'E.	210	3	209	32° 57'	32° 56'	4° 10'	22° 15'	diſtance 261 miles.

TRAVERSE TABLE.					
Courſes.	Diſt.	N.	S.	E.	W.
E. ¼ S.	120		5. 9	119. 9	
E. ½ N.	90	8. 8		89. 6	
		8. 8	5. 9	209. 5	Dep.
	Diff.	5. 9			
	Lat.	2. 9			

The variation being allowed on the courſes, they will ſtand as in the adjoined table; then with the difference of latitude 2. 9, and the departure 209. 5, the courſe is N. 87° 12'E. and the diſtance 210 miles nearly.

Yeſterday's latitude	32° 54' N.
Difference of latitude	3 N.
Latitude by account	32° 57 N.

Which differs only one mile from the latitude by obſervation; therefore this day's work needs no correction.

With the middle latitude 32° 55', and the departure 209. 5. the difference of longitude is found = 250 miles

	4° 10' E.
Yeſterday's longitude	26° 25 W.
Longitude in	22° 15 W.

To find the bearing and diſtance of Funchal.

Latitude in	32° 56' N.	Longitude in	22° 15' W.
Funchal's latitude	32 38 N.	Funchal's longitude	17 5 W.
Diff. of latitude	18	Diff. of longitude	5 10
Sum of latitudes	65 34		60
Middle latitude	32 47		
		In miles	310

Hence the bearing of Funchal is S. 86° 3' E. diſtance 261 miles.

H	K	F	Courſes.	Winds.	Lee-way.	REMARKS on board, Friday, April 10, 1801.
2	9	5	S. E. by E.	S. S. W.		All this day fine breeze, with very clear weather.
4	9	5				
6	9	5				
8	9					
10	9					
12	9					
2	9		E by S. ½ S.			At 10 A. M. made the land. The weſtern part of Madeira bearing per compaſs E. by S. ¾ S. diſtant 15 leagues.
4	9					
6	9					
8	9					
10	9					
12						Variation 1 ¾ point weſterly.

Courſe.	Diſt.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Dif. Long.	Long. in	Bearing & diſt.
S. 83° 39′ E.	244	S. 27	E. 243	N. 32° 29′		E. 4° 48′	W. 17° 27′	

TRAVERSE TABLE.

Courſes.	Diſt.	N.	S.	E.	W.
E. by S. ¼ S.	111		27. 0	107. 7	
Eaſt.	90			90. 0	
Eaſt.	45			45. 0	
			27. 0	242. 7	

In the traverſe table is placed the bearing and diſtance of the land at 10, A. M. (after allowing the variation.) Hence the whole difference of latitude is 27 miles, the departure 242. 7, the courſe S. 83° 39′ E. diſtance 244 miles.

Yeſterday's latitude	32° 56′ N.
Difference of latitude	27 S.
Latitude by account	32 29 N.
Sum of latitudes	65 25
Middle latitude	32 42

With the middle latitude 32° 42′, and the departure 242. 7, the difference of longitude is found to be 288 miles = 4° 48′ E.

Yeſterday's longitude	22 15 W.
	17 27 W.

Therefore the latitude of the weſtern point of Madeira by my account is 32° 29′ N. and its longitude 17° 27′ W. theſe values differing only one mile from the values given in the table of latitudes and longitudes; I therefore conclude that my journal was nearly exact; and that the latitude and longitude of that part of Madeira were well laid down.

H	K	F	Courſes.	Winds.	Lee-way.	REMARKS on board, Saturday, April 11, 1801.
2						Pleaſant gales and fair weather.
4						
6						At 6 P. M. came too, off Funchal.
8						
10						
12						At 8 P. M went aſhore.
2						
4						
6						
8						
10						
12						

Courſes.	Diſt.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Dif. Long.	Long. in	Bearing & diſt.

AN ABSTRACT OF THE FOREGOING JOURNAL.

Days.	Months. 1801.	Courses.	Dist.	Lat. by D.R.	Lat. Obs.	Long. in.	Bearings and Distances of Funchal at Noon.
Wednesday,	March 25	N. 87° 11′ E.	102	42° 10′N.		67° 57′W	S. 76° 41′ E. distant 2485 miles.
Thursday,	March 26	S. 80° 15′ E.	162	41 43	41° 43′N.	64 22	S. 76 24 E. distant 2319 miles.
Friday,	March 27	S. 73° 0′ E.	195	40 56	40 46	60 14	S. 76 45 E. distant 2129 miles.
Saturday,	March 28	S. 42° 29′ E.	138	39 04	39 01	58 12	S. 79 04 E. distant 2037 miles.
Sunday,	March 29	South.	76	37 38	37 48	58 12	S. 81 15 E. distant 2038 miles.
Monday,	March 30	N. 76° 17′ E.	31	37 55		57 34	S. 80 55 E. distant 2008 miles.
Tuesday,	March 31	East.	151	37 55		54 23	S. 80 9 E. distant 1855 miles.
Wednesday,	April 1	S. 85° 24′ E.	202	37 39	37 30	50 8	S. 79 48 E. distant 1649 miles.
Thursday,	April 2	S. 79° 56′ E.	202	36 55		45 59	S. 79 46 E. distant 1447 miles.
Friday,	April 3	S. 79° 22′ E.	217	36 15	36 17	41 34	S. 79 45 E. distant 1231 miles.
Saturday,	April 4	S. 31° 57′ E.	120	34 55	34 35	40 16	S. 84 14 E. distant 1164 miles.
Sunday,	April 5	S. 83° 36′ E.	101	34 24	34 21	38 15	S. 84 27 E. distant 1064 miles.
Monday,	April 6	E. ¼ S.	216	33 49	33 48	33 57	S. 85 16 E. distant 850 miles.
Tuesday,	April 7	S. 80° 20′ E.	210	33 13		29 49	S. 86 53 E. distant 642 miles.
Wednesday,	April 8	S. 83° 45′ E.	172	32 54		26 25	S. 88 3 E. distant 471 miles.
Thursday,	April 9	N. 89° 12′ E.	210	32 57	32 56	22 15	S. 86 3 E. distant 261 miles.
Friday,	April 10	S. 83° 39′ E.	244	32 29		17 27	Made the land, bearing E. by S. ¾ S. dist. 15 leag.
Saturday,	April 11	Came to anchor at 4 P. M. in Funchal road.					

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	60.9	03.0	121	120.9	05.9	181	180.8	08.9	241	240.7	11.8
2	02.0	00.1	62	61.9	03.0	22	121.9	06.0	82	181.8	08.9	42	241.7	11.9
3	03.0	00.1	63	62.9	03.1	23	122.9	06.0	83	182.8	09.0	43	242.7	11.9
4	04.0	00.2	64	63.9	03.1	24	123.9	06.1	84	183.8	09.0	44	243.7	12.0
5	05.0	00.2	65	64.9	03.2	25	124.8	06.1	85	184.8	09.1	45	244.7	12.0
6	06.0	00.3	66	65.9	03.2	26	125.8	06.2	86	185.8	09.1	46	245.7	12.1
7	07.0	00.3	67	66.9	03.3	27	126.8	06.2	87	186.8	09.2	47	246.7	12.1
8	08.0	00.4	68	67.9	03.3	28	127.8	06.3	88	187.8	09.2	48	247.7	12.2
9	09.0	00.4	69	68.9	03.4	29	128.8	06.3	89	188.8	09.3	49	248.7	12.2
10	10.0	00.5	70	69.9	03.4	30	129.8	06.4	90	189.8	09.3	50	249.7	12.3
11	11.0	00.5	71	70.9	03.5	131	130.8	06.4	191	190.8	09.4	251	250.7	12.3
12	12.0	00.6	72	71.9	03.5	32	131.8	06.5	92	191.8	09.4	52	251.7	12.4
13	13.0	00.6	73	72.9	03.6	33	132.8	06.5	93	192.8	09.5	53	252.7	12.4
14	14.0	00.7	74	73.9	03.6	34	133.8	06.6	94	193.8	09.5	54	253.7	12.5
15	15.0	00.7	75	74.9	03.7	35	134.8	06.6	95	194.8	09.6	55	254.7	12.5
16	16.0	00.8	76	75.9	03.7	36	135.8	06.7	96	195.8	09.6	56	255.7	12.6
17	17.0	00.8	77	76.9	03.8	37	136.8	06.7	97	196.8	09.7	57	256.7	12.6
18	18.0	00.9	78	77.9	03.8	38	137.8	06.8	98	197.8	09.7	58	257.7	12.7
19	19.0	00.9	79	78.9	03.9	39	138.8	06.8	99	198.8	09.8	59	258.7	12.7
20	20.0	01.0	80	79.9	03.9	40	139.8	06.9	200	199.8	09.8	60	259.7	12.8
21	21.0	01.0	81	80.9	04.0	141	140.8	06.9	201	200.8	09.9	261	260.7	12.8
22	22.0	01.1	82	81.9	04.0	42	141.8	07.0	02	201.8	09.9	62	261.7	12.9
23	23.0	01.1	83	82.9	04.1	43	142.8	07.0	03	202.8	10.0	63	262.7	12.9
24	24.0	01.2	84	83.9	04.1	44	143.8	07.1	04	203.8	10.0	64	263.7	13.0
25	25.0	01.2	85	84.9	04.2	45	144.8	07.1	05	204.8	10.1	65	264.7	13.0
26	26.0	01.3	86	85.9	04.2	46	145.8	07.2	06	205.8	10.1	66	265.7	13.1
27	27.0	01.3	87	86.9	04.3	47	146.8	07.2	07	206.8	10.2	67	266.7	13.1
28	28.0	01.4	88	87.9	04.3	48	147.8	07.3	08	207.7	10.2	68	267.7	13.2
29	29.0	01.4	89	88.9	04.4	49	148.8	07.3	09	208.7	10.3	69	268.7	13.2
30	30.0	01.5	90	89.9	04.4	50	149.8	07.4	10	209.7	10.3	70	269.7	13.2
31	31.0	01.5	91	90.9	04.5	151	150.8	07.4	211	210.7	10.4	271	270.7	13.3
32	32.0	01.6	92	91.9	04.5	52	151.8	07.5	12	211.7	10.4	72	271.7	13.3
33	33.0	01.6	93	92.9	04.6	53	152.8	07.5	13	212.7	10.5	73	272.7	13.4
34	34.0	01.7	94	93.9	04.6	54	153.8	07.6	14	213.7	10.5	74	273.7	13.4
35	35.0	01.7	95	94.9	04.7	55	154.8	07.6	15	214.7	10.5	75	274.7	13.5
36	36.0	01.8	96	95.9	04.7	56	155.8	07.7	16	215.7	10.6	76	275.7	13.5
37	37.0	01.8	97	96.9	04.8	57	156.8	07.7	17	216.7	10.6	77	276.7	13.6
38	38.0	01.9	98	97.9	04.8	58	157.8	07.8	18	217.7	10.7	78	277.7	13.6
39	39.0	01.9	99	98.9	04.9	59	158.8	07.8	19	218.7	10.7	79	278.7	13.7
40	40.0	02.0	100	99.9	04.9	60	159.8	07.9	20	219.7	10.8	80	279.7	13.7
41	41.0	02.0	101	100.9	05.0	161	160.8	07.9	221	220.7	10.8	281	280.7	13.8
42	41.9	02.1	02	101.9	05.0	62	161.8	07.9	22	221.7	10.9	82	281.7	13.8
43	42.9	02.1	03	102.9	05.1	63	162.8	08.0	23	222.7	10.9	83	282.7	13.9
44	43.9	02.2	04	103.9	05.1	64	163.8	08.0	24	223.7	11.0	84	283.7	13.9
45	44.9	02.2	05	104.9	05.2	65	164.8	08.1	25	224.7	11.0	85	284.7	14.0
46	45.9	02.3	06	105.9	05.2	66	165.8	08.1	26	225.7	11.1	86	285.7	14.0
47	46.9	02.3	07	106.9	05.3	67	166.8	08.2	27	226.7	11.1	87	286.7	14.1
48	47.9	02.4	08	107.9	05.3	68	167.8	08.2	28	227.7	11.2	88	287.7	14.1
49	48.9	02.4	09	108.9	05.3	69	168.8	08.3	29	228.7	11.2	89	288.7	14.2
50	49.9	02.5	10	109.9	05.4	70	169.8	08.3	30	229.7	11.3	90	289.7	14.2
51	50.9	02.5	111	110.9	05.4	171	170.8	08.4	231	230.7	11.3	291	290.6	14.3
52	51.9	02.6	12	111.9	05.5	72	171.8	08.4	32	231.7	11.4	92	291.6	14.3
53	52.9	02.6	13	112.9	05.5	73	172.8	08.5	33	232.7	11.4	93	292.6	14.4
54	53.9	02.6	14	113.9	05.6	74	173.8	08.5	34	233.7	11.5	94	293.6	14.4
55	54.9	02.7	15	114.9	05.6	75	174.8	08.6	35	234.7	11.5	95	294.6	14.5
56	55.9	02.7	16	115.9	05.7	76	175.8	08.6	36	235.7	11.6	96	295.6	14.5
57	56.9	02.8	17	116.9	05.7	77	176.8	08.7	37	236.7	11.6	97	296.6	14.6
58	57.9	02.8	18	117.9	05.8	78	177.8	08.7	38	237.7	11.7	98	297.6	14.6
59	58.9	02.9	19	118.9	05.8	79	178.8	08.8	39	238.7	11.7	99	298.6	14.7
60	59.9	02.9	20	119.9	05.9	80	179.8	08.8	40	239.7	11.8	300	299.6	14.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 7¾ Points.

Table I. Difference of Latitude and Departure for ½ Point.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.0	121	120.4	11.9	181	180.1	17.7	241	239.8	23.6
2	02.0	00.2	62	61.7	06.1	22	121.4	12.0	82	181.1	17.8	42	240.8	23.7
3	03.0	00.3	63	62.7	06.2	23	122.4	12.1	83	182.1	17.9	43	241.8	23.8
4	04.0	00.4	64	63.7	06.3	24	123.4	12.2	84	183.1	18.0	44	242.8	23.9
5	05.0	00.5	65	64.7	06.4	25	124.4	12.3	85	184.1	18.1	45	243.8	24.0
6	06.0	00.6	66	65.7	06.5	26	125.4	12.4	86	185.1	18.2	46	244.8	24.1
7	07.0	00.7	67	66.7	06.6	27	126.4	12.4	87	186.1	18.3	47	245.8	24.2
8	08.0	00.8	68	67.7	06.7	28	127.4	12.5	88	187.1	18.4	48	246.8	24.3
9	09.0	00.9	69	68.7	06.8	29	128.4	12.6	89	188.1	18.5	49	247.8	24.4
10	10.0	01.0	70	69.7	06.9	30	129.4	12.7	90	189.1	18.6	50	248.8	24.5
11	10.9	01.1	71	70.7	07.0	131	130.4	12.8	191	190.1	18.7	251	249.8	24.6
12	11.9	01.2	72	71.7	07.1	32	131.4	12.9	92	191.1	18.8	52	250.8	24.7
13	12.9	01.3	73	72.6	07.2	33	132.4	13.0	93	192.1	18.9	53	251.8	24.8
14	13.9	01.4	74	73.6	07.3	34	133.4	13.1	94	193.1	19.0	54	252.8	24.9
15	14.9	01.5	75	74.6	07.4	35	134.3	13.2	95	194.1	19.1	55	253.8	25.0
16	15.9	01.6	76	75.6	07.4	36	135.3	13.3	96	195.1	19.2	56	254.8	25.1
17	16.9	01.7	77	76.6	07.5	37	136.3	13.4	97	196.1	19.3	57	255.8	25.2
18	17.9	01.8	78	77.6	07.6	38	137.3	13.5	98	197.0	19.4	58	256.8	25.3
19	18.9	01.9	79	78.6	07.7	39	138.3	13.6	99	198.0	19.5	59	257.8	25.4
20	19.9	02.0	80	79.6	07.8	40	139.3	13.7	200	199.0	19.6	60	258.7	25.5
21	20.9	02.1	81	80.6	07.9	141	140.3	13.8	201	200.0	19.7	261	259.7	25.6
22	21.9	02.2	82	81.6	08.0	42	141.3	13.9	02	201.0	19.8	62	260.7	25.7
23	22.9	02.3	83	82.6	08.1	43	142.3	14.0	03	202.0	19.9	63	261.7	25.8
24	23.9	02.4	84	83.6	08.2	44	143.3	14.1	04	203.0	20.0	64	262.7	25.9
25	24.9	02.5	85	84.6	08.3	45	144.3	14.2	05	204.0	20.1	65	263.7	26.0
26	25.9	02.5	86	85.6	08.4	46	145.3	14.3	06	205.0	20.2	66	264.7	26.1
27	26.9	02.6	87	86.6	08.5	47	146.3	14.4	07	206.0	20.3	67	265.7	26.2
28	27.9	02.7	88	87.6	08.6	48	147.3	14.5	08	207.0	20.4	68	266.7	26.3
29	28.9	02.8	89	88.6	08.7	49	148.3	14.6	09	208.0	20.5	69	267.7	26.4
30	29.9	02.9	90	89.6	08.8	50	149.3	14.7	10	209.0	20.6	70	268.7	26.5
31	30.9	03.0	91	90.6	08.9	151	150.3	14.8	211	210.0	20.7	271	269.7	26.6
32	31.8	03.1	92	91.6	09.0	52	151.3	14.9	12	211.0	20.8	72	270.7	26.7
33	32.8	03.2	93	92.6	09.1	53	152.3	15.0	13	212.0	20.9	73	271.7	26.8
34	33.8	03.3	94	93.5	09.2	54	153.3	15.1	14	213.0	21.0	74	272.7	26.9
35	34.8	03.4	95	94.5	09.3	55	154.3	15.2	15	214.0	21.1	75	273.7	27.0
36	35.8	03.5	96	95.5	09.4	56	155.2	15.3	16	215.0	21.2	76	274.7	27.1
37	36.8	03.6	97	96.5	09.5	57	156.2	15.4	17	216.0	21.3	77	275.7	27.2
38	37.8	03.7	98	97.5	09.6	58	157.2	15.5	18	217.0	21.4	78	276.7	27.2
39	38.8	03.8	99	98.5	09.7	59	158.2	15.6	19	217.9	21.5	79	277.7	27.3
40	39.8	03.9	100	99.5	09.8	60	159.2	15.7	20	218.9	21.6	80	278.7	27.4
41	40.8	04.0	101	100.5	09.9	161	160.2	15.8	221	219.9	21.7	281	279.6	27.5
42	41.8	04.1	02	101.5	10.0	62	161.2	15.9	22	220.9	21.8	82	280.6	27.6
43	42.8	04.2	03	102.5	10.1	63	162.2	16.0	23	221.9	21.9	83	281.6	27.7
44	43.8	04.3	04	103.5	10.2	64	163.2	16.1	24	222.9	22.0	84	282.6	27.8
45	44.8	04.4	05	104.5	10.3	65	164.2	16.2	25	223.9	22.1	85	283.6	27.9
46	45.8	04.5	06	105.5	10.4	66	165.2	16.3	26	224.9	22.2	86	284.6	28.0
47	46.8	04.6	07	106.5	10.5	67	166.2	16.4	27	225.9	22.2	87	285.6	28.1
48	47.8	04.7	08	107.5	10.6	68	167.2	16.5	28	226.9	22.3	88	286.6	28.2
49	48.8	04.8	09	108.5	10.7	69	168.2	16.6	29	227.9	22.4	89	287.6	28.3
50	49.8	04.9	10	109.5	10.8	70	169.2	16.7	30	228.9	22.5	90	288.6	28.4
51	50.8	05.0	111	110.5	10.9	171	170.2	16.8	231	229.9	22.6	291	289.6	28.5
52	51.7	05.1	12	111.5	11.0	72	171.2	16.9	32	230.9	22.7	92	290.6	28.6
53	52.7	05.2	13	112.5	11.1	73	172.2	17.0	33	231.9	22.8	93	291.6	28.7
54	53.7	05.3	14	113.5	11.2	74	173.2	17.1	34	232.9	22.9	94	292.6	28.8
55	54.7	05.4	15	114.4	11.3	75	174.2	17.2	35	233.9	23.0	95	293.6	28.9
56	55.7	05.5	16	115.4	11.4	76	175.2	17.3	36	234.9	23.1	96	294.6	29.0
57	56.7	05.6	17	116.4	11.5	77	176.1	17.3	37	235.9	23.2	97	295.6	29.1
58	57.7	05.7	18	117.4	11.6	78	177.1	17.4	38	236.9	23.3	98	296.6	29.2
59	58.7	05.8	19	118.4	11.7	79	178.1	17.5	39	237.8	23.4	99	297.6	29.3
60	59.7	05.9	20	119.4	11.8	80	179.1	17.6	40	238.8	23.5	300	298.6	29.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 7½ Points.

TABLE I. Difference of Latitude and Departure for ¾ Point.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.3	09.0	121	119.7	17.8	181	179.0	26.6	241	238.4	35.4
2	02.0	00.3	62	61.3	09.1	22	120.7	17.9	82	180.0	26.7	42	239.4	35.5
3	03.0	00.4	63	62.3	09.2	23	121.7	18.0	83	181.0	26.9	43	240.4	35.7
4	04.0	00.6	64	63.3	09.4	24	122.7	18.2	84	182.0	27.0	44	241.4	35.8
5	04.9	00.7	65	64.3	09.5	25	123.6	18.3	85	183.0	27.1	45	242.3	35.9
6	05.9	00.9	66	65.3	09.7	26	124.6	18.5	86	184.0	27.3	46	243.3	36.1
7	06.9	01.0	67	66.3	09.8	27	125.6	18.6	87	185.0	27.4	47	244.3	36.2
8	07.9	01.2	68	67.3	10.0	28	126.6	18.8	88	186.0	27.6	48	245.3	36.4
9	08.9	01.3	69	68.3	10.1	29	127.6	18.9	89	187.0	27.7	49	246.3	36.5
10	09.9	01.5	70	69.2	10.3	30	128.6	19.1	90	187.9	27.9	50	247.3	36.7
11	10.9	01.6	71	70.2	10.4	131	129.6	19.2	191	188.9	28.0	251	248.3	36.8
12	11.9	01.8	72	71.2	10.6	32	130.6	19.4	92	189.9	28.2	52	249.3	37.0
13	12.9	01.9	73	72.2	10.7	33	131.6	19.5	93	190.9	28.3	53	250.3	37.1
14	13.8	02.1	74	73.2	10.9	34	132.5	19.7	94	191.9	28.5	54	251.3	37.3
15	14.8	02.2	75	74.2	11.0	35	133.5	19.8	95	192.9	28.6	55	252.2	37.4
16	15.8	02.3	76	75.2	11.2	36	134.5	20.0	96	193.9	28.8	56	253.2	37.6
17	16.8	02.5	77	76.2	11.3	37	135.5	20.1	97	194.9	28.9	57	254.2	37.7
18	17.8	02.6	78	77.2	11.4	38	136.5	20.2	98	195.9	29.1	58	255.2	37.9
19	18.8	02.8	79	78.1	11.6	39	137.5	20.4	99	196.8	29.2	59	256.2	38.0
20	19.8	02.9	80	79.1	11.7	40	138.5	20.5	200	197.8	29.3	60	257.2	38.1
21	20.8	03.1	81	80.1	11.9	141	139.5	20.7	201	198.8	29.5	261	258.2	38.3
22	21.8	03.2	82	81.1	12.0	42	140.5	20.8	02	199.8	29.6	62	259.2	38.4
23	22.8	03.4	83	82.1	12.2	43	141.5	21.0	03	200.8	29.8	63	260.2	38.6
24	23.7	03.5	84	83.1	12.3	44	142.4	21.1	04	201.8	29.9	64	261.1	38.7
25	24.7	03.7	85	84.1	12.5	45	143.4	21.3	05	202.8	30.1	65	262.1	38.9
26	25.7	03.8	86	85.1	12.6	46	144.4	21.4	06	203.8	30.2	66	263.1	39.0
27	26.7	04.0	87	86.1	12.8	47	145.4	21.6	07	204.8	30.4	67	264.1	39.2
28	27.7	04.1	88	87.0	12.9	48	146.4	21.7	08	205.7	30.5	68	265.1	39.3
29	28.7	04.3	89	88.0	13.1	49	147.4	21.9	09	206.7	30.7	69	266.1	39.5
30	29.7	04.4	90	89.0	13.2	50	148.4	22.0	10	207.7	30.8	70	267.1	39.6
31	30.7	04.5	91	90.0	13.4	151	149.4	22.2	211	208.7	31.0	271	268.1	39.8
32	31.7	04.7	92	91.0	13.5	52	150.4	22.3	12	209.7	31.1	72	269.1	39.9
33	32.6	04.8	93	92.0	13.6	53	151.3	22.4	13	210.7	31.3	73	270.0	40.1
34	33.6	05.0	94	93.0	13.8	54	152.3	22.6	14	211.7	31.4	74	271.0	40.2
35	34.6	05.1	95	94.0	13.9	55	153.3	22.7	15	212.7	31.5	75	272.0	40.4
36	35.6	05.3	96	95.0	14.1	56	154.3	22.9	16	213.7	31.7	76	273.0	40.5
37	36.6	05.4	97	96.0	14.2	57	155.3	23.0	17	214.7	31.8	77	274.0	40.6
38	37.6	05.6	98	96.9	14.4	58	156.3	23.2	18	215.6	32.0	78	275.0	40.8
39	38.6	05.7	99	97.9	14.5	59	157.3	23.3	19	216.6	32.1	79	276.0	40.9
40	39.6	05.9	100	98.9	14.7	60	158.3	23.5	20	217.6	32.3	80	277.0	41.1
41	40.6	06.0	101	99.9	14.8	161	159.3	23.6	221	218.6	32.4	281	278.0	41.2
42	41.5	06.2	02	100.9	15.0	62	160.2	23.8	22	219.6	32.6	82	278.9	41.4
43	42.5	06.3	03	101.9	15.1	63	161.2	23.9	23	220.6	32.7	83	279.9	41.5
44	43.5	06.5	04	102.9	15.3	64	162.2	24.1	24	221.6	32.9	84	280.9	41.7
45	44.5	06.6	05	103.9	15.4	65	163.2	24.2	25	222.6	33.0	85	281.9	41.8
46	45.5	06.7	06	104.9	15.6	66	164.2	24.4	26	223.6	33.2	86	282.9	42.0
47	46.5	06.9	07	105.8	15.7	67	165.2	24.5	27	224.5	33.3	87	283.9	42.1
48	47.5	07.0	08	106.8	15.8	68	166.2	24.7	28	225.5	33.5	88	284.9	42.3
49	48.5	07.2	09	107.8	16.0	69	167.2	24.8	29	226.5	33.6	89	285.9	42.4
50	49.5	07.3	10	108.8	16.1	70	168.2	24.9	30	227.5	33.7	90	286.9	42.6
51	50.4	07.5	111	109.8	16.3	171	169.1	25.1	231	228.5	33.9	291	287.9	42.7
52	51.4	07.6	12	110.8	16.4	72	170.1	25.2	32	229.5	34.0	92	288.8	42.8
53	52.4	07.8	13	111.8	16.6	73	171.1	25.4	33	230.5	34.2	93	289.8	43.0
54	53.4	07.9	14	112.8	16.7	74	172.1	25.5	34	231.5	34.3	94	290.8	43.1
55	54.4	08.1	15	113.8	16.9	75	173.1	25.7	35	232.5	34.5	95	291.8	43.3
56	55.4	08.2	16	114.7	17.0	76	174.1	25.8	36	233.4	34.6	96	292.8	43.4
57	56.4	08.4	17	115.7	17.2	77	175.1	26.0	37	234.4	34.8	97	293.8	43.6
58	57.4	08.5	18	116.7	17.3	78	176.1	26.1	38	235.4	34.9	98	294.8	43.7
59	58.4	08.7	19	117.7	17.5	79	177.1	26.3	39	236.4	35.1	99	295.8	43.9
60	59.4	08.8	20	118.7	17.6	80	178.1	26.4	40	237.4	35.2	300	296.8	44.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 7¼ Points.

Table I. Difference of Latitude and Departure for 1 Point.

Dist.	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.2	61	59.8	11.9	121	118.7	23.6	181	177.5	35.3	241	236.4	47.0
2	02.0	00.4	62	60.8	12.1	22	119.7	23.8	82	178.5	35.5	42	237.4	47.2
3	02.9	00.6	63	61.8	12.3	23	120.6	24.0	83	179.5	35.7	43	238.3	47.4
4	03.9	00.8	64	62.8	12.5	24	121.6	24.2	84	180.5	35.9	44	239.3	47.6
5	04.9	01.0	65	63.8	12.7	25	122.6	24.4	85	181.4	36.1	45	240.3	47.8
6	05.9	01.2	66	64.7	12.9	26	123.6	24.6	86	182.4	36.3	46	241.3	48.0
7	06.9	01.4	67	65.7	13.1	27	124.6	24.8	87	183.4	36.5	47	242.3	48.2
8	07.8	01.6	68	66.7	13.3	28	125.5	25.0	88	184.4	36.7	48	243.3	48.4
9	08.8	01.8	69	67.7	13.5	29	126.5	25.2	89	185.4	36.9	49	244.2	48.6
10	09.8	02.0	70	68.7	13.7	30	127.5	25.4	90	186.3	37.1	50	245.2	48.8
11	10.8	02.1	71	69.6	13.9	131	128.5	25.6	191	187.3	37.3	251	246.2	49.0
12	11.8	02.3	72	70.6	14.0	32	129.5	25.8	92	188.3	37.5	52	247.2	49.2
13	12.8	02.5	73	71.6	14.2	33	130.4	25.9	93	189.3	37.7	53	248.1	49.4
14	13.7	02.7	74	72.6	14.4	34	131.4	26.1	94	190.3	37.8	54	249.1	49.6
15	14.7	02.9	75	73.6	14.6	35	132.4	26.3	95	191.3	38.0	55	250.1	49.7
16	15.7	03.1	76	74.5	14.8	36	133.4	26.5	96	192.2	38.2	56	251.1	49.9
17	16.7	03.3	77	75.5	15.0	37	134.4	26.7	97	193.2	38.4	57	252.1	50.1
18	17.7	03.5	78	76.5	15.2	38	135.3	26.9	98	194.2	38.6	58	253.0	50.3
19	18.6	03.7	79	77.5	15.4	39	136.3	27.1	99	195.2	38.8	59	254.0	50.5
20	19.6	03.9	80	78.5	15.6	40	137.3	27.3	200	196.2	39.0	60	255.0	50.7
21	20.6	04.1	81	79.4	15.8	141	138.3	27.5	201	197.1	39.2	261	256.0	50.9
22	21.6	04.3	82	80.4	16.0	42	139.3	27.7	02	198.1	39.4	62	257.0	51.1
23	22.6	04.5	83	81.4	16.2	43	140.3	27.9	03	199.1	39.6	63	257.9	51.3
24	23.5	04.7	84	82.4	16.4	44	141.2	28.1	04	200.1	39.8	64	258.9	51.5
25	24.5	04.9	85	83.4	16.6	45	142.2	28.3	05	201.1	40.0	65	259.9	51.7
26	25.5	05.1	86	84.3	16.8	46	143.2	28.5	06	202.0	40.2	66	260.9	51.9
27	26.5	05.3	87	85.3	17.0	47	144.2	28.7	07	203.0	40.4	67	261.9	52.1
28	27.5	05.5	88	86.3	17.2	48	145.2	28.9	08	204.0	40.6	68	262.9	52.3
29	28.4	05.7	89	87.3	17.4	49	146.1	29.1	09	205.0	40.8	69	263.8	52.5
30	29.4	05.9	90	88.3	17.6	50	147.1	29.3	10	206.0	41.0	70	264.8	52.7
31	30.4	06.0	91	89.3	17.8	151	148.1	29.5	211	206.9	41.2	271	265.8	52.9
32	31.4	06.2	92	90.2	17.9	52	149.1	29.7	12	207.9	41.4	72	266.8	53.1
33	32.4	06.4	93	91.2	18.1	53	150.1	29.8	13	208.9	41.6	73	267.8	53.3
34	33.3	06.6	94	92.2	18.3	54	151.0	30.0	14	209.9	41.7	74	268.7	53.5
35	34.3	06.8	95	93.2	18.5	55	152.0	30.2	15	210.9	41.9	75	269.7	53.6
36	35.3	07.0	96	94.2	18.7	56	153.0	30.4	16	211.8	42.1	76	270.7	53.8
37	36.3	07.2	97	95.1	18.9	57	154.0	30.6	17	212.8	42.3	77	271.7	54.0
38	37.3	07.4	98	96.1	19.1	58	155.0	30.8	18	213.8	42.5	78	272.7	54.2
39	38.3	07.6	99	97.1	19.3	59	155.9	31.0	19	214.8	42.7	79	273.6	54.4
40	39.2	07.8	100	98.1	19.5	60	156.9	31.2	20	215.8	42.9	80	274.6	54.6
41	40.2	08.0	101	99.1	19.7	161	157.9	31.4	221	216.8	43.1	281	275.6	54.8
42	41.2	08.2	02	100.0	19.9	62	158.9	31.6	22	217.7	43.3	82	276.6	55.0
43	42.2	08.4	03	101.0	20.1	63	159.9	31.8	23	218.7	43.5	83	277.6	55.2
44	43.2	08.6	04	102.0	20.3	64	160.8	32.0	24	219.7	43.7	84	278.5	55.4
45	44.1	08.8	05	103.0	20.5	65	161.8	32.2	25	220.7	43.9	85	279.5	55.6
46	45.1	09.0	06	104.0	20.7	66	162.8	32.4	26	221.7	44.1	86	280.5	55.8
47	46.1	09.2	07	104.9	20.9	67	163.8	32.6	27	222.6	44.3	87	281.5	56.0
48	47.1	09.4	08	105.9	21.1	68	164.8	32.8	28	223.6	44.5	88	282.5	56.2
49	48.1	09.6	09	106.9	21.3	69	165.8	33.0	29	224.6	44.7	89	283.4	56.4
50	49.0	09.8	10	107.9	21.5	70	166.7	33.2	30	225.6	44.9	90	284.4	56.6
51	50.0	09.9	111	108.9	21.7	171	167.7	33.4	231	226.6	45.1	291	285.4	56.8
52	51.0	10.1	12	109.8	21.9	72	168.7	33.6	32	227.5	45.3	92	286.4	57.0
53	52.0	10.3	13	110.8	22.0	73	169.7	33.8	33	228.5	45.5	93	287.4	57.2
54	53.0	10.5	14	111.8	22.2	74	170.7	33.9	34	229.5	45.7	94	288.4	57.4
55	53.9	10.7	15	112.8	22.4	75	171.6	34.1	35	230.5	45.8	95	289.3	57.6
56	54.9	10.9	16	113.8	22.6	76	172.6	34.3	36	231.5	46.0	96	290.3	57.7
57	55.9	11.1	17	114.8	22.8	77	173.6	34.5	37	232.4	46.2	97	291.3	57.9
58	56.9	11.3	18	115.7	23.0	78	174.6	34.7	38	233.4	46.4	98	292.3	58.1
59	57.9	11.5	19	116.7	23.2	79	175.6	34.9	39	234.4	46.6	99	293.3	58.3
60	58.8	11.7	20	117.7	23.4	80	176.5	35.1	40	235.4	46.8	300	294.2	58.5
Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

[For 7 Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.2	14.8	121	117.4	29.4	181	175.6	44.0	241	233.8	58.6
2	01.9	00.5	62	60.1	15.1	22	118.3	29.6	82	176.5	44.2	42	234.7	58.8
3	02.9	00.7	63	61.1	15.3	23	119.3	29.9	83	177.5	44.5	43	235.7	59.0
4	03.9	01.0	64	62.1	15.6	24	120.3	30.1	84	178.5	44.7	44	236.7	59.3
5	04.9	01.2	65	63.1	15.8	25	121.3	30.4	85	179.5	45.0	45	237.7	59.5
6	05.8	01.5	66	64.0	16.0	26	122.2	30.6	86	180.4	45.2	46	238.6	59.8
7	06.8	01.7	67	65.0	16.3	27	123.2	30.9	87	181.4	45.4	47	239.6	60.0
8	07.8	01.9	68	66.0	16.5	28	124.2	31.1	88	182.4	45.7	48	240.6	60.3
9	08.7	02.2	69	66.9	16.8	29	125.1	31.3	89	183.3	45.9	49	241.5	60.5
10	09.7	02.4	70	67.9	17.0	30	126.1	31.6	90	184.3	46.2	50	242.5	60.7
11	10.7	02.7	71	68.9	17.3	131	127.1	31.8	191	185.3	46.4	251	243.5	61.0
12	11.6	02.9	72	69.8	17.5	32	128.0	32.1	92	186.2	46.7	52	244.4	61.2
13	12.6	03.2	73	70.8	17.7	33	129.0	32.3	93	187.2	46.9	53	245.4	61.5
14	13.6	03.4	74	71.8	18.0	34	130.0	32.6	94	188.2	47.1	54	246.4	61.7
15	14.6	03.6	75	72.8	18.2	35	131.0	32.8	95	189.2	47.4	55	247.4	62.0
16	15.5	03.9	76	73.7	18.5	36	131.9	33.0	96	190.1	47.6	56	248.3	62.2
17	16.5	04.1	77	74.7	18.7	37	132.9	33.3	97	191.1	47.9	57	249.3	62.4
18	17.5	04.4	78	75.7	19.0	38	133.9	33.5	98	192.1	48.1	58	250.3	62.7
19	18.4	04.6	79	76.6	19.2	39	134.8	33.8	99	193.0	48.4	59	251.2	62.9
20	19.4	04.9	80	77.6	19.4	40	135.8	34.0	200	194.0	48.6	60	252.2	63.2
21	20.4	05.1	81	78.6	19.7	141	136.8	34.3	201	195.0	48.8	261	253.2	63.4
22	21.3	05.3	82	79.5	19.9	42	137.7	34.5	02	195.9	49.1	62	254.1	63.7
23	22.3	05.6	83	80.5	20.2	43	138.7	34.7	03	196.9	49.3	63	255.1	63.9
24	23.3	05.8	84	81.5	20.4	44	139.7	35.0	04	197.9	49.6	64	256.1	64.1
25	24.3	06.1	85	82.5	20.7	45	140.7	35.2	05	198.9	49.8	65	257.1	64.4
26	25.2	06.3	86	83.4	20.9	46	141.6	35.5	06	199.8	50.1	66	258.0	64.6
27	26.2	06.6	87	84.4	21.1	47	142.6	35.7	07	200.8	50.3	67	259.0	64.9
28	27.2	06.8	88	85.4	21.4	48	143.6	36.0	08	201.8	50.5	68	260.0	65.1
29	28.1	07.0	89	86.3	21.6	49	144.5	36.2	09	202.7	50.8	69	260.9	65.4
30	29.1	07.3	90	87.3	21.9	50	145.5	36.4	10	203.7	51.0	70	261.9	65.6
31	30.1	07.5	91	88.3	22.1	151	146.5	36.7	211	204.7	51.3	271	262.9	65.8
32	31.0	07.8	92	89.2	22.4	52	147.4	36.9	12	205.6	51.5	72	263.8	66.1
33	32.0	08.0	93	90.2	22.6	53	148.4	37.2	13	206.6	51.8	73	264.8	66.3
34	33.0	08.3	94	91.2	22.8	54	149.4	37.4	14	207.6	52.0	74	265.8	66.6
35	34.0	08.5	95	92.2	23.1	55	150.4	37.7	15	208.6	52.2	75	266.8	66.8
36	34.9	08.7	96	93.1	23.3	56	151.3	37.9	16	209.5	52.5	76	267.7	67.1
37	35.9	09.0	97	94.1	23.6	57	152.3	38.1	17	210.5	52.7	77	268.7	67.3
38	36.9	09.2	98	95.1	23.8	58	153.3	38.4	18	211.5	53.0	78	269.7	67.5
39	37.8	09.5	99	96.0	24.1	59	154.2	38.6	19	212.4	53.2	79	270.6	67.8
40	38.8	09.7	100	97.0	24.3	60	155.2	38.9	20	213.4	53.5	80	271.6	68.0
41	39.8	10.0	101	98.0	24.5	161	156.2	39.1	221	214.4	53.7	281	272.6	68.3
42	40.7	10.2	02	98.9	24.8	62	157.1	39.4	22	215.3	53.9	82	273.5	68.5
43	41.7	10.4	03	99.9	25.0	63	158.1	39.6	23	216.3	54.2	83	274.5	68.8
44	42.7	10.7	04	100.9	25.3	64	159.1	39.8	24	217.3	54.4	84	275.5	69.0
45	43.7	10.9	05	101.9	25.5	65	160.1	40.1	25	218.3	54.7	85	276.5	69.2
46	44.6	11.2	06	102.8	25.8	66	161.0	40.3	26	219.2	54.9	86	277.4	69.5
47	45.6	11.4	07	103.8	26.0	67	162.0	40.6	27	220.2	55.2	87	278.4	69.7
48	46.6	11.7	08	104.8	26.2	68	163.0	40.8	28	221.2	55.4	88	279.4	70.0
49	47.5	11.9	09	105.7	26.5	69	163.9	41.1	29	222.	55.6	89	280.3	70.2
50	48.5	12.1	10	106.7	26.7	70	164.9	41.3	30	223.1	55.9	90	281.3	70.5
51	49.5	12.4	111	107.7	27.0	171	165.9	41.5	231	224.1	56.1	291	282.3	70.7
52	50.4	12.6	12	108.6	27.2	72	166.8	41.8	32	225.0	56.4	92	283.2	71.0
53	51.4	12.9	13	109.6	27.5	73	167.8	42.0	33	226.0	56.6	93	284.2	71.2
54	52.4	13.1	14	110.6	27.7	74	168.8	42.3	34	227.0	56.9	94	285.2	71.4
55	53.4	13.4	15	111.6	27.9	75	169.8	42.5	35	228.0	57.1	95	286.2	71.7
56	54.3	13.6	16	112.5	28.2	76	170.7	42.8	36	228.9	57.3	96	287.1	71.9
57	55.3	13.8	17	113.5	28.4	77	171.7	43.0	37	229.9	57.6	97	288.1	72.2
58	56.3	14.1	18	114.5	28.7	78	172.7	43.3	38	230.9	57.8	98	289.1	72.4
59	57.2	14.3	19	115.4	28.9	79	173.6	43.5	39	231.8	58.1	99	290.0	72.7
60	58.2	14.6	20	116.4	29.2	80	174.6	43.7	40	232.8	58.3	300	291.0	72.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.4	17.7	121	115.8	35.1	181	173.2	52.5	241	230.6	70.0
2	01.9	00.6	62	59.3	18.0	22	116.7	35.4	82	174.2	52.8	42	231.6	70.2
3	02.9	00.9	63	60.3	18.3	23	117.7	35.7	83	175.1	53.1	43	232.5	70.5
4	03.8	01.2	64	61.2	18.6	24	118.7	36.0	84	176.1	53.4	44	233.5	70.8
5	04.8	01.5	65	62.2	18.9	25	119.6	36.3	85	177.0	53.7	45	234.5	71.1
6	05.7	01.7	66	63.2	19.2	26	120.6	36.6	86	178.0	54.0	46	235.4	71.4
7	06.7	02.0	67	64.1	19.4	27	121.5	36.9	87	178.9	54.3	47	236.4	71.7
8	07.7	02.3	68	65.1	19.7	28	122.5	37.2	88	179.9	54.6	48	237.3	72.0
9	08.6	02.6	69	66.0	20.0	29	123.4	37.4	89	180.9	54.9	49	238.3	72.3
10	09.6	02.9	70	67.0	20.3	30	124.4	37.7	90	181.8	55.2	50	239.2	72.6
11	10.5	03.2	71	67.9	20.6	131	125.4	38.0	191	182.8	55.4	251	240.2	72.9
12	11.5	03.5	72	68.9	20.9	32	126.3	38.3	92	183.7	55.7	52	241.1	73.2
13	12.4	03.8	73	69.9	21.2	33	127.3	38.6	93	184.7	56.0	53	242.1	73.4
14	13.4	04.1	74	70.8	21.5	34	128.2	38.9	94	185.6	56.3	54	243.1	73.7
15	14.4	04.4	75	71.8	21.8	35	129.2	39.2	95	186.6	56.6	55	244.0	74.0
16	15.3	04.6	76	72.7	22.1	36	130.1	39.5	96	187.6	56.9	56	245.0	74.3
17	16.3	04.9	77	73.7	22.4	37	131.1	39.8	97	188.5	57.2	57	245.9	74.6
18	17.2	05.2	78	74.6	22.6	38	132.1	40.1	98	189.5	57.5	58	246.9	74.9
19	18.2	05.5	79	75.6	22.9	39	133.0	40.3	99	190.4	57.8	59	247.8	75.2
20	19.1	05.8	80	76.6	23.2	40	134.0	40.6	200	191.4	58.1	60	248.8	75.5
21	20.1	06.1	81	77.5	23.5	141	134.9	40.9	201	192.3	58.3	261	249.8	75.8
22	21.1	06.4	82	78.5	23.8	42	135.9	41.2	02	193.3	58.6	62	250.7	76.1
23	22.0	06.7	83	79.4	24.1	43	136.8	41.5	03	194.3	58.9	63	251.7	76.3
24	23.0	07.0	84	80.4	24.4	44	137.8	41.8	04	195.2	59.2	64	252.6	76.6
25	23.9	07.3	85	81.3	24.7	45	138.8	42.1	05	196.2	59.5	65	253.6	76.9
26	24.9	07.5	86	82.3	25.0	46	139.7	42.4	06	197.1	59.8	66	254.5	77.2
27	25.8	07.8	87	83.3	25.3	47	140.7	42.7	07	198.1	60.1	67	255.5	77.5
28	26.8	08.1	88	84.2	25.5	48	141.6	43.0	08	199.0	60.4	68	256.5	77.8
29	27.8	08.4	89	85.2	25.8	49	142.6	43.3	09	200.0	60.7	69	257.4	78.1
30	28.7	08.7	90	86.1	26.1	50	143.5	43.5	10	201.0	61.0	70	258.4	78.4
31	29.7	09.0	91	87.1	26.4	151	144.5	43.8	211	201.9	61.3	271	259.3	78.7
32	30.6	09.3	92	88.0	26.7	52	145.5	44.1	12	202.9	61.5	72	260.3	79.0
33	31.6	09.6	93	89.0	27.0	53	146.4	44.4	13	203.8	61.8	73	261.2	79.2
34	32.5	09.9	94	90.0	27.3	54	147.4	44.7	14	204.8	62.1	74	262.2	79.5
35	33.5	10.2	95	90.9	27.6	55	148.3	45.0	15	205.7	62.4	75	263.2	79.8
36	34.4	10.5	96	91.9	27.9	56	149.3	45.3	16	206.7	62.7	76	264.1	80.1
37	35.4	10.7	97	92.8	28.2	57	150.2	45.6	17	207.7	63.0	77	265.1	80.4
38	36.4	11.0	98	93.8	28.4	58	151.2	45.9	18	208.6	63.3	78	266.0	80.7
39	37.3	11.3	99	94.7	28.7	59	152.2	46.2	19	209.6	63.6	79	267.0	81.0
40	38.3	11.6	100	95.7	29.0	60	153.1	46.4	20	210.5	63.9	80	267.9	81.3
41	39.2	11.9	101	96.7	29.3	161	154.1	46.7	221	211.5	64.2	281	268.9	81.6
42	40.2	12.2	02	97.6	29.6	62	155.0	47.0	22	212.4	64.4	82	269.9	81.9
43	41.1	12.5	03	98.6	29.9	63	156.0	47.3	23	213.4	64.7	83	270.8	82.2
44	42.1	12.8	04	99.5	30.2	64	156.9	47.6	24	214.4	65.0	84	271.8	82.4
45	43.1	13.1	05	100.5	30.5	65	157.9	47.9	25	215.3	65.3	85	272.7	82.7
46	44.0	13.4	06	101.4	30.8	66	158.9	48.2	26	216.3	65.6	86	273.7	83.0
47	45.0	13.6	07	102.4	31.1	67	159.8	48.5	27	217.2	65.9	87	274.6	83.3
48	45.9	13.9	08	103.3	31.4	68	160.8	48.8	28	218.2	66.2	88	275.6	83.6
49	46.9	14.2	09	104.3	31.6	69	161.7	49.1	29	219.1	66.5	89	276.6	83.9
50	47.8	14.5	10	105.3	31.9	70	162.7	49.3	30	220.1	66.8	90	277.5	84.2
51	48.8	14.8	111	106.2	32.2	171	163.6	49.6	231	221.1	67.1	291	278.5	84.5
52	49.8	15.1	12	107.2	32.5	72	164.6	49.9	32	222.0	67.3	92	279.4	84.8
53	50.7	15.4	13	108.1	32.8	73	165.6	50.2	33	223.0	67.6	93	280.4	85.1
54	51.7	15.7	14	109.1	33.1	74	166.5	50.5	34	223.9	67.9	94	281.3	85.3
55	52.6	16.0	15	110.0	33.4	75	167.5	50.8	35	224.9	68.2	95	282.3	85.6
56	53.6	16.3	16	111.0	33.7	76	168.4	51.1	36	225.8	68.5	96	283.3	85.9
57	54.5	16.5	17	112.0	34.0	77	169.4	51.4	37	226.8	68.8	97	284.2	86.2
58	55.5	16.8	18	112.9	34.3	78	170.3	51.7	38	227.8	69.1	98	285.2	86.5
59	56.5	17.1	19	113.9	34.5	79	171.3	52.0	39	228.7	69.4	99	286.1	86.8
60	57.4	17.4	20	114.8	34.8	80	172.2	52.3	40	229.7	69.7	300	287.1	87.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 6½ Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.4	20.6	121	113.9	40.8	181	170.4	61.0	241	226.9	81.2
2	01.9	00.7	62	58.4	20.9	22	114.9	41.1	82	171.4	61.3	42	227.9	81.5
3	02.8	01.0	63	59.3	21.2	23	115.8	41.4	83	172.3	61.7	43	228.8	81.9
4	03.8	01.3	64	60.3	21.6	24	116.8	41.8	84	173.2	62.0	44	229.7	82.2
5	04.7	01.7	65	61.2	21.9	25	117.7	42.1	85	174.2	62.3	45	230.7	82.5
6	05.6	02.0	66	62.1	22.2	26	118.6	42.4	86	175.1	62.7	46	231.6	82.9
7	06.6	02.4	67	63.1	22.6	27	119.6	42.8	87	176.1	63.0	47	232.6	83.2
8	07.5	02.7	68	64.0	22.9	28	120.5	43.1	88	177.0	63.3	48	233.5	83.5
9	08.5	03.0	69	65.0	23.2	29	121.5	43.5	89	178.0	63.7	49	234.4	83.9
10	09.4	03.4	70	65.9	23.6	30	122.4	43.8	90	178.9	64.0	50	235.4	84.2
11	10.4	03.7	71	66.8	23.9	131	123.3	44.1	191	179.8	64.3	251	236.3	84.6
12	11.3	04.0	72	67.8	24.3	32	124.3	44.5	92	180.8	64.7	52	237.3	84.9
13	12.2	04.4	73	68.7	24.6	33	125.2	44.8	93	181.7	65.0	53	238.2	85.2
14	13.2	04.7	74	69.7	24.9	34	126.2	45.1	94	182.7	65.4	54	239.2	85.6
15	14.1	05.1	75	70.6	25.3	35	127.1	45.5	95	183.6	65.7	55	240.1	85.9
16	15.1	05.4	76	71.6	25.6	36	128.0	45.8	96	184.5	66.0	56	241.0	86.2
17	16.0	05.7	77	72.5	25.9	37	129.0	46.2	97	185.5	66.4	57	242.0	86.6
18	16.9	06.1	78	73.4	26.3	38	129.9	46.5	98	186.4	66.7	58	242.9	86.9
19	17.9	06.4	79	74.4	26.6	39	130.9	46.8	99	187.4	67.0	59	243.9	87.3
20	18.8	06.7	80	75.3	27.0	40	131.8	47.2	200	188.3	67.4	60	244.8	87.6
21	19.8	07.1	81	76.3	27.3	141	132.8	47.5	201	189.3	67.7	261	245.7	87.9
22	20.7	07.4	82	77.2	27.6	42	133.7	47.8	02	190.2	68.1	62	246.7	88.3
23	21.7	07.7	83	78.1	28.0	43	134.6	48.2	03	191.1	68.4	63	247.6	88.6
24	22.6	08.1	84	79.1	28.3	44	135.6	48.5	04	192.1	68.7	64	248.6	88.9
25	23.5	08.4	85	80.0	28.6	45	136.5	48.8	05	193.0	69.1	65	249.5	89.3
26	24.5	08.8	86	81.0	29.0	46	137.5	49.2	06	194.0	69.4	66	250.5	89.6
27	25.4	09.1	87	81.9	29.3	47	138.4	49.5	07	194.9	69.7	67	251.4	89.9
28	26.4	09.4	88	82.9	29.6	48	139.3	49.9	08	195.8	70.1	68	252.3	90.3
29	27.3	09.8	89	83.8	30.0	49	140.3	50.2	09	196.8	70.4	69	253.3	90.6
30	28.2	10.1	90	84.7	30.3	50	141.2	50.5	10	197.7	70.7	70	254.2	91.0
31	29.2	10.4	91	85.7	30.7	151	142.2	50.9	211	198.7	71.1	271	255.2	91.3
32	30.1	10.8	92	86.6	31.0	52	143.1	51.2	12	199.6	71.4	72	256.1	91.6
33	31.1	11.1	93	87.6	31.3	53	144.1	51.5	13	200.5	71.8	73	257.0	92.0
34	32.0	11.5	94	88.5	31.7	54	145.0	51.9	14	201.5	72.1	74	258.0	92.3
35	33.0	11.8	95	89.4	32.0	55	145.9	52.2	15	202.4	72.4	75	258.9	92.6
36	33.9	12.1	96	90.4	32.3	56	146.9	52.6	16	203.4	72.8	76	259.9	93.0
37	34.8	12.5	97	91.3	32.7	57	147.8	52.9	17	204.3	73.1	77	260.8	93.3
38	35.8	12.8	98	92.3	33.0	58	148.8	53.2	18	205.3	73.4	78	261.7	93.7
39	36.7	13.1	99	93.2	33.4	59	149.7	53.6	19	206.2	73.8	79	262.7	94.0
40	37.7	13.5	100	94.2	33.7	60	150.6	53.9	20	207.1	74.1	80	263.6	94.3
41	38.6	13.8	101	95.1	34.0	161	151.6	54.2	221	208.1	74.5	281	264.6	94.7
42	39.5	14.1	02	96.0	34.4	62	152.5	54.6	22	209.0	74.8	82	265.5	95.0
43	40.5	14.5	03	97.0	34.7	63	153.5	54.9	23	210.0	75.1	83	266.5	95.3
44	41.4	14.8	04	97.9	35.0	64	154.4	55.2	24	210.9	75.5	84	267.4	95.7
45	42.4	15.2	05	98.9	35.4	65	155.4	55.6	25	211.8	75.8	85	268.3	96.0
46	43.3	15.5	06	99.8	35.7	66	156.3	55.9	26	212.8	76.1	86	269.3	96.4
47	44.3	15.8	07	100.7	36.0	67	157.2	56.3	27	213.7	76.5	87	270.2	96.7
48	45.2	16.2	08	101.7	36.4	68	158.2	56.6	28	214.7	76.8	88	271.2	97.0
49	46.1	16.5	09	102.6	36.7	69	159.1	56.9	29	215.6	77.1	89	272.1	97.4
50	47.1	16.8	10	103.6	37.1	70	160.1	57.3	30	216.6	77.5	90	273.0	97.7
51	48.0	17.2	111	104.5	37.4	171	161.0	57.6	231	217.5	77.8	291	274.0	98.0
52	49.0	17.5	12	105.5	37.7	72	161.9	57.9	32	218.4	78.2	92	274.9	98.4
53	49.9	17.9	13	106.4	38.1	73	162.9	58.3	33	219.4	78.5	93	275.9	98.7
54	50.8	18.2	14	107.3	38.4	74	163.8	58.6	34	220.3	78.8	94	276.8	99.0
55	51.8	18.5	15	108.3	38.7	75	164.8	59.0	35	221.3	79.2	95	277.8	99.4
56	52.7	18.9	16	109.2	39.1	76	165.7	59.3	36	222.2	79.5	96	278.7	99.7
57	53.7	19.2	17	110.2	39.4	77	166.7	59.6	37	223.1	79.8	97	279.6	100.1
58	54.6	19.5	18	111.1	39.8	78	167.6	60.0	38	224.1	80.2	98	280.6	100.4
59	55.6	19.9	19	112.0	40.1	79	168.5	60.3	39	225.0	80.5	99	281.5	100.7
60	56.5	20.2	20	113.0	40.4	80	169.5	60.6	40	226.0	80.9	300	282.5	101.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.4	23.3	121	111.8	46.3	181	167.2	69.3	241	222.7	92.2
2	01.8	00.8	62	57.3	23.7	22	112.7	46.7	82	168.1	69.6	42	223.6	92.6
3	02.8	01.1	63	58.2	24.1	23	113.6	47.1	83	169.1	70.0	43	224.5	93.0
4	03.7	01.5	64	59.1	24.5	24	114.6	47.5	84	170.0	70.4	44	225.4	93.4
5	04.6	01.9	65	60.1	24.9	25	115.5	47.8	85	170.9	70.8	45	226.4	93.8
6	05.5	02.3	66	61.0	25.3	26	116.4	48.2	86	171.8	71.2	46	227.3	94.1
7	06.5	02.7	67	61.9	25.6	27	117.3	48.6	87	172.8	71.6	47	228.2	94.5
8	07.4	03.1	68	62.8	26.0	28	118.3	49.0	88	173.7	71.9	48	229.1	94.9
9	08.3	03.4	69	63.7	26.4	29	119.2	49.4	89	174.6	72.3	49	230.0	95.3
10	09.2	03.8	70	64.7	26.8	30	120.1	49.7	90	175.5	72.7	50	231.0	95.7
11	10.2	04.2	71	65.6	27.2	131	121.0	50.1	191	176.5	73.1	251	231.9	96.1
12	11.1	04.6	72	66.5	27.6	32	122.0	50.5	92	177.4	73.5	52	232.8	96.4
13	12.0	05.0	73	67.4	27.9	33	122.9	50.9	93	178.3	73.9	53	233.7	96.8
14	12.9	05.4	74	68.4	28.3	34	123.8	51.3	94	179.2	74.2	54	234.7	97.2
15	13.9	05.7	75	69.3	28.7	35	124.7	51.7	95	180.2	74.6	55	235.6	97.6
16	14.8	06.1	76	70.2	29.1	36	125.6	52.0	96	181.1	75.0	56	236.5	98.0
17	15.7	06.5	77	71.1	29.5	37	126.6	52.4	97	182.0	75.4	57	237.4	98.3
18	16.6	06.9	78	72.1	29.8	38	127.5	52.8	98	182.9	75.8	58	238.4	98.7
19	17.6	07.3	79	73.0	30.2	39	128.4	53.2	99	183.9	76.2	59	239.3	99.1
20	18.5	07.7	80	73.9	30.6	40	129.3	53.6	200	184.8	76.5	60	240.2	99.5
21	19.4	08.0	81	74.8	31.0	141	130.3	54.0	201	185.7	76.9	261	241.1	99.9
22	20.3	08.4	82	75.8	31.4	42	131.2	54.3	02	186.6	77.3	62	242.1	100.3
23	21.2	08.8	83	76.7	31.8	43	132.1	54.7	03	187.5	77.7	63	243.0	100.6
24	22.2	09.2	84	77.6	32.1	44	133.0	55.1	04	188.5	78.1	64	243.9	101.0
25	23.1	09.6	85	78.5	32.5	45	134.0	55.5	05	189.4	78.5	65	244.8	101.4
26	24.0	09.9	86	79.5	32.9	46	134.9	55.9	06	190.3	78.8	66	245.8	101.8
27	24.9	10.3	87	80.4	33.3	47	135.8	56.3	07	191.2	79.2	67	246.7	102.2
28	25.9	10.7	88	81.3	33.7	48	136.7	56.6	08	192.2	79.6	68	247.6	102.6
29	26.8	11.1	89	82.2	34.1	49	137.7	57.0	09	193.1	80.0	69	248.5	102.9
30	27.7	11.5	90	83.1	34.4	50	138.6	57.4	10	194.0	80.4	70	249.4	103.3
31	28.6	11.9	91	84.1	34.8	151	139.5	57.8	211	194.9	80.7	271	250.4	103.7
32	29.6	12.2	92	85.0	35.2	52	140.4	58.2	12	195.9	81.1	72	251.3	104.1
33	30.5	12.6	93	85.9	35.6	53	141.4	58.6	13	196.8	81.5	73	252.2	104.5
34	31.4	13.0	94	86.8	36.0	54	142.3	58.9	14	197.7	81.9	74	253.1	104.9
35	32.3	13.4	95	87.8	36.4	55	143.2	59.3	15	198.6	82.3	75	254.1	105.2
36	33.3	13.8	96	88.7	36.7	56	144.1	59.7	16	199.6	82.7	76	255.0	105.6
37	34.2	14.2	97	89.6	37.1	57	145.0	60.1	17	200.5	83.0	77	255.9	106.0
38	35.1	14.5	98	90.5	37.5	58	146.0	60.5	18	201.4	83.4	78	256.8	106.4
39	36.0	14.9	99	91.5	37.9	59	146.9	60.8	19	202.3	83.8	79	257.8	106.8
40	37.0	15.3	100	92.4	38.3	60	147.8	61.2	20	203.3	84.2	80	258.7	107.2
41	37.9	15.7	101	93.3	38.7	161	148.7	61.6	221	204.2	84.6	281	259.6	107.5
42	38.8	16.1	02	94.2	39.0	62	149.7	62.0	22	205.1	85.0	82	260.5	107.9
43	39.7	16.5	03	95.2	39.4	63	150.6	62.4	23	206.0	85.3	83	261.5	108.3
44	40.7	16.8	04	96.1	39.8	64	151.5	62.8	24	206.9	85.7	84	262.4	108.7
45	41.6	17.2	05	97.0	40.2	65	152.4	63.1	25	207.9	86.1	85	263.3	109.1
46	42.5	17.6	06	97.9	40.6	66	153.4	63.5	26	208.8	86.5	86	264.2	109.4
47	43.4	18.0	07	98.9	40.9	67	154.3	63.9	27	209.7	86.9	87	265.2	109.8
48	44.3	18.4	08	99.8	41.3	68	155.2	64.3	28	210.6	87.3	88	266.1	110.2
49	45.3	18.8	09	100.7	41.7	69	156.1	64.7	29	211.6	87.6	89	267.0	110.6
50	46.2	19.1	10	101.6	42.1	70	157.1	65.1	30	212.5	88.0	90	267.9	111.0
51	47.1	19.5	111	102.6	42.5	171	158.0	65.4	231	213.4	88.4	291	268.8	111.4
52	48.0	19.9	12	103.5	42.9	72	158.9	65.8	32	214.3	88.8	92	269.8	111.7
53	49.0	20.3	13	104.4	43.2	73	159.8	66.2	33	215.3	89.2	93	270.7	112.1
54	49.9	20.7	14	105.3	43.6	74	160.8	66.6	34	216.2	89.5	94	271.6	112.5
55	50.8	21.0	15	106.2	44.0	75	161.7	67.0	35	217.1	89.9	95	272.5	112.9
56	51.7	21.4	16	107.2	44.4	76	162.6	67.4	36	218.0	90.3	96	273.5	113.3
57	52.7	21.8	17	108.1	44.8	77	163.5	67.7	37	219.0	90.7	97	274.4	113.7
58	53.6	22.2	18	109.0	45.2	78	164.5	68.1	38	219.9	91.1	98	275.3	114.0
59	54.5	22.6	19	109.9	45.5	79	165.4	68.5	39	220.8	91.5	99	276.2	114.4
60	55.4	23.0	20	110.9	45.9	80	166.3	68.9	40	221.7	91.8	300	277.2	114.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE I. Difference of Latitude and Departure for 2¼ Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.1	26.1	121	109.4	51.7	181	163.6	77.4	241	217.9	103.0
2	01.8	00.9	62	56.0	26.5	22	110.3	52.2	82	164.5	77.8	42	218.8	103.5
3	02.7	01.3	63	57.0	26.9	23	111.2	52.6	83	165.4	78.2	43	219.7	103.9
4	03.6	01.7	64	57.9	27.4	24	112.1	53.0	84	166.3	78.7	44	220.6	104.3
5	04.5	02.1	65	58.8	27.8	25	113.0	53.4	85	167.2	79.1	45	221.5	104.8
6	05.4	02.6	66	59.7	28.2	26	113.9	53.9	86	168.1	79.5	46	222.4	105.2
7	06.3	03.0	67	60.6	28.6	27	114.8	54.3	87	169.0	80.0	47	223.3	105.6
8	07.2	03.4	68	61.5	29.1	28	115.7	54.7	88	169.9	80.4	48	324.2	106.0
9	08.1	03.8	69	62.4	29.5	29	116.6	55.2	89	170.9	80.8	49	225.1	106.5
10	09.0	04.3	70	63.3	29.9	30	117.5	55.6	90	171.8	81.2	50	226.0	106.9
11	09.9	04.7	71	64.2	30.4	131	118.4	56.0	191	172.7	81.7	251	226.9	107.3
12	10.8	05.1	72	65.1	30.8	32	119.3	56.4	92	173.6	82.1	52	227.8	107.7
13	11.8	05.6	73	66.0	31.2	33	120.2	56.9	93	174.5	82.5	53	228.7	108.2
14	12.7	06.0	74	66.9	31.6	34	121.1	57.3	94	175.4	82.9	54	229.6	108.6
15	13.6	06.4	75	67.8	32.1	35	122.0	57.7	95	176.3	83.4	55	230.5	109.0
16	14.5	06.8	76	68.7	32.5	36	122.9	58.1	96	177.2	83.8	56	231.4	109.5
17	15.4	07.3	77	69.6	32.9	37	123.8	58.6	97	178.1	84.2	57	232.3	109.9
18	16.3	07.7	78	70.5	33.3	38	124.8	59.0	98	179.0	84.7	58	233.2	110.3
19	17.2	08.1	79	71.4	33.8	39	125.7	59.4	99	179.9	85.1	59	234.1	110.7
20	18.1	08.6	80	72.3	34.2	40	126.6	59.9	200	180.8	85.5	60	235.0	111.2
21	19.0	09.0	81	73.2	34.6	141	127.5	60.3	201	181.7	85.9	261	235.9	111.6
22	19.9	09.4	82	74.1	35.1	42	128.4	60.7	02	182.6	86.4	62	236.8	112.0
23	20.8	09.8	83	75.0	35.5	43	129.3	61.1	03	183.5	86.8	63	237.7	112.4
24	21.7	10.3	84	75.9	35.9	44	130.2	61.6	04	184.4	87.2	64	238.7	112.9
25	22.6	10.7	85	76.8	36.3	45	131.1	62.0	05	185.3	87.6	65	239.6	113.3
26	23.5	11.1	86	77.7	36.8	46	132.0	62.4	06	186.2	88.1	66	240.5	113.7
27	24.4	11.5	87	78.6	37.2	47	132.9	62.9	07	187.1	88.5	67	241.4	114.2
28	25.3	12.0	88	79.6	37.6	48	133.8	63.3	08	188.0	88.9	68	242.3	114.6
29	26.2	12.4	89	80.5	38.1	49	134.7	63.7	09	188.9	89.4	69	243.2	115.0
30	27.1	12.8	90	81.4	38.5	50	135.6	64.1	10	189.8	89.8	70	244.1	115.4
31	28.0	13.3	91	82.3	38.9	151	136.5	64.6	211	190.7	90.2	271	245.0	115.9
32	28.9	13.7	92	83.2	39.3	52	137.4	65.0	12	191.6	90.6	72	245.9	116.3
33	29.8	14.1	93	84.1	39.8	53	138.3	65.4	13	192.5	91.1	73	246.8	116.7
34	30.7	14.5	94	85.0	40.2	54	139.2	65.8	14	193.5	91.5	74	247.7	117.2
35	31.6	15.0	95	85.9	40.6	55	140.1	66.3	15	194.4	91.9	75	248.6	117.6
36	32.5	15.4	96	86.8	41.0	56	141.0	66.7	16	195.3	92.4	76	249.5	118.0
37	33.4	15.8	97	87.7	41.5	57	141.9	67.1	17	196.2	92.8	77	250.4	118.4
38	34.4	16.2	98	88.6	41.9	58	142.8	67.6	18	197.1	93.2	78	251.3	118.9
39	35.3	16.7	99	89.5	42.3	59	143.7	68.0	19	198.0	93.6	79	252.2	119.3
40	36.2	17.1	100	90.4	42.8	60	144.6	68.4	20	198.9	94.1	80	253.1	119.7
41	37.1	17.5	101	91.3	43.2	161	145.5	68.8	221	199.8	94.5	281	254.0	120.1
42	38.0	18.0	02	92.2	43.6	62	146.4	69.3	22	200.7	94.9	82	254.9	120.6
43	38.9	18.4	03	93.1	44.0	63	147.4	69.7	23	201.6	95.3	83	255.8	121.0
44	39.8	18.8	04	94.0	44.5	64	148.3	70.1	24	202.5	95.8	84	256.7	121.4
45	40.7	19.2	05	94.9	44.9	65	149.2	70.5	25	203.4	96.2	85	257.6	121.9
46	41.6	19.7	06	95.8	45.3	66	150.1	71.0	26	204.3	96.6	86	258.5	122.3
47	42.5	20.1	07	96.7	45.7	67	151.0	71.4	27	205.2	97.1	87	259.4	122.7
48	43.4	20.5	08	97.6	46.2	68	151.9	71.8	28	206.1	97.5	88	260.3	123.1
49	44.3	21.0	09	98.5	46.6	69	152.8	72.3	29	207.0	97.9	89	261.3	123.6
50	45.2	21.4	10	99.4	47.0	70	153.7	72.7	30	207.9	98.3	90	262.2	124.0
51	46.1	21.8	111	100.3	47.5	171	154.6	73.1	231	208.8	98.8	291	263.1	124.4
52	47.0	22.2	12	101.2	47.9	72	155.5	73.5	32	209.7	99.2	92	264.0	124.8
53	47.9	22.7	13	102.2	48.3	73	156.4	74.0	33	210.6	99.6	93	264.9	125.3
54	48.8	23.1	14	103.1	48.7	74	157.3	74.4	34	211.5	100.0	94	265.8	125.7
55	49.7	23.5	15	104.0	49.2	75	158.2	74.8	35	212.4	100.5	95	266.7	126.1
56	50.6	23.9	16	104.9	49.6	76	159.1	75.2	36	213.3	100.9	96	267.6	126.6
57	51.5	24.4	17	105.8	50.0	77	160.0	75.7	37	214.2	101.3	97	268.5	127.0
58	52.4	24.8	18	106.7	50.5	78	160.9	76.1	38	215.1	101.8	98	269.4	127.4
59	53.3	25.2	19	107.6	50.9	79	161.8	76.5	39	216.1	102.2	99	270.3	127.8
60	54.2	25.7	20	108.5	51.3	80	162.7	77.0	40	217.0	102.6	300	271.2	128.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 5¾ Points.

TABLE I. Difference of Latitude and Departure for 2½ Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.8	28.8	121	106.7	57.0	181	159.6	85.3	241	212.5	113.6
2	01.8	00.9	62	54.7	29.2	22	107.6	57.5	82	160.5	85.8	42	213.4	114.1
3	02.6	01.4	63	55.6	29.7	23	108.5	58.0	83	161.4	86.3	43	214.3	114.5
4	03.5	01.9	64	56.4	30.2	24	109.4	58.5	84	162.3	86.7	44	215.2	115.0
5	04.4	02.4	65	57.3	30.6	25	110.2	58.9	85	163.2	87.2	45	216.1	115.5
6	05.3	02.8	66	58.2	31.1	26	111.1	59.4	86	164.0	87.7	46	217.0	116.0
7	06.2	03.3	67	59.1	31.6	27	112.0	59.9	87	164.9	88.2	47	217.8	116.4
8	07.1	03.8	68	60.0	32.1	28	112.9	60.3	88	165.8	88.6	48	218.7	116.9
9	07.9	04.2	69	60.9	32.5	29	113.8	60.8	89	166.7	89.1	49	219.6	117.4
10	08.8	04.7	70	61.7	33.0	30	114.6	61.3	90	167.6	89.6	50	220.5	117.8
11	09.7	05.2	71	62.6	33.5	131	115.5	61.8	191	168.4	90.0	251	221.4	118.3
12	10.6	05.7	72	63.5	33.9	32	116.4	62.2	92	169.3	90.5	52	222.2	118.8
13	11.5	06.1	73	64.4	34.4	33	117.3	62.7	93	170.2	91.0	53	223.1	119.3
14	12.3	06.6	74	65.3	34.9	34	118.2	63.2	94	171.1	91.5	54	224.0	119.7
15	13.2	07.1	75	66.1	35.4	35	119.1	63.6	95	172.0	91.9	55	224.9	120.2
16	14.1	07.5	76	67.0	35.8	36	119.9	64.1	96	172.9	92.4	56	225.8	120.7
17	15.0	08.0	77	67.9	36.3	37	120.8	64.6	97	173.7	92.9	57	226.7	121.1
18	15.9	08.5	78	68.8	36.8	38	121.7	65.1	98	174.6	93.3	58	227.5	121.6
19	16.8	09.0	79	69.7	37.2	39	122.6	65.5	99	175.5	93.8	59	228.4	122.1
20	17.6	09.4	80	70.6	37.7	40	123.5	66.0	200	176.4	94.3	60	229.3	122.6
21	18.5	09.9	81	71.4	38.2	141	124.4	66.5	201	177.3	94.8	261	230.2	123.0
22	19.4	10.4	82	72.3	38.7	42	125.2	66.9	02	178.1	95.2	62	231.1	123.5
23	20.3	10.8	83	73.2	39.1	43	126.1	67.4	03	179.0	95.7	63	231.9	124.0
24	21.2	11.3	84	74.1	39.6	44	127.0	67.9	04	179.9	96.2	64	232.8	124.4
25	22.0	11.8	85	75.0	40.1	45	127.9	68.4	05	180.8	96.6	65	233.7	124.9
26	22.9	12.3	86	75.8	40.5	46	128.8	68.8	06	181.7	97.1	66	234.6	125.4
27	23.8	12.7	87	76.7	41.0	47	129.6	69.3	07	182.6	97.6	67	235.5	125.9
28	24.7	13.2	88	77.6	41.5	48	130.5	69.8	08	183.4	98.1	68	236.4	126.3
29	25.6	13.7	89	78.5	42.0	49	131.4	70.2	09	184.3	98.5	69	237.2	126.8
30	26.5	14.1	90	79.4	42.4	50	132.3	70.7	10	185.2	99.0	70	238.1	127.3
31	27.3	14.6	91	80.3	42.9	151	133.2	71.2	211	186.1	99.5	271	239.0	127.7
32	28.2	15.1	92	81.1	43.4	52	134.1	71.7	12	187.0	99.9	72	239.9	128.2
33	29.1	15.6	93	82.0	43.8	53	134.9	72.1	13	187.8	100.4	73	240.8	128.7
34	30.0	16.0	94	82.9	44.3	54	135.8	72.6	14	188.7	100.9	74	241.6	129.2
35	30.9	16.5	95	83.8	44.8	55	136.7	73.1	15	189.6	101.4	75	242.5	129.6
36	31.7	17.0	96	84.7	45.3	56	137.6	73.5	16	190.5	101.8	76	243.4	130.1
37	32.6	17.4	97	85.5	45.7	57	138.5	74.0	17	191.4	102.3	77	244.3	130.6
38	33.5	17.9	98	86.4	46.2	58	139.3	74.5	18	192.3	102.8	78	245.2	131.0
39	34.4	18.4	99	87.3	46.7	59	140.2	75.0	19	193.1	103.2	79	246.1	131.5
40	35.3	18.9	100	88.2	47.1	60	141.1	75.4	20	194.0	103.7	80	246.9	132.0
41	36.2	19.3	101	89.1	47.6	161	142.0	75.9	221	194.9	104.2	281	247.8	132.5
42	37.0	19.8	02	90.0	48.1	62	142.9	76.4	22	195.8	104.7	82	248.7	132.9
43	37.9	20.3	03	90.8	48.6	63	143.8	76.8	23	196.7	105.1	83	249.6	133.4
44	38.8	20.7	04	91.7	49.0	64	144.6	77.3	24	197.6	105.6	84	250.5	133.9
45	39.7	21.2	05	92.6	49.5	65	145.5	77.8	25	198.4	106.1	85	251.3	134.3
46	40.6	21.7	06	93.5	50.0	66	146.4	78.3	26	199.3	106.5	86	252.2	134.8
47	41.5	22.2	07	94.4	50.4	67	147.3	78.7	27	200.2	107.0	87	253.1	135.3
48	42.3	22.6	08	95.2	50.9	68	148.2	79.2	28	201.1	107.5	88	254.0	135.8
49	43.2	23.1	09	96.1	51.4	69	149.0	79.7	29	202.0	107.9	89	254.9	136.2
50	44.1	23.6	10	97.0	51.9	70	149.9	80.1	30	202.8	108.4	90	255.8	136.7
51	45.0	24.0	111	97.9	52.3	171	150.8	80.6	231	203.7	108.9	291	256.6	137.2
52	45.9	24.5	12	98.8	52.8	72	151.7	81.1	32	204.6	109.4	92	257.5	137.6
53	46.7	25.0	13	99.7	53.3	73	152.6	81.6	33	205.5	109.8	93	258.4	138.1
54	47.6	25.5	14	100.5	53.7	74	153.5	82.0	34	206.4	110.3	94	259.3	138.6
55	48.5	25.9	15	101.4	54.2	75	154.3	82.5	35	207.3	110.8	95	260.2	139.1
56	49.4	26.4	16	102.3	54.7	76	155.2	83.0	36	208.1	111.2	96	261.0	139.5
57	50.3	26.9	17	103.2	55.2	77	156.1	83.4	37	209.0	111.7	97	261.9	140.0
58	51.2	27.3	18	104.1	55.6	78	157.0	83.9	38	209.9	112.2	98	262.8	140.5
59	52.0	27.8	19	104.9	56.1	79	157.9	84.4	39	210.8	112.7	99	263.7	140.9
60	52.9	28.3	20	105.8	56.6	80	158.7	84.9	40	211.7	113.1	300	264.6	141.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 5½ Points.

TABLE I. Difference of Latitude and Departure for 2¾ Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.8	62.2	181	155.2	93.1	241	206.7	123.9
2	01.7	01.0	62	53.2	31.9	22	104.6	62.7	82	156.1	93.6	42	207.6	124.4
3	02.6	01.5	63	54.0	32.4	23	105.5	63.2	83	157.0	94.1	43	208.4	124.9
4	03.4	02.1	64	54.9	32.9	24	106.4	63.7	84	157.8	94.6	44	209.3	125.4
5	04.3	02.6	65	55.8	33.4	25	107.2	64.3	85	158.7	95.1	45	210.1	126.0
6	05.1	03.1	66	56.6	33.9	26	108.1	64.8	86	159.5	95.6	46	211.0	126.5
7	06.0	03.6	67	57.5	34.4	27	108.9	65.3	87	160.4	96.1	47	211.9	127.0
8	06.9	04.1	68	58.3	35.0	28	109.8	65.8	88	161.3	96.7	48	212.7	127.5
9	07.7	04.6	69	59.2	35.5	29	110.6	66.3	89	162.1	97.2	49	213.6	128.0
10	08.6	05.1	70	60.0	36.0	30	111.5	66.8	90	163.0	97.7	50	214.4	128.5
11	09.4	05.7	71	60.9	36.5	131	112.4	67.3	191	163.8	98.2	251	215.3	129.0
12	10.3	06.2	72	61.8	37.0	32	113.2	67.9	92	164.7	98.7	52	216.1	129.6
13	11.2	06.7	73	62.6	37.5	33	114.1	68.4	93	165.5	99.2	53	217.0	130.1
14	12.0	07.2	74	63.5	38.0	34	114.9	68.9	94	166.4	99.7	54	217.9	130.6
15	12.9	07.7	75	64.3	38.6	35	115.8	69.4	95	167.3	100.3	55	218.7	131.1
16	13.7	08.2	76	65.2	39.1	36	116.7	69.9	96	168.1	100.8	56	219.6	131.6
17	14.6	08.7	77	66.0	39.6	37	117.5	70.4	97	169.0	101.3	57	220.4	132.1
18	15.4	09.3	78	66.9	40.1	38	118.4	70.9	98	169.8	101.8	58	221.3	132.6
19	16.3	09.8	79	67.8	40.6	39	119.2	71.5	99	170.7	102.3	59	222.2	133.2
20	17.2	10.3	80	68.6	41.1	40	120.1	72.0	200	171.5	102.8	60	223.0	133.7
21	18.0	10.8	81	69.5	41.6	141	120.9	72.5	201	172.4	103.3	261	223.9	134.2
22	18.9	11.3	82	70.3	42.2	42	121.8	73.0	02	173.3	103.8	62	224.7	134.7
23	19.7	11.8	83	71.2	42.7	43	122.7	73.5	03	174.1	104.4	63	225.6	135.2
24	20.6	12.3	84	72.0	43.2	44	123.5	74.0	04	175.0	104.9	64	226.4	135.7
25	21.4	12.9	85	72.9	43.7	45	124.4	74.5	05	175.8	105.4	65	227.3	136.2
26	22.3	13.4	86	73.8	44.2	46	125.2	75.1	06	176.7	105.9	66	228.2	136.8
27	23.2	13.9	87	74.6	44.7	47	126.1	75.6	07	177.5	106.4	67	229.0	137.3
28	24.0	14.4	88	75.5	45.2	48	126.9	76.1	08	178.4	106.9	68	229.9	137.8
29	24.9	14.9	89	76.3	45.8	49	127.8	76.6	09	179.3	107.4	69	230.7	138.3
30	25.7	15.4	90	77.2	46.3	50	128.7	77.1	10	180.1	108.0	70	231.6	138.8
31	26.6	15.9	91	78.1	46.8	151	129.5	77.6	211	181.0	108.5	271	232.4	139.3
32	27.4	16.5	92	78.9	47.3	52	130.4	78.1	12	181.8	109.0	72	233.3	139.8
33	28.3	17.0	93	79.8	47.8	53	131.2	78.7	13	182.7	109.5	73	234.2	140.4
34	29.2	17.5	94	80.6	48.3	54	132.1	79.2	14	183.6	110.0	74	235.0	140.9
35	30.0	18.0	95	81.5	48.8	55	132.9	79.7	15	184.4	110.5	75	235.9	141.4
36	30.9	18.5	96	82.3	49.4	56	133.8	80.2	16	185.3	111.0	76	236.7	141.9
37	31.7	19.0	97	83.2	49.9	57	134.7	80.7	17	186.1	111.6	77	237.6	142.4
38	32.6	19.5	98	84.1	50.4	58	135.5	81.2	18	187.0	112.1	78	238.4	142.9
39	33.5	20.1	99	84.9	50.9	59	136.4	81.7	19	187.8	112.6	79	239.3	143.4
40	34.3	20.6	100	85.8	51.4	60	137.2	82.3	20	188.7	113.1	80	240.2	143.9
41	35.2	21.1	101	86.6	51.9	161	138.1	82.8	221	189.6	113.6	281	241.0	144.5
42	36.0	21.6	02	87.5	52.4	62	139.0	83.3	22	190.4	114.1	82	241.9	145.0
43	36.9	22.1	03	88.3	53.0	63	139.8	83.8	23	191.3	114.6	83	242.7	145.5
44	37.7	22.6	04	89.2	53.5	64	140.7	84.3	24	192.1	115.2	84	243.6	146.0
45	38.6	23.1	05	90.1	54.0	65	141.5	84.8	25	193.0	115.7	85	244.5	146.5
46	39.5	23.6	06	90.9	54.5	66	142.4	85.3	26	193.8	116.2	86	245.3	147.0
47	40.3	24.2	07	91.8	55.0	67	143.2	85.9	27	194.7	116.7	87	246.2	147.5
48	41.2	24.7	08	92.6	55.5	68	144.1	86.4	28	195.6	117.2	88	247.0	148.1
49	42.0	25.2	09	93.5	56.0	69	145.0	86.9	29	196.4	117.7	89	247.9	148.6
50	42.9	25.7	10	94.4	56.6	70	145.8	87.4	30	197.3	118.2	90	248.7	149.1
51	43.7	26.2	111	95.2	57.1	171	146.7	87.9	231	198.1	118.8	291	249.6	149.6
52	44.6	26.7	12	96.1	57.6	72	147.5	88.4	32	199.0	119.3	92	250.5	150.1
53	45.5	27.2	13	96.9	58.1	73	148.4	88.9	33	199.9	119.8	93	251.3	150.6
54	46.3	27.8	14	97.8	58.6	74	149.2	89.5	34	200.7	120.3	94	252.2	151.1
55	47.2	28.3	15	98.6	59.1	75	150.1	90.0	35	201.6	120.8	95	253.0	151.7
56	48.0	28.8	16	99.5	59.6	76	151.0	90.5	36	202.4	121.3	96	253.9	152.2
57	48.9	29.3	17	100.4	60.2	77	151.8	91.0	37	203.3	121.8	97	254.7	152.7
58	49.7	29.8	18	101.2	60.7	78	152.7	91.5	38	204.1	122.4	98	255.6	153.2
59	50.6	30.3	19	102.1	61.2	79	153.5	92.0	39	205.0	122.9	99	256.5	153.7
60	51.5	30.8	20	102.9	61.7	80	154.4	92.5	40	205.9	123.4	300	257.3	154.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 5¼ Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.7	33.9	121	100.6	67.2	181	150.5	100.5	241	200.4	133.9
2	01.7	01.1	62	51.6	34.4	22	101.4	67.8	82	151.3	101.1	42	201.2	134.4
3	02.5	01.7	63	52.4	35.0	23	102.3	68.3	83	152.2	101.7	43	202.0	135.0
4	03.3	02.2	64	53.2	35.6	24	103.1	68.9	84	153.0	102.2	44	202.9	135.5
5	04.2	02.8	65	54.0	36.1	25	103.9	69.4	85	153.8	102.8	45	203.7	136.1
6	05.0	03.3	66	54.9	36.7	26	104.8	70.0	86	154.7	103.3	46	204.5	136.7
7	05.8	03.9	67	55.7	37.2	27	105.6	70.5	87	155.5	103.9	47	205.4	137.2
8	06.7	04.4	68	56.5	37.8	28	106.4	71.1	88	156.3	104.4	48	206.2	137.8
9	07.5	05.0	69	57.4	38.3	29	107.3	71.7	89	157.1	105.0	49	207.0	138.3
10	08.3	05.6	70	58.2	38.9	30	108.1	72.2	90	158.0	105.5	50	207.9	138.9
11	09.1	06.1	71	59.0	39.4	131	108.9	72.8	191	158.8	106.1	251	208.7	139.4
12	10.0	06.7	72	59.9	40.0	32	109.8	73.3	92	159.6	106.7	52	209.5	140.0
13	10.8	07.2	73	60.7	40.6	33	110.6	73.9	93	160.5	107.2	53	210.4	140.5
14	11.6	07.8	74	61.5	41.1	34	111.4	74.4	94	161.3	107.8	54	211.2	141.1
15	12.5	08.3	75	62.4	41.7	35	112.2	75.0	95	162.1	108.3	55	212.0	141.7
16	13.3	08.9	76	63.2	42.2	36	113.1	75.5	96	163.0	108.9	56	212.9	142.2
17	14.1	09.4	77	64.0	42.8	37	113.9	76.1	97	163.8	109.4	57	213.7	142.8
18	15.0	10.0	78	64.9	43.3	38	114.7	76.7	98	164.6	110.0	58	214.5	143.3
19	15.8	10.6	79	65.7	43.9	39	115.6	77.2	99	165.5	110.5	59	215.4	143.9
20	16.6	11.1	80	66.5	44.4	40	116.4	77.8	200	166.3	111.1	60	216.2	144.4
21	17.5	11.7	81	67.3	45.0	141	117.2	78.3	201	167.1	111.7	261	217.0	145.0
22	18.3	12.2	82	68.2	45.6	42	118.1	78.9	02	168.0	112.2	62	217.8	145.5
23	19.1	12.8	83	69.0	46.1	43	118.9	79.4	03	168.8	112.8	63	218.7	146.1
24	20.0	13.3	84	69.8	46.7	44	119.7	80.0	04	169.6	113.3	64	219.5	146.7
25	20.8	13.9	85	70.7	47.2	45	120.6	80.5	05	170.5	113.9	65	220.3	147.2
26	21.6	14.4	86	71.5	47.8	46	121.4	81.1	06	171.3	114.4	66	221.2	147.8
27	22.4	15.0	87	72.3	48.3	47	122.2	81.7	07	172.1	115.0	67	222.0	148.3
28	23.3	15.6	88	73.2	48.9	48	123.1	82.2	08	172.9	115.5	68	222.8	148.9
29	24.1	16.1	89	74.0	49.4	49	123.9	82.8	09	173.8	116.1	69	223.7	149.4
30	24.9	16.7	90	74.8	50.0	50	124.7	83.3	10	174.6	116.7	70	224.5	150.0
31	25.8	17.2	91	75.7	50.6	151	125.6	83.9	211	175.4	117.2	271	225.3	150.5
32	26.6	17.8	92	76.5	51.1	52	126.4	84.4	12	176.3	117.8	72	226.2	151.1
33	27.4	18.3	93	77.3	51.7	53	127.2	85.0	13	177.1	118.3	73	227.0	151.7
34	28.3	18.9	94	78.2	52.2	54	128.0	85.5	14	177.9	118.9	74	227.8	152.2
35	29.1	19.4	95	79.0	52.8	55	128.9	86.1	15	178.8	119.4	75	228.7	152.8
36	29.9	20.0	96	79.8	53.3	56	129.7	86.7	16	179.6	120.0	76	229.5	153.3
37	30.8	20.6	97	80.7	53.9	57	130.5	87.2	17	180.4	120.5	77	230.3	153.9
38	31.6	21.1	98	81.5	54.4	58	131.4	87.8	18	181.3	121.1	78	231.1	154.4
39	32.4	21.7	99	82.3	55.0	59	132.2	88.3	19	182.1	121.7	79	232.0	155.0
40	33.3	22.2	100	83.1	55.6	60	133.0	88.9	20	182.9	122.2	80	232.8	155.5
41	34.1	22.8	101	84.0	56.1	161	133.9	89.4	221	183.8	122.8	281	233.6	156.1
42	34.9	23.3	02	84.8	56.7	62	134.7	90.0	22	184.6	123.3	82	234.5	156.7
43	35.8	23.9	03	85.6	57.2	63	135.5	90.5	23	185.4	123.9	83	235.3	157.2
44	36.6	24.4	04	86.5	57.8	64	136.4	91.1	24	186.2	124.4	84	236.1	157.8
45	37.4	25.0	05	87.3	58.3	65	137.2	91.7	25	187.1	125.0	85	237.0	158.3
46	38.2	25.6	06	88.1	58.9	66	138.0	92.2	26	187.9	125.5	86	237.8	158.9
47	39.1	26.1	07	89.0	59.4	67	138.9	92.8	27	188.7	126.1	87	238.6	159.4
48	39.9	26.7	08	89.8	60.0	68	139.7	93.3	28	189.6	126.7	88	239.5	160.0
49	40.7	27.2	09	90.6	60.6	69	140.5	93.9	29	190.4	127.2	89	240.3	160.5
50	41.6	27.8	10	91.5	61.1	70	141.3	94.4	30	191.2	127.8	90	241.1	161.1
51	42.4	28.3	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3	291	242.0	161.7
52	43.2	28.9	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9	92	242.8	162.2
53	44.1	29.4	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4	93	243.6	162.8
54	44.9	30.0	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0	94	244.5	163.3
55	45.7	30.6	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5	95	245.3	163.9
56	46.6	31.1	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1	96	246.1	164.4
57	47.4	31.7	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7	97	246.9	165.0
58	48.2	32.2	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2	98	247.8	165.5
59	49.1	32.8	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8	99	248.6	166.1
60	49.9	33.3	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3	300	249.4	166.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE I. Difference of Latitude and Departure for 3¼ Points.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	49.0	36.3	121	97.2	72.1	181	145.4	107.8	241	193.6	143.6
2	01.6	01.2	62	49.8	36.9	22	98.0	72.7	82	146.2	108.4	42	194.4	144.2
3	02.4	01.8	63	50.6	37.5	23	98.8	73.3	83	147.0	109.0	43	195.2	144.8
4	03.2	02.4	64	51.4	38.1	24	99.6	73.9	84	147.8	109.6	44	196.0	145.4
5	04.0	03.0	65	52.2	38.7	25	100.4	74.5	85	148.6	110.2	45	196.8	145.9
6	04.8	03.6	66	53.0	39.3	26	101.2	75.1	86	149.4	110.8	46	197.6	146.5
7	05.6	04.2	67	53.8	39.9	27	102.0	75.7	87	150.2	111.4	47	198.4	147.1
8	06.4	04.8	68	54.6	40.5	28	102.8	76.2	88	151.0	112.0	48	199.2	147.7
9	07.2	05.4	69	55.4	41.1	29	103.6	76.8	89	151.8	112.6	49	200.0	148.3
10	08.0	06.0	70	56.2	41.7	30	104.4	77.4	90	152.6	113.2	50	200.8	148.9
11	08.8	06.6	71	57.0	42.3	131	105.2	78.0	191	153.4	113.8	251	201.6	149.5
12	09.6	07.1	72	57.8	42.9	32	106.0	78.6	92	154.2	114.4	52	202.4	150.1
13	10.4	07.7	73	58.6	43.5	33	106.8	79.2	93	155.0	115.0	53	203.2	150.7
14	11.2	08.3	74	59.4	44.1	34	107.6	79.8	94	155.8	115.6	54	204.0	151.3
15	12.0	08.9	75	60.2	44.7	35	108.4	80.4	95	156.6	116.2	55	204.8	151.9
16	12.9	09.5	76	61.0	45.3	36	109.2	81.0	96	157.4	116.8	56	205.6	152.5
17	13.7	10.1	77	61.8	45.9	37	110.0	81.6	97	158.2	117.4	57	206.4	153.1
18	14.5	10.7	78	62.7	46.5	38	110.8	82.2	98	159.0	117.9	58	207.2	153.7
19	15.3	11.3	79	63.5	47.1	39	111.6	82.8	99	159.8	118.5	59	208.0	154.3
20	16.1	11.9	80	64.3	47.7	40	112.4	83.4	200	160.6	119.1	60	208.8	154.9
21	16.9	12.5	81	65.1	48.3	141	113.3	84.0	201	161.4	119.7	261	209.6	155.5
22	17.7	13.1	82	65.9	48.8	42	114.1	84.6	02	162.2	120.3	62	210.4	156.1
23	18.5	13.7	83	66.7	49.4	43	114.9	85.2	03	163.1	120.9	63	211.2	156.7
24	19.3	14.3	84	67.5	50.0	44	115.7	85.8	04	163.9	121.5	64	212.0	157.3
25	20.1	14.9	85	68.3	50.6	45	116.5	86.4	05	164.7	122.1	65	212.8	157.9
26	20.9	15.5	86	69.1	51.2	46	117.3	87.0	06	165.5	122.7	66	213.7	158.5
27	21.7	16.1	87	69.9	51.8	47	118.1	87.6	07	166.3	123.3	67	214.5	159.1
28	22.5	16.7	88	70.7	52.4	48	118.9	88.2	08	167.1	123.9	68	215.3	159.6
29	23.3	17.3	89	71.5	53.0	49	119.7	88.8	09	167.9	124.5	69	216.1	160.2
30	24.1	17.9	90	72.3	53.6	50	120.5	89.4	10	168.7	125.1	70	216.9	160.8
31	24.9	18.5	91	73.1	54.2	151	121.3	90.0	211	169.5	125.7	271	217.7	161.4
32	25.7	19.1	92	73.9	54.8	52	122.1	90.5	12	170.3	126.3	72	218.5	162.0
33	26.5	19.7	93	74.7	55.4	53	122.9	91.1	13	171.1	126.9	73	219.3	162.6
34	27.3	20.3	94	75.5	56.0	54	123.7	91.7	14	171.9	127.5	74	210.1	163.2
35	28.1	20.8	95	76.3	56.6	55	124.5	92.3	15	172.7	128.1	75	220.9	163.8
36	28.9	21.4	96	77.1	57.2	56	125.3	92.9	16	173.5	128.7	76	221.7	164.4
37	29.7	22.0	97	77.9	57.8	57	126.1	93.5	17	174.3	129.3	77	222.5	165.0
38	30.5	22.6	98	78.7	58.4	58	126.9	94.1	18	175.1	129.9	78	223.3	165.6
39	31.3	23.2	99	79.5	59.0	59	127.7	94.7	19	175.9	130.5	79	224.1	166.2
40	32.1	23.8	100	80.3	59.6	60	128.5	95.3	20	176.7	131.1	80	224.9	166.8
41	32.9	24.4	101	81.1	60.2	161	129.3	95.9	221	177.5	131.6	281	225.7	167.4
42	33.7	25.0	02	81.9	60.8	62	130.1	96.5	22	178.3	132.2	82	226.5	168.0
43	34.5	25.6	03	82.7	61.4	63	130.9	97.1	23	179.1	132.8	83	227.3	168.6
44	35.3	26.2	04	83.5	62.0	64	131.7	97.7	24	179.9	133.4	84	228.1	169.2
45	36.1	26.8	05	84.3	62.5	65	132.5	98.3	25	180.7	134.0	85	228.9	169.8
46	36.9	27.4	06	85.1	63.1	66	133.3	98.9	26	181.5	134.6	86	229.7	170.4
47	37.8	28.0	07	85.9	63.7	67	134.1	99.5	27	182.3	135.2	87	230.5	171.0
48	38.6	28.6	08	86.7	64.3	68	134.9	100.1	28	183.1	135.8	88	231.3	171.6
49	39.4	29.2	09	87.5	64.9	69	135.7	100.7	29	183.9	136.4	89	232.1	172.2
50	40.2	29.8	10	88.4	65.5	70	136.5	101.3	30	184.7	137.0	90	232.9	172.8
51	41.0	30.4	111	89.2	66.1	171	137.3	101.9	231	185.5	137.6	291	233.7	173.3
52	41.8	31.0	12	90.0	66.7	72	138.2	102.5	32	186.3	138.2	92	234.5	173.9
53	42.6	31.6	13	90.8	67.3	73	139.0	103.1	33	187.1	138.8	93	235.3	174.5
54	43.4	32.2	14	91.6	67.9	74	139.8	103.7	34	188.0	139.4	94	236.1	175.1
55	44.2	32.8	15	92.4	68.5	75	140.6	104.2	35	188.8	140.0	95	236.9	175.7
56	45.0	33.4	16	93.2	69.1	76	141.4	104.8	36	189.6	140.6	96	237.7	176.3
57	45.8	34.0	17	94.0	69.7	77	142.2	105.4	37	190.4	141.2	97	238.6	176.9
58	46.6	34.6	18	94.8	70.3	78	143.0	106.0	38	191.2	141.8	98	239.4	177.5
59	47.4	35.1	19	95.6	70.9	79	143.8	106.6	39	192.0	142.4	99	240.2	178.1
60	48.2	35.7	20	96.4	71.5	80	144.6	107.2	40	192.8	143.0	300	241.0	178.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 4¾ Points.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.0	61	47.2	38.7	121	93.5	76.8	181	139.9	114.8	241	186.3	152.9
2	01.5	01.3	62	47.9	39.3	22	94.3	77.4	82	140.7	115.5	42	187.1	153.5
3	02.3	01.9	63	48.7	40.0	23	95.1	78.0	83	141.5	116.1	43	187.8	154.2
4	03.1	02.5	64	49.5	40.6	24	95.9	78.7	84	142.2	116.7	44	188.6	154.8
5	03.9	03.2	65	50.2	41.2	25	96.6	79.3	85	143.0	117.4	45	189.4	155.4
6	04.6	03.8	66	51.0	41.9	26	97.4	79.9	86	143.8	118.0	46	190.2	156.1
7	05.4	04.4	67	51.8	42.5	27	98.2	80.6	87	144.6	118.6	47	190.9	156.7
8	06.2	05.1	68	52.6	43.1	28	98.9	81.2	88	145.3	119.3	48	191.7	157.3
9	07.0	05.7	69	53.3	43.8	29	99.7	81.8	89	146.1	119.9	49	192.5	158.0
10	07.7	06.3	70	54.1	44.4	30	100.5	82.5	90	146.9	120.5	50	193.3	158.6
11	08.5	07.0	71	54.9	45.0	131	101.3	83.1	191	147.6	121.2	251	194.0	159.2
12	09.3	07.6	72	55.7	45.7	32	102.0	83.7	92	148.4	121.8	52	194.8	159.9
13	10.0	08.2	73	56.4	46.3	33	102.8	84.4	93	149.2	122.4	53	195.6	160.5
14	10.8	08.9	74	57.2	46.9	34	103.6	85.0	94	150.0	123.1	54	196.3	161.1
15	11.6	09.5	75	58.0	47.6	35	104.4	85.6	95	150.7	123.7	55	197.1	161.8
16	12.4	10.2	76	58.7	48.2	36	105.1	86.3	96	151.5	124.3	56	197.9	162.4
17	13.1	10.8	77	59.5	48.8	37	105.9	86.9	97	152.3	125.0	57	198.7	163.0
18	13.9	11.4	78	60.3	49.5	38	106.7	87.5	98	153.1	125.6	58	199.4	163.7
19	14.7	12.1	79	61.1	50.1	39	107.4	88.2	99	153.8	126.2	59	200.2	164.3
20	15.5	12.7	80	61.8	50.8	40	108.2	88.8	200	154.6	126.9	60	201.0	164.9
21	16.2	13.3	81	62.6	51.4	141	109.0	89.4	201	155.4	127.5	261	201.8	165.6
22	17.0	14.0	82	63.4	52.0	42	109.8	90.1	02	156.1	128.1	62	202.5	166.2
23	17.8	14.6	83	64.2	52.7	43	110.5	90.7	03	156.9	128.8	63	203.3	166.8
24	18.6	15.2	84	64.9	53.3	44	111.3	91.4	04	157.7	129.4	64	204.1	167.5
25	19.3	15.9	85	65.7	53.9	45	112.1	92.0	05	158.5	130.1	65	204.8	168.1
26	20.1	16.5	86	66.5	54.6	46	112.9	92.6	06	159.2	130.7	66	205.6	168.7
27	20.9	17.1	87	67.3	55.2	47	113.6	93.3	07	160.0	131.3	67	206.4	169.4
28	21.6	17.8	88	68.0	55.8	48	114.4	93.9	08	160.8	132.0	68	207.2	170.0
29	22.4	18.4	89	68.8	56.5	49	115.2	94.5	09	161.6	132.6	69	207.9	170.7
30	23.2	19.0	90	69.6	57.1	50	116.0	95.2	10	162.3	133.2	70	208.7	171.3
31	24.0	19.7	91	70.3	57.7	151	116.7	95.8	211	163.1	133.9	271	209.5	171.9
32	24.7	20.3	92	71.1	58.4	52	117.5	96.4	12	163.9	134.5	72	210.3	172.6
33	25.5	20.9	93	71.9	59.0	53	118.3	97.1	13	164.7	135.1	73	211.0	173.2
34	26.3	21.6	94	72.7	59.6	54	119.0	97.7	14	165.4	135.8	74	211.8	173.8
35	27.1	22.2	95	73.4	60.3	55	119.8	98.3	15	166.2	136.4	75	212.6	174.5
36	27.8	22.8	96	74.2	60.9	56	120.6	99.0	16	167.0	137.0	76	213.4	175.1
37	28.6	23.5	97	75.0	61.5	57	121.4	99.6	17	167.7	137.7	77	214.1	175.7
38	29.4	24.1	98	75.8	62.2	58	122.1	100.2	18	168.5	138.3	78	214.9	176.4
39	30.1	24.7	99	76.5	62.8	59	122.9	100.9	19	169.3	138.9	79	215.7	177.0
40	30.9	25.4	100	77.3	63.4	60	123.7	101.5	20	170.1	139.6	80	216.4	177.6
41	31.7	26.0	101	78.1	64.1	161	124.5	102.1	221	170.8	140.2	281	217.2	178.3
42	32.5	26.6	02	78.8	64.7	62	125.2	102.8	22	171.6	140.8	82	218.0	178.9
43	33.2	27.3	03	79.6	65.3	63	126.0	103.4	23	172.4	141.5	83	218.8	179.5
44	34.0	27.9	04	80.4	66.0	64	126.8	104.0	24	173.2	142.1	84	219.5	180.2
45	34.8	28.5	05	81.2	66.6	65	127.5	104.7	25	173.9	142.7	85	220.3	180.8
46	35.6	29.2	06	81.9	67.2	66	128.3	105.3	26	174.7	143.4	86	221.1	181.4
47	36.3	29.8	07	82.7	67.9	67	129.1	105.9	27	175.5	144.0	87	221.9	182.1
48	37.1	30.5	08	83.5	68.5	68	129.9	106.6	28	176.2	144.6	88	222.6	182.7
49	37.9	31.1	09	84.3	69.1	69	130.6	107.2	29	177.0	145.3	89	223.4	183.3
50	38.7	31.7	10	85.0	69.8	70	131.4	107.8	30	177.8	145.9	90	224.2	184.0
51	39.4	32.4	111	85.8	70.4	171	132.2	108.5	231	178.6	146.5	291	224.9	184.6
52	40.2	33.0	12	86.6	71.1	72	133.0	109.1	32	179.3	147.2	92	225.7	185.2
53	41.0	33.6	13	87.4	71.7	73	133.7	109.8	33	180.1	147.8	93	226.5	185.9
54	41.7	34.3	14	88.1	72.3	74	134.5	110.4	34	180.9	148.4	94	227.3	186.5
55	42.5	34.9	15	88.9	73.0	75	135.3	111.0	35	181.7	149.1	95	228.0	187.1
56	43.3	35.5	16	89.7	73.6	76	136.0	111.7	36	182.4	149.7	96	228.8	187.8
57	44.1	36.2	17	90.4	74.2	77	136.8	112.3	37	183.2	150.4	97	229.6	188.4
58	44.8	36.8	18	91.2	74.9	78	137.6	112.9	38	184.0	151.0	98	230.4	189.0
59	45.6	37.4	19	92.0	75.5	79	138.4	113.6	39	184.7	151.6	99	231.1	189.7
60	46.4	38.1	20	92.8	76.1	80	139.1	114.2	40	185.5	152.3	300	231.9	190.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE I. Difference of Latitude and Departure for 3¾ Points.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	45.2	41.0	121	89.7	81.3	181	134.1	121.6	241	178.6	161.8
2	01.5	01.3	62	45.9	41.6	22	90.4	81.9	82	134.9	122.2	42	179.3	162.5
3	02.2	02.0	63	46.7	42.3	23	91.1	82.6	83	135.6	122.9	43	180.1	163.2
4	03.0	02.7	64	47.4	43.0	24	91.9	83.3	84	136.3	123.6	44	180.8	163.9
5	03.7	03.4	65	48.2	43.7	25	92.6	83.9	85	137.1	124.2	45	181.5	164.5
6	04.4	04.0	66	48.9	44.3	26	93.4	84.6	86	137.8	124.9	46	182.3	165.2
7	05.2	04.7	67	49.6	45.0	27	94.1	85.3	87	138.6	125.6	47	183.0	165.9
8	05.9	05.4	68	50.4	45.7	28	94.8	86.0	88	139.3	126.3	48	183.8	166.5
9	06.7	06.0	69	51.1	46.3	29	95.6	86.6	89	140.0	126.9	49	184.5	167.2
10	07.4	06.7	70	51.9	47.0	30	96.3	87.3	90	140.8	127.6	50	185.2	167.9
11	08.2	07.4	71	52.6	47.7	131	97.1	88.0	191	141.5	128.3	251	186.0	168.6
12	08.9	08.1	72	53.3	48.4	32	97.8	88.6	92	142.3	128.9	52	186.7	169.2
13	09.6	08.7	73	54.1	49.0	33	98.5	89.3	93	143.0	129.6	53	187.5	169.9
14	10.4	09.4	74	54.8	49.7	34	99.3	90.0	94	143.7	130.3	54	188.2	170.6
15	11.1	10.1	75	55.6	50.4	35	100.0	90.7	95	144.5	131.0	55	188.9	171.2
16	11.9	10.7	76	56.3	51.0	36	100.8	91.3	96	145.2	131.6	56	189.7	171.9
17	12.6	11.4	77	57.1	51.7	37	101.5	92.0	97	146.0	132.3	57	190.4	172.6
18	13.3	12.1	78	57.8	52.4	38	102.3	92.7	98	146.7	133.0	58	191.2	173.3
19	14.1	12.8	79	58.5	53.1	39	103.0	93.3	99	147.4	133.6	59	191.9	173.9
20	14.8	13.4	80	59.3	53.7	40	103.7	94.0	200	148.2	134.3	60	192.6	174.6
21	15.6	14.1	81	60.0	54.4	141	104.5	94.7	201	148.9	135.0	261	193.4	175.3
22	16.3	14.8	82	60.8	55.1	42	105.2	95.4	02	149.7	135.7	62	194.1	175.9
23	17.0	15.4	83	61.5	55.7	43	106.0	96.0	03	150.4	136.3	63	194.9	176.6
24	17.8	16.1	84	62.2	56.4	44	106.7	96.7	04	151.2	137.0	64	195.6	177.3
25	18.5	16.8	85	63.0	57.1	45	107.4	97.4	05	151.9	137.7	65	196.4	178.0
26	19.3	17.5	86	63.7	57.8	46	108.2	98.0	06	152.6	138.3	66	197.1	178.6
27	20.0	18.1	87	64.5	58.4	47	108.9	98.7	07	153.4	139.0	67	197.8	179.3
28	20.7	18.8	88	65.2	59.1	48	109.7	99.4	08	154.1	139.7	68	198.6	180.0
29	21.5	19.5	89	65.9	59.8	49	110.4	100.1	09	154.9	140.4	69	199.3	180.6
30	22.2	20.1	90	66.7	60.4	50	111.1	100.7	10	155.6	141.0	70	200.1	181.3
31	23.0	20.8	91	67.4	61.1	151	111.9	101.4	211	156.3	141.7	271	200.8	182.0
32	23.7	21.5	92	68.2	61.8	52	112.6	102.1	12	157.1	142.4	72	201.5	182.7
33	24.5	22.2	93	68.9	62.5	53	113.4	102.7	13	157.8	143.0	73	202.3	183.3
34	25.2	22.8	94	69.6	63.1	54	114.1	103.4	14	158.6	143.7	74	203.0	184.0
35	25.9	23.5	95	70.4	63.8	55	114.8	104.1	15	159.3	144.4	75	203.8	184.7
36	26.7	24.2	96	71.1	64.5	56	115.6	104.8	16	160.0	145.1	76	204.5	185.4
37	27.4	24.8	97	71.9	65.1	57	116.3	105.4	17	160.8	145.7	77	205.2	186.0
38	28.2	25.5	98	72.6	65.8	58	117.1	106.1	18	161.5	146.4	78	206.0	186.7
39	28.9	26.2	99	73.4	66.5	59	117.8	106.8	19	162.3	147.1	79	206.7	187.4
40	29.6	26.9	100	74.1	67.2	60	118.6	107.4	20	163.0	147.7	80	207.5	188.0
41	30.4	27.5	101	74.8	67.8	161	119.3	108.1	221	163.8	148.4	281	208.2	188.7
42	31.1	28.2	02	75.6	68.5	62	120.0	108.8	22	164.5	149.1	82	208.9	189.4
43	31.9	28.9	03	76.3	69.2	63	120.8	109.5	23	165.2	149.8	83	209.7	190.1
44	32.6	29.5	04	77.1	69.8	64	121.5	110.1	24	166.0	150.4	84	210.4	190.7
45	33.3	30.2	05	77.8	70.5	65	122.3	110.8	25	166.7	151.1	85	211.2	191.4
46	34.1	30.9	06	78.5	71.2	66	123.0	111.5	26	167.5	151.8	86	211.9	192.1
47	34.8	31.6	07	79.3	71.9	67	123.7	112.2	27	168.2	152.4	87	212.7	192.7
48	35.6	32.2	08	80.0	72.5	68	124.5	112.8	28	168.9	153.1	88	213.4	193.4
49	36.3	32.9	09	80.8	73.2	69	125.2	113.5	29	169.7	153.8	89	214.1	194.1
50	37.0	33.6	10	81.5	73.9	70	126.0	114.2	30	170.4	154.5	90	214.9	194.8
51	37.8	34.2	111	82.2	74.5	171	126.7	114.8	231	171.2	155.1	291	215.6	195.4
52	38.5	34.9	12	83.0	75.2	72	127.4	115.5	32	171.9	155.8	92	216.4	196.1
53	39.3	35.6	13	83.7	75.9	73	128.2	116.2	33	172.6	156.5	93	217.1	196.8
54	40.0	36.3	14	84.5	76.6	74	128.9	116.9	34	173.4	157.1	94	217.8	197.4
55	40.8	36.9	15	85.2	77.2	75	129.7	117.5	35	174.1	157.8	95	218.6	198.1
56	41.5	37.6	16	86.0	77.9	76	130.4	118.2	36	174.9	158.5	96	219.3	198.8
57	42.2	38.3	17	86.7	78.6	77	131.1	118.9	37	175.6	159.2	97	220.1	199.5
58	43.0	39.0	18	87.4	79.2	78	131.9	119.5	38	176.3	159.8	98	220.8	200.1
59	43.7	39.6	19	88.2	79.9	79	132.6	120.2	39	177.1	160.5	99	221.5	200.8
60	44.5	40.3	20	88.9	80.6	80	133.4	120.9	40	177.8	161.2	300	222.3	201.5
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 4¼ Points.

Table I. Difference of Latitude and Departure for 4 Points.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	04.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.4	204.4
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 4 Points.

TABLE II. Difference of Latitude and Departure for 1 Degree.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist.	Lat.	Dep.	Dist	Lat.	Dep.	Dist.	Lat.	Dep
1	01.0	00.0	61	61.0	01.1	121	121.0	02.1	181	181.0	03.2	241	241.0	04.2
2	02.0	00.0	62	62.0	01.1	22	122.0	02.1	82	182.0	03.2	42	242.0	04.2
3	03.0	00.1	63	63.0	01.1	23	123.0	02.1	83	183.0	03.2	43	243.0	04.2
4	04.0	00.1	64	64.0	01.1	24	124.0	02.2	84	184.0	03.2	44	244.0	04.3
5	05.0	00.1	65	65.0	01.1	25	125.0	02.2	85	185.0	03.2	45	245.0	04.3
6	06.0	00.1	66	66.0	01.2	26	126.0	02.2	86	186.0	03.2	46	246.0	04.3
7	07.0	00.1	67	67.0	01.2	27	127.0	02.2	87	187.0	03.3	47	247.0	04.3
8	08.0	00.1	68	68.0	01.2	28	128.0	02.2	88	188.0	03.3	48	248.0	04.3
9	09.0	00.2	69	69.0	01.2	29	129.0	02.3	89	189.0	03.3	49	249.0	04.3
10	10.0	00.2	70	70.0	01.2	30	130.0	02.3	90	190.0	03.3	50	250.0	04.4
11	11.0	00.2	71	71.0	01.2	131	131.0	02.3	191	191.0	03.3	251	251.0	04.4
12	12.0	00.2	72	72.0	01.3	32	132.0	02.3	92	192.0	03.4	52	252.0	04.4
13	13.0	00.2	73	73.0	01.3	33	133.0	02.3	93	193.0	03.4	53	253.0	04.4
14	14.0	00.2	74	74.0	01.3	34	134.0	02.3	94	194.0	03.4	54	254.0	04.4
15	15.0	00.3	75	75.0	01.3	35	135.0	02.4	95	195.0	03.4	55	255.0	04.5
16	16.0	00.3	76	76.0	01.3	36	136.0	02.4	96	196.0	03.4	56	256.0	04.5
17	17.0	00.3	77	77.0	01.3	37	137.0	02.4	97	197.0	03.4	57	257.0	04.5
18	18.0	00.3	78	78.0	01.4	38	138.0	02.4	98	198.0	03.5	58	258.0	04.5
19	19.0	00.3	79	79.0	01.4	39	139.0	02.4	99	199.0	03.5	59	259.0	04.5
20	20.0	00.3	80	80.0	01.4	40	140.0	02.4	200	200.0	03.5	60	260.0	04.5
21	21.0	00.4	81	81.0	01.4	141	141.0	02.5	201	201.0	03.5	261	261.0	04.6
22	22.0	00.4	82	82.0	01.4	42	142.0	02.5	02	202.0	03.5	62	262.0	04.6
23	23.0	00.4	83	83.0	01.4	43	143.0	02.5	03	203.0	03.5	63	263.0	04.6
24	24.0	00.4	84	84.0	01.5	44	144.0	02.5	04	204.0	03.6	64	264.0	04.6
25	25.0	00.4	85	85.0	01.5	45	145.0	02.5	05	205.0	03.6	65	265.0	04.6
26	26.0	00.5	86	86.0	01.5	46	146.0	02.5	06	206.0	03.6	66	266.0	04.6
27	27.0	00.5	87	87.0	01.5	47	147.0	02.6	07	207.0	03.6	67	267.0	04.7
28	28.0	00.5	88	88.0	01.5	48	148.0	02.6	08	208.0	03.6	68	268.0	04.7
29	29.0	00.5	89	89.0	01.6	49	149.0	02.6	09	209.0	03.6	69	269.0	04.7
30	30.0	00.5	90	90.0	01.6	50	150.0	02.6	10	210.0	03.7	70	270.0	04.7
31	31.0	00.5	91	91.0	01.6	151	151.0	02.6	211	211.0	03.7	271	271.0	04.7
32	32.0	00.6	92	92.0	01.6	52	152.0	02.7	12	212.0	03.7	72	272.0	04.7
33	33.0	00.6	93	93.0	01.6	53	153.0	02.7	13	213.0	03.7	73	273.0	04.8
34	34.0	00.6	94	94.0	01.6	54	154.0	02.7	14	214.0	03.7	74	274.0	04.8
35	35.0	00.6	95	95.0	01.7	55	155.0	02.7	15	215.0	03.8	75	275.0	04.8
36	36.0	00.6	96	96.0	01.7	56	156.0	02.7	16	216.0	03.8	76	276.0	04.8
37	37.0	00.6	97	97.0	01.7	57	157.0	02.7	17	217.0	03.8	77	277.0	04.8
38	38.0	00.7	98	98.0	01.7	58	158.0	02.8	18	218.0	03.8	78	278.0	04.9
39	39.0	00.7	99	99.0	01.7	59	159.0	02.8	19	219.0	03.8	79	279.0	04.9
40	40.0	00.7	100	100.0	01.7	60	160.0	02.8	20	220.0	03.8	80	280.0	04.9
41	41.0	00.7	101	101.0	01.8	161	161.0	02.8	221	221.0	03.9	281	281.0	04.9
42	42.0	00.7	02	102.0	01.8	62	162.0	02.8	22	222.0	03.9	82	282.0	04.9
43	43.0	00.8	03	103.0	01.8	63	163.0	02.8	23	223.0	03.9	83	283.0	04.9
44	44.0	00.8	04	104.0	01.8	64	164.0	02.9	24	224.0	03.9	84	284.0	05.0
45	45.0	00.8	05	105.0	01.8	65	165.0	02.9	25	225.0	03.9	85	285.0	05.0
46	46.0	00.8	06	106.0	01.8	66	166.0	02.9	26	226.0	03.9	86	286.0	05.0
47	47.0	00.8	07	107.0	01.9	67	167.0	02.9	27	227.0	04.0	87	287.0	05.0
48	48.0	00.8	08	108.0	01.9	68	168.0	02.9	28	228.0	04.0	88	288.0	05.0
49	49.0	00.9	09	109.0	01.9	69	169.0	02.9	29	229.0	04.0	89	289.0	05.0
50	50.0	00.9	10	110.0	01.9	70	170.0	03.0	30	230.0	04.0	90	290.0	05.1
51	51.0	00.9	111	111.0	01.9	171	171.0	03.0	231	231.0	04.0	291	291.0	05.1
52	52.0	00.9	12	112.0	02.0	72	172.0	03.0	32	232.0	04.0	92	292.0	05.1
53	53.0	00.9	13	113.0	02.0	73	173.0	03.0	33	233.0	04.1	93	293.0	05.1
54	54.0	00.9	14	114.0	02.0	74	174.0	03.0	34	234.0	04.1	94	294.0	05.1
55	55.0	01.0	15	115.0	02.0	75	175.0	03.1	35	235.0	04.1	95	295.0	05.1
56	56.0	01.0	16	116.0	02.0	76	176.0	03.1	36	236.0	04.1	96	296.0	05.2
57	57.0	01.0	17	117.0	02.0	77	177.0	03.1	37	237.0	04.1	97	297.0	05.2
58	58.0	01.0	18	118.0	02.1	78	178.0	03.1	38	238.0	04.2	98	298.0	05.2
59	59.0	01.0	19	119.0	02.1	79	179.0	03.1	39	239.0	04.2	99	299.0	05.2
60	60.0	01.0	20	120.0	02.1	80	180.0	03.1	40	240.0	04.2	300	300.0	05.2
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist.	Dep.	Lat.

(For 89 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	02.1	121	120.9	04.2	181	180.9	06.3	241	240.9	08.4
2	02.0	00.1	62	62.0	02.2	22	121.9	04.3	82	181.9	06.4	42	241.9	08.4
3	03.0	00.1	63	63.0	02.2	23	122.9	04.3	83	182.9	06.4	43	242.9	08.9
4	04.0	00.1	64	64.0	02.2	24	123.9	04.3	84	183.9	06.4	44	243.9	08.5
5	05.0	00.2	65	65.0	02.3	25	124.9	04.4	85	184.9	06.5	45	244.9	08.6
6	06.0	00.2	66	66.0	02.3	26	125.9	04.4	86	185.9	06.5	46	245.9	08.6
7	07.0	00.2	67	67.0	02.3	27	126.9	04.4	87	186.9	06.5	47	246.8	08.6
8	08.0	00.3	68	68.0	02.4	28	127.9	04.5	88	187.9	06.6	48	247.8	08.7
9	09.0	00.3	69	69.0	02.4	29	128.9	04.5	89	188.9	06.6	49	248.8	08.7
10	10.0	00.3	70	70.0	02.4	30	129.9	04.5	90	189.9	06.6	50	249.8	08.7
11	11.0	00.4	71	71.0	02.5	131	130.9	04.6	191	190.9	06.7	251	250.8	08.8
12	12.0	00.4	72	72.0	02.5	32	131.9	04.6	92	191.9	06.7	52	251.8	08.8
13	13.0	00.5	73	73.0	02.5	33	132.9	04.6	93	192.9	06.7	53	252.8	08.8
14	14.0	00.5	74	74.0	02.6	34	133.9	04.7	94	193.9	06.8	54	253.8	08.9
15	15.0	00.5	75	75.0	02.6	35	134.9	04.7	95	194.9	06.8	55	254.8	08.9
16	16.0	00.6	76	76.0	02.7	36	135.9	04.7	96	195.9	06.8	56	255.8	08.9
17	17.0	00.6	77	77.0	02.7	37	136.9	04.8	97	196.9	06.9	57	256.8	09.0
18	18.0	00.6	78	78.0	02.7	38	137.9	04.8	98	197.9	06.9	58	257.8	09.0
19	19.0	00.7	79	79.0	02.8	39	138.9	04.9	99	198.9	06.9	59	258.8	09.0
20	20.0	00.7	80	80.0	02.8	40	139.9	04.9	200	199.9	07.0	60	259.8	09.1
21	21.0	00.7	81	81.0	02.8	141	140.9	04.9	201	200.9	07.0	261	260.8	09.1
22	22.0	00.8	82	82.0	02.9	42	141.9	05.0	02	201.9	07.0	62	261.8	09.1
23	23.0	00.8	83	82.9	02.9	43	142.9	05.0	03	202.9	07.1	63	262.8	09.2
24	24.0	00.8	84	83.9	02.9	44	143.9	05.0	04	203.9	07.1	64	263.8	09.2
25	25.0	00.9	85	84.9	03.0	45	144.9	05.1	05	204.9	07.2	65	264.8	09.2
26	26.0	00.9	86	85.9	03.0	46	145.9	05.1	06	205.9	07.2	66	265.8	09.3
27	27.0	00.9	87	86.9	03.0	47	146.9	05.1	07	206.9	07.2	67	266.8	09.3
28	28.0	01.0	88	87.9	03.1	48	147.9	05.2	08	207.9	07.3	68	267.8	09.4
29	29.0	01.0	89	88.9	03.1	49	148.9	05.2	09	208.9	07.3	69	268.8	09.4
30	30.0	01.0	90	89.9	03.1	50	149.9	05.2	10	209.9	07.3	70	269.8	09.4
31	31.0	01.1	91	90.9	03.2	151	150.9	05.3	211	210.9	07.4	271	270.8	09.5
32	32.0	01.1	92	91.9	03.2	52	151.9	05.3	12	211.9	07.4	72	271.8	09.5
33	33.0	01.2	93	92.9	03.2	53	152.9	05.3	13	212.9	07.4	73	272.8	09.5
34	34.0	01.2	94	93.9	03.3	54	153.9	05.4	14	213.9	07.5	74	273.8	09.5
35	35.0	01.2	95	94.9	03.3	55	154.9	05.4	15	214.9	07.5	75	274.8	09.6
36	36.0	01.3	96	95.9	03.4	56	155.9	05.4	16	215.9	07.5	76	275.8	09.6
37	37.0	01.3	97	96.9	03.4	57	156.9	05.5	17	216.9	07.6	77	276.8	09.7
38	38.0	01.3	98	97.9	03.4	58	157.9	05.5	18	217.9	07.6	78	277.8	09.7
39	39.0	01.4	99	98.9	03.5	59	158.9	05.5	19	218.9	07.6	79	278.8	09.7
40	40.0	01.4	100	99.9	03.5	60	159.9	05.6	20	219.9	07.7	80	279.8	09.8
41	41.0	01.4	101	100.9	03.5	161	160.9	05.6	221	220.9	07.7	281	280.8	09.8
42	42.0	01.5	02	101.9	03.6	62	161.9	05.7	22	221.9	07.7	82	281.8	09.8
43	43.0	01.5	03	102.9	03.6	63	162.9	05.7	23	222.9	07.8	83	282.8	09.9
44	44.0	01.5	04	103.9	03.6	64	163.9	05.7	24	223.9	07.8	84	283.8	09.9
45	45.0	01.6	05	104.9	03.7	65	164.9	05.8	25	224.9	07.9	85	284.8	09.9
46	46.0	01.6	06	105.9	03.7	66	165.9	05.8	26	225.9	07.9	86	285.8	10.0
47	47.0	01.6	07	106.9	03.7	67	166.9	05.8	27	226.9	07.9	87	286.8	10.0
48	48.0	01.7	08	107.9	03.8	68	167.9	05.9	28	227.9	08.0	88	287.8	10.1
49	49.0	01.7	09	108.9	03.8	69	168.9	05.9	29	228.9	08.0	89	288.8	10.1
50	50.0	01.7	10	109.9	03.8	70	169.9	05.9	30	229.9	08.0	90	289.8	10.1
51	51.0	01.8	111	110.9	03.9	171	170.9	06.0	231	230.9	08.1	291	290.8	10.2
52	52.0	01.8	12	111.9	03.9	72	171.9	06.0	32	231.9	08.1	92	291.8	10.2
53	53.0	01.8	13	112.9	03.9	73	172.9	06.0	33	232.9	08.1	93	292.8	10.2
54	54.0	01.9	14	113.9	04.0	74	173.9	06.1	34	233.9	08.2	94	293.8	10.3
55	55.0	01.9	15	114.9	04.0	75	174.9	06.1	35	234.9	08.2	95	294.8	10.3
56	56.0	02.0	16	115.9	04.0	76	175.9	06.1	36	235.9	08.2	96	295.8	10.3
57	57.0	02.0	17	116.9	04.1	77	176.9	06.2	37	236.9	08.3	97	296.8	10.4
58	58.0	02.0	18	117.9	04.1	78	177.9	06.2	38	237.9	08.3	98	297.8	10.4
59	59.0	02.1	19	118.9	04.2	79	178.9	06.2	39	238.9	08.3	99	298.8	10.4
60	60.0	02.1	20	119.9	04.2	80	179.9	06.3	40	239.9	08.4	300	299.8	10.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 88 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	03.2	121	120.8	06.3	181	180.8	09.5	241	240.7	12.6
2	02.0	00.1	62	61.9	03.2	22	121.8	06.4	82	181.8	09.5	42	241.7	12.7
3	03.0	00.2	63	62.9	03.3	23	122.8	06.4	83	182.7	09.6	43	242.7	12.7
4	04.0	00.2	64	63.9	03.3	24	123.8	06.5	84	183.7	09.6	44	243.7	12.8
5	05.0	00.3	65	64.9	03.4	25	124.8	06.5	85	184.7	09.7	45	244.7	12.8
6	06.0	00.3	66	65.9	03.5	26	125.8	06.6	86	185.7	09.7	46	245.7	12.9
7	07.0	00.4	67	66.9	03.5	27	126.8	06.6	87	186.7	09.8	47	246.7	12.9
8	08.0	00.4	68	67.9	03.6	28	127.8	06.7	88	187.7	09.8	48	247.7	13.0
9	09.0	00.5	69	68.9	03.6	29	128.8	06.8	89	188.7	09.9	49	248.7	13.0
10	10.0	00.5	70	69.9	03.7	30	129.8	06.8	90	189.7	09.9	50	249.7	13.1
11	11.0	00.6	71	70.9	03.7	131	130.8	06.9	191	190.7	10.0	251	250.7	13.1
12	12.0	00.6	72	71.9	03.8	32	131.8	06.9	92	191.7	10.0	52	251.7	13.2
13	13.0	00.7	73	72.9	03.8	33	132.8	07.0	93	192.7	10.1	53	252.7	13.2
14	14.0	00.7	74	73.9	03.9	34	133.8	07.0	94	193.7	10.2	54	253.7	13.3
15	15.0	00.8	75	74.9	03.9	35	134.8	07.1	95	194.7	10.2	55	254.7	13.3
16	16.0	00.8	76	75.9	04.0	36	135.8	07.1	96	195.7	10.3	56	255.6	13.4
17	17.0	00.9	77	76.9	04.0	37	136.8	07.2	97	196.7	10.3	57	256.6	13.5
18	18.0	00.9	78	77.9	04.1	38	137.8	07.2	98	197.7	10.4	58	257.6	13.5
19	19.0	01.0	79	78.9	04.1	39	138.8	07.3	99	198.7	10.4	59	258.6	13.6
20	20.0	01.0	80	79.9	04.2	40	139.8	07.3	200	199.7	10.5	60	259.6	13.6
21	21.0	01.1	81	80.9	04.2	141	140.8	07.4	201	200.7	10.5	261	260.6	13.7
22	22.0	01.2	82	81.9	04.3	42	141.8	07.4	02	201.7	10.6	62	261.6	13.7
23	23.0	01.2	83	82.9	04.3	43	142.8	07.5	03	202.7	10.6	63	262.6	13.8
24	24.0	01.3	84	83.9	04.4	44	143.8	07.5	04	203.7	10.7	64	263.6	13.8
25	25.0	01.3	85	84.9	04.4	45	144.8	07.6	05	204.7	10.7	65	264.6	13.9
26	26.0	01.4	86	85.9	04.5	46	145.8	07.6	06	205.7	10.8	66	265.6	13.9
27	27.0	01.4	87	86.9	04.6	47	146.8	07.7	07	206.7	10.8	67	266.6	14.0
28	28.0	01.5	88	87.9	04.6	48	147.8	07.7	08	207.7	10.9	68	267.6	14.0
29	29.0	01.5	89	88.9	04.7	49	148.8	07.8	09	208.7	10.9	69	268.6	14.1
30	30.0	01.6	90	89.9	04.7	50	149.8	07.9	10	209.7	11.0	70	269.6	14.1
31	31.0	01.6	91	90.9	04.8	151	150.8	07.9	211	210.7	11.0	271	270.6	14.2
32	32.0	01.7	92	91.9	04.8	52	151.8	08.0	12	211.7	11.1	72	271.6	14.2
33	33.0	01.7	93	92.9	04.9	53	152.8	08.0	13	212.7	11.1	73	272.6	14.3
34	34.0	01.8	94	93.9	04.9	54	153.8	08.1	14	213.7	11.2	74	273.6	14.3
35	35.0	01.8	95	94.9	05.0	55	154.8	08.1	15	214.7	11.3	75	274.6	14.4
36	36.0	01.9	96	95.9	05.0	56	155.8	08.2	16	215.7	11.3	76	275.6	14.4
37	36.9	01.9	97	96.9	05.1	57	156.8	08.2	17	216.7	11.4	77	276.6	14.5
38	37.9	02.0	98	97.9	05.1	58	157.8	08.3	18	217.7	11.4	78	277.6	14.5
39	38.9	02.0	99	98.9	05.2	59	158.8	08.3	19	218.7	11.5	79	278.6	14.6
40	39.9	02.1	100	99.9	05.2	60	159.8	08.4	20	219.7	11.5	80	279.6	14.7
41	40.9	02.1	101	100.9	05.3	161	160.8	08.[illegible]	221	220.7	11.6	281	280.6	14.7
42	41.9	02.2	02	101.9	05.3	62	161.8	08.5	22	221.7	11.6	82	281.6	14.8
43	42.9	02.3	03	102.9	05.4	63	162.8	08.5	23	222.7	11.7	83	282.6	14.8
44	43.9	02.3	04	103.9	05.4	64	163.8	08.6	24	223.7	11.7	84	283.6	14.9
45	44.9	02.4	05	104.9	05.5	65	164.8	08.6	25	224.7	11.8	85	284.6	14.9
46	45.9	02.4	06	105.9	05.5	66	165.8	08.7	26	225.7	11.8	86	285.6	15.0
47	46.9	02.5	07	106.9	05.6	67	166.8	08.7	27	226.7	11.9	87	286.6	15.0
48	47.9	02.5	08	107.9	05.7	68	167.8	08.8	28	227.7	11.9	88	287.6	15.1
49	48.9	02.6	09	108.9	05.7	69	168.8	08.8	29	228.7	12.0	89	288.6	15.1
50	49.9	02.6	10	109.8	05.8	70	169.8	08.9	30	229.7	12.0	90	289.6	15.2
51	50.9	02.7	111	110.8	05.8	171	170.8	08.9	231	230.7	12.1	291	290.6	15.2
52	51.9	02.7	12	111.8	05.9	72	171.8	09.0	32	231.7	12.1	92	291.6	15.3
53	52.9	02.8	13	112.8	05.9	73	172.8	09.1	33	232.7	12.2	93	292.6	15.3
54	53.9	02.8	14	113.8	06.0	74	173.8	09.1	34	233.7	12.2	94	293.6	15.4
55	54.9	02.9	15	114.8	06.0	75	174.8	09.2	35	234.7	12.3	95	294.6	15.4
56	55.9	02.9	16	115.8	06.1	76	175.8	09.2	36	235.7	12.4	96	295.6	15.5
57	56.9	03.0	17	116.8	06.1	77	176.8	09.3	37	236.7	12.4	97	296.6	15.5
58	57.9	03.0	18	117.8	06.2	78	177.8	09.3	38	237.7	12.5	98	297.6	15.6
59	58.9	03.1	19	118.8	06.2	79	178.8	09.4	39	238.7	12.5	99	298.6	15.6
60	59.9	03.1	20	119.8	06.3	80	179.8	09.4	40	239.7	12.6	300	299.6	15.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	04.3	121	120.7	08.4	181	180.6	12.6	241	240.4	16.8
2	02.0	00.1	62	61.8	04.3	22	121.7	08.5	82	181.6	12.7	42	241.4	16.9
3	03.0	00.2	63	62.8	04.4	23	122.7	08.6	83	182.6	12.8	43	242.4	17.0
4	04.0	00.3	64	63.8	04.5	24	123.7	08.6	84	183.6	12.8	44	243.4	17.0
5	05.0	00.3	65	64.8	04.5	25	124.7	08.7	85	184.5	12.9	45	244.4	17.1
6	06.0	00.4	66	65.8	04.6	26	125.7	08.8	86	185.5	13.0	46	245.4	17.2
7	07.0	00.5	67	66.8	04.7	27	126.7	08.9	87	186.5	13.0	47	246.4	17.2
8	08.0	00.6	68	67.8	04.7	28	127.7	08.9	88	187.5	13.1	48	247.4	17.3
9	09.0	00.6	69	68.8	04.8	29	128.7	09.0	89	188.5	13.2	49	248.4	17.4
10	10.0	00.7	70	69.8	04.9	30	129.7	09.1	90	189.5	13.3	50	249.4	17.4
11	11.0	00.8	71	70.8	05.0	131	130.7	09.1	191	190.5	13.3	251	250.4	17.5
12	12.0	00.8	72	71.8	05.0	32	131.7	09.2	92	191.5	13.4	52	251.4	17.6
13	13.0	00.9	73	72.8	05.1	33	132.7	09.3	93	192.5	13.5	53	252.4	17.6
14	14.0	01.0	74	73.8	05.2	34	133.7	09.3	94	193.5	13.5	54	253.4	17.7
15	15.0	01.0	75	74.8	05.2	35	134.7	09.4	95	194.5	13.6	55	254.4	17.8
16	16.0	01.1	76	75.8	05.3	36	135.7	09.5	96	195.5	13.7	56	255.4	17.9
17	17.0	01.2	77	76.8	05.4	37	136.7	09.6	97	196.5	13.7	57	256.4	17.9
18	18.0	01.3	78	77.8	05.4	38	137.7	09.6	98	197.5	13.8	58	257.4	18.0
19	19.0	01.3	79	78.8	05.5	39	138.7	09.7	99	198.5	13.9	59	258.4	18.1
20	20.0	01.4	80	79.8	05.6	40	139.7	09.8	200	199.5	14.0	60	259.4	18.1
21	20.9	01.5	81	80.8	05.7	141	140.7	09.8	201	200.5	14.0	261	260.4	18.2
22	21.9	01.5	82	81.8	05.7	42	141.7	09.9	02	201.5	14.1	62	261.4	18.3
23	22.9	01.6	83	82.8	05.8	43	142.7	10.0	03	202.5	14.2	63	262.4	18.3
24	23.9	01.7	84	83.8	05.9	44	143.6	10.0	04	203.5	14.2	64	263.4	18.4
25	24.9	01.7	85	84.8	05.9	45	144.6	10.1	05	204.5	14.3	65	264.4	18.5
26	25.9	01.8	86	85.8	06.0	46	145.6	10.2	06	205.5	14.4	66	265.4	18.6
27	26.9	01.9	87	86.8	06.1	47	146.6	10.3	07	206.5	14.4	67	266.3	18.6
28	27.9	02.0	88	87.8	06.1	48	147.6	10.3	08	207.5	14.5	68	267.3	18.7
29	28.9	02.0	89	88.8	06.2	49	148.6	10.4	09	208.5	14.6	69	268.3	18.8
30	29.9	02.1	90	89.8	06.3	50	149.6	10.5	10	209.5	14.6	70	269.3	18.8
31	30.9	02.2	91	90.8	06.3	151	150.6	10.5	211	210.5	14.7	271	270.3	18.9
32	31.9	02.2	92	91.8	06.4	52	151.6	10.6	12	211.5	14.8	72	271.3	19.0
33	32.9	02.3	93	92.8	06.5	53	152.6	10.7	13	212.5	14.9	73	272.3	19.0
34	33.9	02.4	94	93.8	06.6	54	153.6	10.7	14	213.5	14.9	74	273.3	19.1
35	34.9	02.4	95	94.8	06.6	55	154.6	10.8	15	214.5	15.0	75	274.3	19.2
36	35.9	02.5	96	95.8	06.7	56	155.6	10.9	16	215.5	15.1	76	275.3	19.3
37	36.9	02.6	97	96.8	06.8	57	156.6	11.0	17	216.5	15.1	77	276.3	19.3
38	37.9	02.7	98	97.8	06.8	58	157.6	11.0	18	217.5	15.2	78	277.3	19.4
39	38.9	02.7	99	98.8	06.9	59	158.6	11.1	19	218.5	15.3	79	278.3	19.5
40	39.9	02.8	100	99.8	07.0	60	159.6	11.2	20	219.5	15.3	80	279.3	19.5
41	40.9	02.9	101	100.8	07.0	161	160.6	11.2	221	220.5	15.4	281	280.3	19.6
42	41.9	02.9	02	101.8	07.1	62	161.6	11.3	22	221.5	15.5	82	281.3	19.7
43	42.9	03.0	03	102.7	07.2	63	162.6	11.4	23	222.5	15.6	83	282.3	19.7
44	43.9	03.1	04	103.7	07.3	64	163.6	11.4	24	223.5	15.6	84	283.3	19.8
45	44.9	03.1	05	104.7	07.3	65	164.6	11.5	25	224.5	15.7	85	284.3	19.9
46	45.9	03.2	06	105.7	07.4	66	165.6	11.6	26	225.4	15.8	86	285.3	20.0
47	46.9	03.3	07	106.7	07.5	67	166.6	11.6	27	226.4	15.8	87	286.3	20.0
48	47.9	03.3	08	107.7	07.5	68	167.6	11.7	28	227.4	15.9	88	287.3	20.1
49	48.9	03.4	09	108.7	07.6	69	168.6	11.8	29	228.4	16.0	89	288.3	20.2
50	49.9	03.5	10	109.7	07.7	70	169.6	11.9	30	229.4	16.0	90	289.3	20.2
51	50.9	03.6	111	110.7	07.7	171	170.6	11.9	231	230.4	16.1	291	290.3	20.3
52	51.9	03.6	12	111.7	07.8	72	171.6	12.0	32	231.4	16.2	92	291.3	20.4
53	52.9	03.7	13	112.7	07.9	73	172.6	12.1	33	232.4	16.3	93	292.3	20.4
54	53.9	03.8	14	113.7	08.0	74	173.6	12.1	34	233.4	16.3	94	293.3	20.5
55	54.9	03.8	15	114.7	08.0	75	174.6	12.2	35	234.4	16.4	95	294.3	20.6
56	55.9	03.9	16	115.7	08.1	76	175.6	12.3	36	235.4	16.5	96	295.3	20.6
57	56.9	04.0	17	116.7	08.2	77	176.6	12.3	37	236.4	16.5	97	296.3	20.7
58	57.9	04.0	18	117.7	08.2	78	177.6	12.4	38	237.4	16.6	98	297.3	20.8
59	58.9	04.1	19	118.7	08.3	79	178.6	12.5	39	238.4	16.7	99	298.3	20.9
60	59.9	04.2	20	119.7	08.4	80	179.6	12.6	40	239.4	16.7	300	299.3	20.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II. Difference of Latitude and Departure for 5 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.8	05.3	121	120.5	10.5	181	180.3	15.8	241	240.1	21.0
2	02.0	00.2	62	61.8	05.4	22	121.5	10.6	82	181.3	15.9	42	241.1	21.1
3	03.0	00.3	63	62.8	05.5	23	122.5	10.7	83	182.3	15.9	43	242.1	21.2
4	04.0	00.3	64	63.8	05.6	24	123.5	10.8	84	183.3	16.0	44	243.1	21.3
5	05.0	00.4	65	64.8	05.7	25	124.5	10.9	85	184.3	16.1	45	244.1	21.4
6	06.0	00.5	66	65.7	05.8	26	125.5	11.0	86	185.3	16.2	46	245.1	21.4
7	07.0	00.6	67	66.7	05.8	27	126.5	11.1	87	186.3	16.3	47	246.1	21.5
8	08.0	00.7	68	67.7	05.9	28	127.5	11.2	88	187.3	16.4	48	247.1	21.6
9	09.0	00.8	69	68.7	06.0	29	128.5	11.2	89	188.3	16.5	49	248.1	21.7
10	10.0	00.9	70	69.7	06.1	30	129.5	11.3	90	189.3	16.6	50	249.0	21.8
11	11.0	01.0	71	70.7	06.2	131	130.5	11.4	191	190.3	16.6	251	250.0	21.9
12	12.0	01.0	72	71.7	06.3	32	131.5	11.5	92	191.3	16.7	52	251.0	22.0
13	13.0	01.1	73	72.7	06.4	33	132.5	11.6	93	192.3	16.8	53	252.0	22.1
14	13.9	01.2	74	73.7	06.4	34	133.5	11.7	94	193.3	16.9	54	253.0	22.1
15	14.9	01.3	75	74.7	06.5	35	134.5	11.8	95	194.3	17.0	55	254.0	22.2
16	15.9	01.4	76	75.7	06.6	36	135.5	11.9	96	195.3	17.1	56	255.0	22.3
17	16.9	01.5	77	76.7	06.7	37	136.5	11.9	97	196.3	17.2	57	256.0	22.4
18	17.9	01.6	78	77.7	06.8	38	137.5	12.0	98	197.2	17.3	58	257.0	22.5
19	18.9	01.7	79	78.7	06.9	39	138.5	12.1	99	198.2	17.3	59	258.0	22.6
20	19.9	01.7	80	79.7	07.0	40	139.5	12.2	200	199.2	17.4	60	259.0	22.7
21	20.9	01.8	81	80.7	07.1	141	140.5	12.3	201	200.2	17.5	261	260.0	22.7
22	21.9	01.9	82	81.7	07.1	42	141.5	12.4	02	201.2	17.6	62	261.0	22.8
23	22.9	02.0	83	82.7	07.2	43	142.5	12.5	03	202.2	17.7	63	262.0	22.9
24	23.9	02.1	84	83.7	07.3	44	143.5	12.6	04	203.2	17.8	64	263.0	23.0
25	24.9	02.2	85	84.7	07.4	45	144.4	12.6	05	204.2	17.9	65	264.0	23.1
26	25.9	02.3	86	85.7	07.5	46	145.4	12.7	06	205.2	18.0	66	265.0	23.2
27	26.9	02.4	87	86.7	07.6	47	146.4	12.8	07	206.2	18.0	67	266.0	23.3
28	27.9	02.4	88	87.7	07.7	48	147.4	12.9	08	207.2	18.1	68	267.0	23.4
29	28.9	02.5	89	88.7	07.8	49	148.4	13.0	09	208.2	18.2	69	268.0	23.4
30	29.9	02.6	90	89.7	07.8	50	149.4	13.1	10	209.2	18.3	70	269.0	23.5
31	30.9	02.7	91	90.7	07.9	151	150.4	13.2	211	210.2	18.4	271	270.0	23.6
32	31.9	02.8	92	91.6	08.0	52	151.4	13.2	12	211.2	18.5	72	271.0	23.7
33	32.9	02.9	93	92.6	08.1	53	152.4	13.3	13	212.2	18.6	73	272.0	23.8
34	33.9	03.0	94	93.6	08.2	54	153.4	13.4	14	213.2	18.7	74	273.0	23.9
35	34.9	03.1	95	94.6	08.3	55	154.4	13.5	15	214.2	18.7	75	274.0	24.0
36	35.9	03.1	96	95.6	08.4	56	155.4	13.6	16	215.2	18.8	76	274.9	24.1
37	36.9	03.2	97	96.6	08.5	57	156.4	13.7	17	216.2	18.9	77	275.9	24.1
38	37.9	03.3	98	97.6	08.5	58	157.4	13.8	18	217.2	19.0	78	276.9	24.2
39	38.9	03.4	99	98.6	08.6	59	158.4	13.9	19	218.2	19.1	79	277.9	24.3
40	39.8	03.5	100	99.6	08.7	60	159.4	13.9	20	219.2	19.2	80	278.9	24.4
41	40.8	03.6	101	100.6	08.8	161	160.4	14.0	221	220.2	19.3	281	279.9	24.5
42	41.8	03.7	02	101.6	08.9	62	161.4	14.1	22	221.2	19.3	82	280.9	24.6
43	42.8	03.7	03	102.6	09.0	63	162.4	14.2	23	222.2	19.4	83	281.9	24.7
44	43.8	03.8	04	103.6	09.1	64	163.4	14.3	24	223.1	19.5	84	282.9	24.8
45	44.8	03.9	05	104.6	09.2	65	164.4	14.4	25	224.1	19.6	85	283.9	24.8
46	45.8	04.0	06	105.6	09.2	66	165.4	14.5	26	225.1	19.7	86	284.9	24.9
47	46.8	04.1	07	106.6	09.3	67	166.4	14.6	27	226.1	19.8	87	285.9	25.0
48	47.8	04.2	08	107.6	09.4	68	167.4	14.6	28	227.1	19.9	88	286.9	25.1
49	48.8	04.3	09	108.6	09.5	69	168.4	14.7	29	228.1	20.0	89	287.9	25.2
50	49.8	04.4	10	109.6	09.6	70	169.4	14.8	30	229.1	20.0	90	288.9	25.3
51	50.8	04.4	111	110.6	09.7	171	170.3	14.9	231	230.1	20.1	291	289.9	25.4
52	51.8	04.5	12	111.6	09.8	72	171.3	15.0	32	231.1	20.2	92	290.9	25.4
53	52.8	04.6	13	112.6	09.8	73	172.3	15.1	33	232.1	20.3	93	291.9	25.5
54	53.8	04.7	14	113.6	09.9	74	173.3	15.2	34	233.1	20.4	94	292.9	25.6
55	54.8	04.8	15	114.6	10.0	75	174.3	15.3	35	234.1	20.5	95	293.9	25.7
56	55.8	04.9	16	115.6	10.1	76	175.3	15.3	36	235.1	20.6	96	294.9	25.8
57	56.8	05.0	17	116.6	10.2	77	176.3	15.4	37	236.1	20.7	97	295.9	25.9
58	57.8	05.1	18	117.6	10.3	78	177.3	15.5	38	237.1	20.7	98	296.9	26.0
59	58.8	05.1	19	118.5	10.4	79	178.3	15.6	39	238.1	20.8	99	297.9	26.1
60	59.8	05.2	20	119.5	10.5	80	179.3	15.7	40	239.1	20.9	300	298.9	26.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 85 Degrees.

TABLE II. Difference of Latitude and Departure for 6 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.4	121	120.3	12.6	181	180.0	18.9	241	239.7	25.2
2	02.0	00.2	62	61.7	06.5	22	121.3	12.8	82	181.0	19.0	42	240.7	25.3
3	03.0	00.3	63	62.7	06.6	23	122.3	12.9	83	182.0	19.1	43	241.7	25.4
4	04.0	00.4	64	63.6	06.7	24	123.3	13.0	84	183.0	19.2	44	242.7	25.5
5	05.0	00.5	65	64.6	06.8	25	124.3	13.1	85	184.0	19.3	45	243.7	25.6
6	06.0	00.6	66	65.6	06.9	26	125.3	13.2	86	185.0	19.4	46	244.7	25.7
7	07.0	00.7	67	66.6	07.0	27	126.3	13.3	87	186.0	19.5	47	245.6	25.8
8	08.0	00.8	68	67.6	07.1	28	127.3	13.4	88	187.0	19.7	48	246.6	25.9
9	09.0	00.9	69	68.6	07.2	29	128.3	13.5	89	188.0	19.8	49	247.6	26.0
10	09.9	01.0	70	69.6	07.3	30	129.3	13.6	90	189.0	19.9	50	248.6	26.1
11	10.9	01.1	71	70.6	07.4	131	130.3	13.7	191	190.0	20.0	251	249.6	26.2
12	11.9	01.3	72	71.6	07.5	32	131.3	13.8	92	190.9	20.1	52	250.6	26.3
13	12.9	01.4	73	72.6	07.6	33	132.3	13.9	93	191.9	20.2	53	251.6	26.4
14	13.9	01.5	74	73.6	07.7	34	133.3	14.0	94	192.9	20.3	54	252.6	26.6
15	14.9	01.6	75	74.6	07.8	35	134.3	14.1	95	193.9	20.4	55	253.6	26.7
16	15.9	01.7	76	75.6	07.9	36	135.3	14.2	96	194.9	20.5	56	254.6	26.8
17	16.9	01.8	77	76.6	08.0	37	136.2	14.3	97	195.9	20.6	57	255.6	26.9
18	17.9	01.9	78	77.6	08.2	38	137.2	14.4	98	196.9	20.7	58	256.6	27.0
19	18.9	02.0	79	78.6	08.3	39	138.2	14.5	99	197.9	20.8	59	257.6	27.1
20	19.9	02.1	80	79.6	08.4	40	139.2	14.6	200	198.9	20.9	60	258.6	27.2
21	20.9	02.2	81	80.6	08.5	141	140.2	14.7	201	199.9	21.0	261	259.6	27.3
22	21.9	02.3	82	81.6	08.6	42	141.2	14.8	02	200.9	21.1	62	260.6	27.4
23	22.9	02.4	83	82.5	08.7	43	142.2	14.9	03	201.9	21.2	63	261.6	27.5
24	23.9	02.5	84	83.5	08.8	44	143.2	15.1	04	202.9	21.3	64	262.6	27.6
25	24.9	02.6	85	84.5	08.9	45	144.2	15.2	05	203.9	21.4	65	263.5	27.7
26	25.9	02.7	86	85.5	09.0	46	145.2	15.3	06	204.9	21.5	66	264.5	27.8
27	26.9	02.8	87	86.5	09.1	47	146.2	15.4	07	205.9	21.6	67	265.5	27.9
28	27.8	02.9	88	87.5	09.2	48	147.2	15.5	08	206.9	21.7	68	266.5	28.0
29	28.8	03.0	89	88.5	09.3	49	148.2	15.6	09	207.9	21.8	69	267.5	28.1
30	29.8	03.1	90	89.5	09.4	50	149.2	15.7	10	208.8	22.0	70	268.5	28.2
31	30.8	03.2	91	90.5	09.5	151	150.2	15.8	211	209.8	22.1	271	269.5	28.3
32	31.8	03.3	92	91.5	09.6	52	151.2	15.9	12	210.8	22.2	72	270.5	28.4
33	32.8	03.4	93	92.5	09.7	53	152.2	16.0	13	211.8	22.3	73	271.5	28.5
34	33.8	03.6	94	93.5	09.8	54	153.2	16.1	14	212.8	22.4	74	272.5	28.6
35	34.8	03.7	95	94.5	09.9	55	154.2	16.2	15	213.8	22.5	75	273.5	28.7
36	35.8	03.8	96	95.5	10.0	56	155.1	16.3	16	214.8	22.6	76	274.5	28.8
37	36.8	03.9	97	96.5	10.1	57	156.1	16.4	17	215.8	22.7	77	275.5	29.0
38	37.8	04.0	98	97.5	10.2	58	157.1	16.5	18	216.8	22.8	78	276.5	29.1
39	38.8	04.1	99	98.5	10.3	59	158.1	16.6	19	217.8	22.9	79	277.5	29.2
40	39.8	04.2	100	99.5	10.5	60	159.1	16.7	20	218.8	23.0	80	278.5	29.3
41	40.8	04.3	101	100.4	10.6	161	160.1	16.8	221	219.8	23.1	281	279.5	29.4
42	41.8	04.4	02	101.4	10.7	62	161.1	16.9	22	220.8	23.2	82	280.5	29.5
43	42.8	04.5	03	102.4	10.8	63	162.1	17.0	23	221.8	23.3	83	281.4	29.6
44	43.8	04.6	04	103.4	10.9	64	163.1	17.1	24	222.8	23.4	84	282.4	29.7
45	44.8	04.7	05	104.4	11.0	65	164.1	17.2	25	223.8	23.5	85	283.4	29.8
46	45.7	04.8	06	105.4	11.1	66	165.1	17.4	26	224.8	23.6	86	284.4	29.9
47	46.7	04.9	07	106.4	11.2	67	166.1	17.5	27	225.8	23.7	87	285.4	30.0
48	47.7	05.0	08	107.4	11.3	68	167.1	17.6	28	226.8	23.8	88	286.4	30.1
49	48.7	05.1	09	108.4	11.4	69	168.1	17.7	29	227.7	23.9	89	287.4	30.2
50	49.7	05.2	10	109.4	11.5	70	169.1	17.8	30	228.7	24.0	90	288.4	30.3
51	50.7	05.3	111	110.4	11.6	171	170.1	17.9	231	229.7	24.1	291	289.4	30.4
52	51.7	05.4	12	111.4	11.7	72	171.1	18.0	32	230.7	24.3	92	290.4	30.5
53	52.7	05.5	13	112.4	11.8	73	172.1	18.1	33	231.7	24.4	93	291.4	30.6
54	53.7	05.6	14	113.4	11.9	74	173.0	18.2	34	232.7	24.5	94	292.4	30.7
55	54.7	05.7	15	114.4	12.0	75	174.0	18.3	35	233.7	24.6	95	293.4	30.8
56	55.7	05.9	16	115.4	12.1	76	175.0	18.4	36	234.7	24.7	96	294.4	30.9
57	56.7	06.0	17	116.4	12.2	77	176.0	18.5	37	235.7	24.8	97	295.4	31.0
58	57.7	06.1	18	117.4	12.3	78	177.0	18.6	38	236.7	24.9	98	296.4	31.1
59	58.7	06.2	19	118.3	12.4	79	178.0	18.7	39	237.7	25.0	99	297.4	31.3
60	59.7	06.3	20	119.3	12.5	80	179.0	18.8	40	238.7	25.1	300	298.4	31.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 84 Degrees.

TABLE II. Difference of Latitude and Departure for 7 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.5	07.4	121	120.1	14.7	181	179.7	22.1	241	239.2	29.4
2	02.0	00.2	62	61.5	07.6	22	121.1	14.9	82	180.6	22.2	42	240.2	29.5
3	03.0	00.4	63	62.5	07.7	23	122.1	15.0	83	181.6	22.3	43	241.2	29.6
4	04.0	00.5	64	63.5	07.8	24	123.1	15.1	84	182.6	22.4	44	242.2	29.7
5	05.0	00.6	65	64.5	07.9	25	124.1	15.2	85	183.6	22.5	45	243.2	29.9
6	06.0	00.7	66	65.5	08.0	26	125.1	15.4	86	184.6	22.7	46	244.2	30.0
7	06.9	00.9	67	66.5	08.2	27	126.1	15.5	87	185.6	22.8	47	245.2	30.1
8	07.9	01.0	68	67.5	08.3	28	127.0	15.6	88	186.6	22.9	48	246.2	30.2
9	08.9	01.1	69	68.5	08.4	29	128.0	15.7	89	187.6	23.0	49	247.1	30.3
10	09.9	01.2	70	69.5	08.5	30	129.0	15.8	90	188.6	23.2	50	248.1	30.5
11	10.9	01.3	71	70.5	08.7	131	130.0	16.0	191	189.6	23.3	251	249.1	30.6
12	11.9	01.5	72	71.5	08.8	32	131.0	16.1	92	190.6	23.4	52	250.1	30.7
13	12.9	01.6	73	72.5	08.9	33	132.0	16.2	93	191.6	23.5	53	251.1	30.8
14	13.9	01.7	74	73.4	09.0	34	133.0	16.3	94	192.6	23.6	54	252.1	31.0
15	14.9	01.8	75	74.4	09.1	35	134.0	16.5	95	193.5	23.8	55	253.1	31.1
16	15.9	01.9	76	75.4	09.3	36	135.0	16.6	96	194.5	23.9	56	254.1	31.2
17	16.9	02.1	77	76.4	09.4	37	136.0	16.7	97	195.5	24.0	57	255.1	31.3
18	17.9	02.2	78	77.4	09.5	38	137.0	16.8	98	196.5	24.1	58	256.1	31.4
19	18.9	02.3	79	78.4	09.6	39	138.0	16.9	99	197.5	24.3	59	257.1	31.6
20	19.9	02.4	80	79.4	09.7	40	139.0	17.1	200	198.5	24.4	60	258.1	31.7
21	20.8	02.6	81	80.4	09.9	141	139.9	17.2	201	199.5	24.5	261	259.1	31.8
22	21.8	02.7	82	81.4	10.0	42	140.9	17.3	02	200.5	24.6	62	260.0	31.9
23	22.8	02.8	83	82.4	10.1	43	141.9	17.4	03	201.5	24.7	63	261.0	32.1
24	23.8	02.9	84	83.4	10.2	44	142.9	17.5	04	202.5	24.9	64	262.0	32.2
25	24.8	03.0	85	84.4	10.4	45	143.9	17.7	05	203.5	25.0	65	263.0	32.3
26	25.8	03.2	86	85.4	10.5	46	144.9	17.8	06	204.5	25.1	66	264.0	32.4
27	26.8	03.3	87	86.4	10.6	47	145.9	17.9	07	205.5	25.2	67	265.0	32.5
28	27.8	03.4	88	87.3	10.7	48	146.9	18.0	08	206.4	25.3	68	266.0	32.7
29	28.8	03.5	89	88.3	10.8	49	147.9	18.2	09	207.4	25.5	69	267.0	32.8
30	29.8	03.7	90	89.3	11.0	50	148.9	18.3	10	208.4	25.6	70	268.0	32.9
31	30.8	03.8	91	90.3	11.1	151	149.9	18.4	211	209.4	25.7	271	269.0	33.0
32	31.8	03.9	92	91.3	11.2	52	150.9	18.5	12	210.4	25.8	72	270.0	33.1
33	32.8	04.0	93	92.3	11.3	53	151.9	18.6	13	211.4	26.0	73	271.0	33.3
34	33.7	04.1	94	93.3	11.5	54	152.9	18.8	14	212.4	26.1	74	272.0	33.4
35	34.7	04.3	95	94.3	11.6	55	153.8	18.9	15	213.4	26.2	75	273.0	33.5
36	35.7	04.4	96	95.3	11.7	56	154.8	19.0	16	214.4	26.3	76	273.9	33.6
37	36.7	04.5	97	96.3	11.8	57	155.8	19.1	17	215.4	26.4	77	274.9	33.8
38	37.7	04.6	98	97.3	11.9	58	156.8	19.3	18	216.4	26.6	78	275.9	33.9
39	38.7	04.8	99	98.3	12.1	59	157.8	19.4	19	217.4	26.7	79	276.9	34.0
40	39.7	04.9	100	99.3	12.2	60	158.8	19.5	20	218.4	26.8	80	277.9	34.1
41	40.7	05.0	101	100.2	12.3	161	159.8	19.6	221	219.4	26.9	281	278.9	34.2
42	41.7	05.1	02	101.2	12.4	62	160.8	19.7	22	220.3	27.1	82	279.9	34.4
43	42.7	05.2	03	102.2	12.6	63	161.8	19.9	23	221.3	27.2	83	280.9	34.5
44	43.7	05.4	04	103.2	12.7	64	162.8	20.0	24	222.3	27.3	84	281.9	34.6
45	44.7	05.5	05	104.2	12.8	65	163.8	20.1	25	223.3	27.4	85	282.9	34.7
46	45.7	05.6	06	105.2	12.9	66	164.8	20.2	26	224.3	27.5	86	283.9	34.9
47	46.6	05.7	07	106.2	13.0	67	165.8	20.4	27	225.3	27.7	87	284.9	35.0
48	47.6	05.8	08	107.2	13.2	68	166.7	20.5	28	226.3	27.8	88	285.9	35.1
49	48.6	06.0	09	108.2	13.3	69	167.7	20.6	29	227.3	27.9	89	286.8	35.2
50	49.6	06.1	10	109.2	13.4	70	168.7	20.7	30	228.3	28.0	90	287.8	35.3
51	50.6	06.2	111	110.2	13.5	171	169.7	20.8	231	229.3	28.2	291	288.8	35.5
52	51.6	06.3	12	111.2	13.6	72	170.7	21.0	32	230.3	28.3	92	289.8	35.6
53	52.6	06.5	13	112.2	13.8	73	171.7	21.1	33	231.3	28.4	93	290.8	35.7
54	53.6	06.6	14	113.2	13.9	74	172.7	21.2	34	232.3	28.5	94	291.8	35.8
55	54.6	06.7	15	114.1	14.0	75	173.7	21.3	35	233.2	28.6	95	292.8	36.0
56	55.6	06.8	16	115.1	14.1	76	174.7	21.4	36	334.2	28.8	96	293.8	36.1
57	56.6	06.9	17	116.1	14.3	77	175.7	21.6	37	235.2	28.9	97	294.8	36.2
58	57.6	07.1	18	117.1	14.4	78	176.7	21.7	38	236.2	29.0	98	295.8	36.3
59	58.6	07.2	19	118.1	14.5	79	177.7	21.8	39	237.2	29.1	99	296.8	36.4
60	59.6	07.3	20	119.1	14.6	80	178.7	21.9	40	238.2	29.2	300	297.8	36.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 83 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.4	08.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	02.0	00.3	62	61.4	08.6	22	120.8	17.0	82	180.2	25.3	42	239.6	33.7
3	03.0	00.4	63	62.4	08.8	23	121.8	17.1	83	181.2	25.5	43	240.6	33.8
4	04.0	00.6	64	63.4	08.9	24	122.8	17.3	84	182.2	25.6	44	241.6	34.0
5	05.0	00.7	65	64.4	09.0	25	123.8	17.4	85	183.2	25.7	45	242.6	34.1
6	05.9	00.8	66	65.4	09.2	26	124.8	17.5	86	184.2	25.9	46	243.6	34.2
7	06.9	01.0	67	66.3	09.3	27	125.8	17.7	87	185.2	26.0	47	244.6	34.4
8	07.9	01.1	68	67.3	09.5	28	126.8	17.8	88	186.2	26.2	48	245.6	34.5
9	08.9	01.3	69	68.3	09.6	29	127.7	18.0	89	187.2	26.3	49	246.6	34.7
10	09.9	01.4	70	69.3	09.7	30	128.7	18.1	90	188.2	26.4	50	247.6	34.8
11	10.9	01.5	71	70.3	09.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	01.7	72	71.3	10.0	32	130.7	18.4	92	190.1	26.7	52	249.5	35.1
13	12.9	01.8	73	72.3	10.2	33	131.7	18.5	93	191.1	26.9	53	250.5	35.2
14	13.9	01.9	74	73.3	10.3	34	132.7	18.6	94	192.1	27.0	54	251.5	35.3
15	14.9	02.1	75	74.3	10.4	35	133.7	18.8	95	193.1	27.1	55	252.5	35.5
16	15.8	02.2	76	75.3	10.6	36	134.7	18.9	96	194.1	27.3	56	253.5	35.6
17	16.8	02.4	77	76.3	10.7	37	135.7	19.1	97	195.1	27.4	57	254.5	35.8
18	17.8	02.5	78	77.2	10.9	38	136.7	19.2	98	196.1	27.6	58	255.5	35.9
19	18.8	02.6	79	78.2	11.0	39	137.7	19.3	99	197.1	27.7	59	256.5	36.0
20	19.8	02.8	80	79.2	11.1	40	138.6	19.5	200	198.1	27.8	60	257.5	36.2
21	20.8	02.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	03.1	82	81.2	11.4	42	140.6	19.8	02	200.0	28.1	62	259.5	36.5
23	22.8	03.2	83	82.2	11.6	43	141.6	19.9	03	201.0	28.3	63	260.4	36.6
24	23.8	03.3	84	83.2	11.7	44	142.6	20.0	04	202.0	28.4	64	261.4	36.7
25	24.8	03.5	85	84.2	11.8	45	143.6	20.2	05	203.0	28.5	65	262.4	36.9
26	25.7	03.6	86	85.2	12.0	46	144.6	20.3	06	204.0	28.7	66	263.4	37.0
27	26.7	03.8	87	86.2	12.1	47	145.6	20.5	07	205.0	28.8	67	264.4	37.2
28	27.7	03.9	88	87.1	12.2	48	146.6	20.6	08	206.0	28.9	68	265.4	37.3
29	28.7	04.0	89	88.1	12.4	49	147.5	20.7	09	207.0	29.1	69	266.4	37.4
30	29.7	04.2	90	89.1	12.5	50	148.5	20.9	10	208.0	29.2	70	267.4	37.6
31	30.7	04.3	91	90.1	12.7	151	149.5	21.0	211	208.9	29.4	271	268.4	37.7
32	31.7	04.5	92	91.1	12.8	52	150.5	21.2	12	209.9	29.5	72	269.4	37.9
33	32.7	04.6	93	92.1	12.9	53	151.5	21.3	13	210.9	29.6	73	270.3	38.0
34	33.7	04.7	94	93.1	13.1	54	152.5	21.4	14	211.9	29.8	74	271.3	38.1
35	34.7	04.9	95	94.1	13.2	55	153.5	21.6	15	212.9	29.9	75	272.3	38.3
36	35.6	05.0	96	95.1	13.4	56	154.5	21.7	16	213.9	30.1	76	273.3	38.4
37	36.6	05.1	97	96.1	13.5	57	155.5	21.9	17	214.9	30.2	77	274.3	38.6
38	37.6	05.3	98	97.0	13.6	58	156.5	22.0	18	215.9	30.3	78	275.3	38.7
39	38.6	05.4	99	98.0	13.8	59	157.5	22.1	19	216.9	30.5	79	276.3	38.8
40	39.6	05.6	100	99.0	13.9	60	158.4	22.3	20	217.9	30.6	80	277.3	39.0
41	40.6	05.7	101	100.0	14.1	161	159.4	22.4	221	218.8	30.8	281	278.3	39.1
42	41.6	05.8	02	101.0	14.2	62	160.4	22.5	22	219.8	30.9	82	279.3	39.2
43	42.6	06.0	03	102.0	14.3	63	161.4	22.7	23	220.8	31.0	83	280.2	39.4
44	43.6	06.1	04	103.0	14.5	64	162.4	22.8	24	221.8	31.2	84	281.2	39.5
45	44.6	06.3	05	104.0	14.6	65	163.4	23.0	25	222.8	31.3	85	282.2	39.7
46	45.6	06.4	06	105.	14.8	66	164.4	23.1	26	223.8	31.5	86	283.2	39.8
47	46.5	06.5	07	106.0	14.9	67	165.4	23.2	27	224.8	31.6	87	284.2	39.9
48	47.5	06.7	08	106.9	15.0	68	166.4	23.4	28	225.8	31.7	88	285.2	40.1
49	48.5	06.8	09	107.9	15.2	69	167.4	23.5	29	226.8	31.9	89	286.2	40.2
50	49.5	07.0	10	108.9	15.3	70	168.3	23.7	30	227.8	32.0	90	287.2	40.4
51	50.5	07.1	111	109.9	15.4	171	169.3	23.8	231	228.8	32.1	291	288.2	40.5
52	51.5	07.2	12	110.9	15.6	72	170.3	23.9	32	229.7	32.3	92	289.2	40.6
53	52.5	07.4	13	111.9	15.7	73	171.3	24.1	33	230.7	32.4	93	290.1	40.8
54	53.5	07.5	14	112.9	15.9	74	172.3	24.2	34	231.7	32.6	94	291.1	40.9
55	54.5	07.7	15	113.9	16.0	75	173.3	24.4	35	232.7	32.7	95	292.1	41.1
56	55.5	07.8	16	114.9	16.1	76	174.3	24.5	36	233.7	32.8	96	293.1	41.2
57	56.4	07.9	17	115.9	16.3	77	175.3	24.6	37	234.7	33.0	97	294.1	41.3
58	57.4	08.1	18	116.9	16.4	78	176.3	24.8	38	235.7	33.1	98	295.1	41.5
59	58.4	08.2	19	117.8	16.6	79	177.3	24.9	39	236.7	33.3	99	296.1	41.6
60	59.4	08.4	20	118.8	16.7	80	178.2	25.1	40	237.7	33.4	300	297.1	41.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	60.2	09.5	121	119.5	18.9	181	178.8	28.3	241	238.0	37.7
2	02.0	00.3	62	61.2	09.7	22	120.5	19.1	82	179.8	28.5	42	239.0	37.9
3	03.0	00.5	63	62.2	09.9	23	121.5	19.2	83	180.7	28.6	43	240.0	38.0
4	04.0	00.6	64	63.2	10.0	24	122.5	19.4	84	181.7	28.8	44	241.0	38.2
5	04.9	00.8	65	64.2	10.2	25	123.5	19.6	85	182.7	28.9	45	242.0	38.3
6	05.9	00.9	66	65.2	10.3	26	124.4	19.7	86	183.7	29.1	46	243.0	38.5
7	06.9	01.1	67	66.2	10.5	27	125.4	19.9	87	184.7	29.3	47	244.0	38.6
8	07.9	01.3	68	67.2	10.6	28	126.4	20.0	88	185.7	29.4	48	244.9	38.8
9	08.9	01.4	69	68.2	10.8	29	127.4	20.2	89	186.7	29.6	49	245.9	39.0
10	09.9	01.6	70	69.1	11.0	30	128.4	20.3	90	187.7	29.7	50	246.9	39.1
11	10.9	01.7	71	70.1	11.1	131	129.4	20.5	191	188.6	29.9	251	247.9	39.3
12	11.9	01.9	72	71.1	11.3	32	130.4	20.6	92	189.6	30.0	52	248.9	39.4
13	12.8	02.0	73	72.1	11.4	33	131.4	20.8	93	190.6	30.2	53	249.9	39.6
14	13.8	02.2	74	73.1	11.6	34	132.4	21.0	94	191.6	30.3	54	250.9	39.7
15	14.8	02.3	75	74.1	11.7	35	133.3	21.1	95	192.6	30.5	55	251.9	39.9
16	15.8	02.5	76	75.1	11.9	36	134.3	21.3	96	193.6	30.7	56	252.8	40.0
17	16.8	02.7	77	76.1	12.0	37	135.3	21.4	97	194.6	30.8	57	253.8	40.2
18	17.8	02.8	78	77.0	12.2	38	136.3	21.6	98	195.6	31.0	58	254.8	40.4
19	18.8	03.0	79	78.0	12.4	39	137.3	21.7	99	196.5	31.1	59	255.8	40.5
20	19.8	03.1	80	79.0	12.5	40	138.3	21.9	200	197.5	31.3	60	256.8	40.7
21	20.7	03.3	81	80.0	12.7	141	139.3	22.1	201	198.5	31.4	261	257.8	40.8
22	21.7	03.4	82	81.0	12.8	42	140.3	22.2	02	199.5	31.6	62	258.8	41.0
23	22.7	03.6	83	82.0	13.0	43	141.2	22.4	03	200.5	31.8	63	259.8	41.1
24	23.7	03.8	84	83.0	13.1	44	142.2	22.5	04	201.5	31.9	64	260.7	41.3
25	24.7	03.9	85	84.0	13.3	45	143.2	22.7	05	202.5	32.1	65	261.7	41.5
26	25.7	04.1	86	84.9	13.5	46	144.2	22.8	06	203.5	32.2	66	262.7	41.6
27	26.7	04.2	87	85.9	13.6	47	145.2	23.0	07	204.5	32.4	67	263.7	41.8
28	27.7	04.4	88	86.9	13.8	48	146.2	23.2	08	205.4	32.5	68	264.7	41.9
29	28.6	04.5	89	87.9	13.9	49	147.2	23.3	09	206.4	32.7	69	265.7	42.1
30	29.6	04.7	90	88.9	14.1	50	148.2	23.5	10	207.4	32.9	70	266.7	42.2
31	30.6	04.8	91	89.9	14.2	151	149.1	23.6	211	208.4	33.0	271	267.7	42.4
32	31.6	05.0	92	90.9	14.4	52	150.1	23.8	12	209.4	33.2	72	268.7	42.6
33	32.6	05.2	93	91.9	14.5	53	151.1	23.9	13	210.4	33.3	73	269.6	42.7
34	33.6	05.3	94	92.8	14.7	54	152.1	24.1	14	211.4	33.5	74	270.6	42.9
35	34.6	05.5	95	93.8	14.9	55	153.1	24.2	15	212.4	33.6	75	271.6	43.0
36	35.6	05.6	96	94.8	15.0	56	154.1	24.4	16	213.3	33.8	76	272.6	43.2
37	36.5	05.8	97	95.8	15.2	57	155.1	24.6	17	214.3	33.9	77	273.6	43.3
38	37.5	05.9	98	96.8	15.3	58	156.1	24.7	18	215.3	34.1	78	274.6	43.5
39	38.5	06.1	99	97.8	15.5	59	157.0	24.9	19	216.3	34.3	79	275.6	43.6
40	39.5	06.3	100	98.8	15.6	60	158.0	25.0	20	217.3	34.4	80	276.6	43.8
41	40.5	06.4	101	99.8	15.8	161	159.0	25.2	221	218.3	34.6	281	277.5	44.0
42	41.5	06.6	02	100.7	16.0	62	160.0	25.3	22	219.3	34.7	82	278.5	44.1
43	42.5	06.7	03	101.7	16.1	63	161.0	25.5	23	220.3	34.9	83	279.5	44.3
44	43.5	06.9	04	102.7	16.3	64	162.0	25.7	24	221.2	35.0	84	280.5	44.4
45	44.4	07.0	05	103.7	16.4	65	163.0	25.8	25	222.2	35.2	85	281.5	44.6
46	45.4	07.2	06	104.7	16.6	66	164.0	26.0	26	223.2	35.4	86	282.5	44.7
47	46.4	07.4	07	105.7	16.7	67	164.9	26.1	27	224.2	35.5	87	283.5	44.9
48	47.4	07.5	08	106.7	16.9	68	165.9	26.3	28	225.2	35.7	88	284.5	45.1
49	48.4	07.7	09	107.7	17.1	69	166.9	26.4	29	226.2	35.8	89	285.4	45.2
50	49.4	07.8	10	108.6	17.2	70	167.9	26.6	30	227.2	36.0	90	286.4	45.4
51	50.4	08.0	111	109.6	17.4	171	168.9	26.8	231	228.2	36.1	291	287.4	45.5
52	51.4	08.1	12	110.6	17.5	72	169.9	26.9	32	229.1	36.3	92	288.4	45.7
53	52.3	08.3	13	111.6	17.7	73	170.9	27.1	33	230.1	36.4	93	289.4	45.8
54	53.3	08.4	14	112.6	17.8	74	171.9	27.2	34	231.1	36.6	94	290.4	46.0
55	54.3	08.6	15	113.6	18.0	75	172.8	27.4	35	232.1	36.8	95	291.4	46.1
56	55.3	08.8	16	114.6	18.1	76	173.8	27.5	36	233.1	36.9	96	292.4	46.3
57	56.3	08.9	17	115.6	18.3	77	174.8	27.7	37	234.1	37.1	97	293.3	46.5
58	57.3	09.1	18	116.5	18.5	78	175.8	27.8	38	235.1	37.2	98	294.3	46.6
59	58.3	09.2	19	117.5	18.6	79	176.8	28.0	39	236.1	37.4	99	295.3	46.8
60	59.3	09.4	20	118.5	18.8	80	177.8	28.2	40	237.0	37.5	300	296.3	46.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 81 Degrees.

Table II. Difference of Latitude and Departure for 10 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.2	61	60.1	10.6	121	119.2	21.0	181	178.3	31.4	241	237.3	41.8
2	02.0	00.3	62	61.1	10.8	22	120.1	21.2	82	179.2	31.6	42	238.3	42.0
3	03.0	00.5	63	62.0	10.9	23	121.1	21.4	83	180.2	31.8	43	239.3	42.2
4	03.9	00.7	64	63.0	11.1	24	122.1	21.5	84	181.2	32.0	44	240.3	42.4
5	04.9	00.9	65	64.0	11.3	25	123.1	21.7	85	182.2	32.1	45	241.3	42.5
6	05.9	01.0	66	65.0	11.5	26	124.1	21.9	86	183.2	32.3	46	242.3	42.7
7	06.9	01.2	67	66.0	11.6	27	125.1	22.1	87	184.2	32.5	47	243.2	42.9
8	07.9	01.4	68	67.0	11.8	28	126.1	22.2	88	185.1	32.6	48	244.2	43.1
9	08.9	01.6	69	68.0	12.0	29	127.0	22.4	89	186.1	32.8	49	245.2	43.2
10	09.8	01.7	70	68.9	12.2	30	128.0	22.6	90	187.1	33.0	50	246.2	43.4
11	10.8	01.9	71	69.9	12.3	131	129.0	22.7	191	188.1	33.2	251	247.2	43.6
12	11.8	02.1	72	70.9	12.5	32	130.0	22.9	92	189.1	33.3	52	248.2	43.8
13	12.8	02.3	73	71.9	12.7	33	131.0	23.1	93	190.1	33.5	53	249.2	43.9
14	13.8	02.4	74	72.9	12.8	34	132.0	23.3	94	191.1	33.7	54	250.1	44.1
15	14.8	02.6	75	73.9	13.0	35	132.9	23.4	95	192.0	33.9	55	251.1	44.3
16	15.8	02.8	76	74.8	13.2	36	133.9	23.6	96	193.0	34.0	56	252.1	44.5
17	16.7	03.0	77	75.8	13.4	37	134.9	23.8	97	194.0	34.2	57	253.1	44.6
18	17.7	03.1	78	76.8	13.5	38	135.9	24.0	98	195.0	34.4	58	254.1	44.8
19	18.7	03.3	79	77.8	13.7	39	136.9	24.1	99	196.0	34.6	59	255.1	45.0
20	19.7	03.5	80	78.8	13.9	40	137.9	24.3	200	197.0	34.7	60	256.1	45.1
21	20.7	03.6	81	79.8	14.1	141	138.9	24.5	201	197.9	34.9	261	257.0	45.3
22	21.7	03.8	82	80.8	14.2	42	139.8	24.7	02	198.9	35.1	62	258.0	45.5
23	22.7	04.0	83	81.7	14.4	43	140.8	24.8	03	199.9	35.3	63	259.0	45.7
24	23.6	04.2	84	82.7	14.6	44	141.8	25.0	04	200.9	35.4	64	260.0	45.8
25	24.6	04.3	85	83.7	14.8	45	142.8	25.2	05	201.9	35.6	65	261.0	46.0
26	25.6	04.5	86	84.7	14.9	46	143.8	25.4	06	202.9	35.8	66	262.0	46.2
27	26.6	04.7	87	85.7	15.1	47	144.8	25.5	07	203.9	35.9	67	262.9	46.4
28	27.6	04.9	88	86.7	15.3	48	145.8	25.7	08	204.8	36.1	68	263.9	46.5
29	28.6	05.0	89	87.6	15.5	49	146.7	25.9	09	205.8	36.3	69	264.9	46.7
30	29.5	05.2	90	88.6	15.6	50	147.7	26.0	10	206.8	36.5	70	265.9	46.9
31	30.5	05.4	91	89.6	15.8	151	148.7	26.2	211	207.8	36.6	271	266.9	47.1
32	31.5	05.6	92	90.6	16.0	52	149.7	26.4	12	208.8	36.8	72	267.9	47.2
33	32.5	05.7	93	91.6	16.1	53	150.7	26.6	13	209.8	37.0	73	268.9	47.4
34	33.5	05.9	94	92.6	16.3	54	151.7	26.7	14	210.7	37.2	74	269.8	47.6
35	34.5	06.1	95	93.6	16.5	55	152.6	26.9	15	211.7	37.3	75	270.8	47.8
36	35.5	06.3	96	94.5	16.7	56	153.6	27.1	16	212.7	37.5	76	271.8	47.9
37	36.4	06.4	97	95.5	16.8	57	154.6	27.3	17	213.7	37.7	77	272.8	48.1
38	37.4	06.6	98	96.5	17.0	58	155.6	27.4	18	214.7	37.9	78	273.8	48.3
39	38.4	06.8	99	97.5	17.2	59	156.6	27.6	19	215.7	38.0	79	274.8	48.4
40	39.4	06.9	100	98.5	17.4	60	157.6	27.8	20	216.7	38.2	80	275.7	48.6
41	40.4	07.1	101	99.5	17.5	161	158.6	28.0	221	217.6	38.4	281	276.7	48.8
42	41.4	07.3	02	100.5	17.7	62	159.5	28.1	22	218.6	38.5	82	277.7	49.0
43	42.3	07.5	03	101.4	17.9	63	160.5	28.3	23	219.6	38.7	83	278.7	49.1
44	43.3	07.6	04	102.4	18.1	64	161.5	28.5	24	220.6	38.9	84	279.7	49.3
45	44.3	07.8	05	103.4	18.2	65	162.5	28.7	25	221.6	39.1	85	280.7	49.5
46	45.3	08.0	06	104.4	18.4	66	163.5	28.8	26	222.6	39.2	86	281.7	49.7
47	46.3	08.2	07	105.4	18.6	67	164.5	29.0	27	223.6	39.4	87	282.6	49.8
48	47.3	08.3	08	106.4	18.8	68	165.4	29.2	28	224.5	39.6	88	283.6	50.0
49	48.3	08.5	09	107.3	18.9	69	166.4	29.3	29	225.5	39.8	89	284.6	50.2
50	49.2	08.7	10	108.3	19.1	70	167.4	29.5	30	226.5	39.9	90	285.6	50.4
51	50.2	08.9	111	109.3	19.3	171	168.4	29.7	231	227.5	40.1	291	286.6	50.5
52	51.2	09.0	12	110.3	19.4	72	169.4	29.9	32	228.5	40.3	92	287.6	50.7
53	52.2	09.2	13	111.3	19.6	73	170.4	30.0	33	229.5	40.5	93	288.5	50.9
54	53.2	09.4	14	112.3	19.8	74	171.4	30.2	34	230.4	40.6	94	289.5	51.1
55	54.2	09.6	15	113.3	20.0	75	172.3	30.4	35	231.4	40.8	95	290.5	51.2
56	55.1	09.7	16	114.2	20.1	76	173.3	30.6	36	232.4	41.0	96	291.5	51.4
57	56.1	09.9	17	115.2	20.3	77	174.3	30.7	37	233.4	41.2	97	292.5	51.6
58	57.1	10.1	18	116.2	20.5	78	175.3	30.9	38	234.4	41.3	98	293.5	51.7
59	58.1	10.2	19	117.2	20.7	79	176.3	31.1	39	235.4	41.5	99	294.5	51.9
60	59.1	10.4	20	118.2	20.8	80	177.3	31.3	40	236.4	41.7	300	295.4	52.1
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 80 Degrees.

Table II. Difference of Latitude and Departure for 11 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.2	61	59.9	11.6	121	118.8	23.1	181	177.7	34.5	241	236.6	46.0
2	02.0	00.4	62	60.9	11.8	22	119.8	23.3	82	178.7	34.7	42	237.6	46.2
3	02.9	00.6	63	61.8	12.0	23	120.7	23.5	83	179.6	34.9	43	238.5	46.4
4	03.9	00.8	64	62.8	12.2	24	121.7	23.7	84	180.6	35.1	44	239.5	46.6
5	04.9	01.0	65	63.8	12.4	25	122.7	23.9	85	181.6	35.3	45	240.5	46.7
6	05.9	01.1	66	64.8	12.6	26	123.7	24.0	86	182.6	35.5	46	241.5	46.9
7	06.9	01.3	67	65.8	12.8	27	124.7	24.2	87	183.6	35.7	47	242.5	47.1
8	07.9	01.5	68	66.8	13.0	28	125.6	24.4	88	184.5	35.9	48	243.4	47.3
9	08.8	01.7	69	67.7	13.2	29	126.6	24.6	89	185.5	36.1	49	244.4	47.5
10	09.8	01.9	70	68.7	13.4	30	127.6	24.8	90	186.5	36.3	50	245.4	47.7
11	10.8	02.1	71	69.7	13.5	131	128.6	25.0	191	187.5	36.4	251	246.4	47.9
12	11.8	02.3	72	70.7	13.7	32	129.6	25.2	92	188.5	36.6	52	247.4	48.1
13	12.8	02.5	73	71.7	13.9	33	130.6	25.4	93	189.5	36.8	53	248.4	48.3
14	13.7	02.7	74	72.6	14.1	34	131.5	25.6	94	190.4	37.0	54	249.3	48.5
15	14.7	02.9	75	73.6	14.3	35	132.5	25.8	95	191.4	37.2	55	250.3	48.7
16	15.7	03.1	76	74.6	14.5	36	133.5	26.0	96	192.4	37.4	56	251.3	48.8
17	16.7	03.2	77	75.6	14.7	37	134.5	26.1	97	193.4	37.6	57	252.3	49.0
18	17.7	03.4	78	76.6	14.9	38	135.5	26.3	98	194.4	37.8	58	253.3	49.2
19	18.7	03.6	79	77.5	15.1	39	136.4	26.5	99	195.3	38.0	59	254.2	49.4
20	19.6	03.8	80	78.5	15.3	40	137.4	26.7	200	196.3	38.2	60	255.2	49.6
21	20.6	04.0	81	79.5	15.5	141	138.4	26.9	201	197.3	38.4	261	256.2	49.8
22	21.6	04.2	82	80.5	15.6	42	139.4	27.1	02	198.3	38.5	62	257.2	50.0
23	22.6	04.4	83	81.5	15.8	43	140.4	27.3	03	199.3	38.7	63	258.2	50.2
24	23.6	04.6	84	82.5	16.0	44	141.4	27.5	04	200.3	38.9	64	259.1	50.4
25	24.5	04.8	85	83.4	16.2	45	142.3	27.7	05	201.2	39.1	65	260.1	50.6
26	25.5	05.0	86	84.4	16.4	46	143.3	27.9	06	202.2	39.3	66	261.1	50.8
27	26.5	05.2	87	85.4	16.6	47	144.3	28.0	07	203.2	39.5	67	262.1	50.9
28	27.5	05.3	88	86.4	16.8	48	145.3	28.2	08	204.2	39.7	68	263.1	51.1
29	28.5	05.5	89	87.4	17.0	49	146.3	28.4	09	205.2	39.9	69	264.1	51.3
30	29.4	05.7	90	88.3	17.2	50	147.2	28.6	10	206.1	40.1	70	265.0	51.5
31	30.4	05.9	91	89.3	17.4	151	148.2	28.8	211	207.1	40.3	271	266.0	51.7
32	31.4	06.1	92	90.3	17.6	52	149.2	29.0	12	208.1	40.5	72	267.0	51.9
33	32.4	06.3	93	91.3	17.7	53	150.2	29.2	13	209.1	40.6	73	268.0	52.1
34	33.4	06.5	94	92.3	17.9	54	151.2	29.4	14	210.1	40.8	74	269.0	52.3
35	34.4	06.7	95	93.3	18.1	55	152.2	29.6	15	211.0	41.0	75	269.9	52.5
36	35.3	06.9	96	94.2	18.3	56	153.1	29.8	16	212.0	41.2	76	270.9	52.7
37	36.3	07.1	97	95.2	18.5	57	154.1	30.0	17	213.0	41.4	77	271.9	52.9
38	37.3	07.3	98	96.2	18.7	58	155.1	30.1	18	214.0	41.6	78	272.9	53.0
39	38.3	07.4	99	97.2	18.9	59	156.1	30.3	19	215.0	41.8	79	273.9	53.2
40	39.3	07.6	100	98.2	19.1	60	157.1	30.5	20	216.0	42.0	80	274.9	53.4
41	40.2	07.8	101	99.1	19.3	161	158.0	30.7	221	216.9	42.2	281	275.8	53.6
42	41.2	08.0	02	100.1	19.5	62	159.0	30.9	22	217.9	42.4	82	276.8	53.8
43	42.2	08.2	03	101.1	19.7	63	160.0	31.1	23	218.9	42.6	83	277.8	54.0
44	43.2	08.4	04	102.1	19.8	64	161.0	31.3	24	219.9	42.7	84	278.8	54.2
45	44.2	08.6	05	103.1	20.0	65	162.0	31.5	25	220.9	42.9	85	279.8	54.4
46	45.2	08.8	06	104.1	20.2	66	163.0	31.7	26	221.8	43.1	86	280.7	54.6
47	46.1	09.0	07	105.0	20.4	67	163.9	31.9	27	222.8	43.3	87	281.7	54.8
48	47.1	09.2	08	106.0	20.6	68	164.9	32.1	28	223.8	43.5	88	282.7	55.0
49	48.1	09.3	09	107.0	20.8	69	165.9	32.2	29	224.8	43.7	89	283.7	55.1
50	49.1	09.5	10	108.0	21.0	70	166.9	32.4	30	225.8	43.9	90	284.7	55.3
51	50.1	09.7	111	109.0	21.2	171	167.9	32.6	231	226.8	44.1	291	285.7	55.5
52	51.0	09.9	12	109.9	21.4	72	168.8	32.8	32	227.7	44.3	92	286.6	55.7
53	52.0	10.1	13	110.9	21.6	73	169.8	33.0	33	228.7	44.5	93	287.6	55.9
54	53.0	10.3	14	111.9	21.8	74	170.8	33.2	34	229.7	44.6	94	288.6	56.1
55	54.0	10.5	15	112.9	21.9	75	171.8	33.4	35	230.7	44.8	95	289.6	56.3
56	55.0	10.7	16	113.9	22.1	76	172.8	33.6	36	231.7	45.0	96	290.6	56.5
57	56.0	10.9	17	114.9	22.3	77	173.7	33.8	37	232.6	45.2	97	291.5	56.7
58	56.9	11.1	18	115.8	22.5	78	174.7	34.0	38	233.6	45.4	98	292.5	56.9
59	57.9	11.3	19	116.8	22.7	79	175.7	34.2	39	234.6	45.6	99	293.5	57.1
60	58.9	11.4	20	117.8	22.9	80	176.7	34.3	40	235.6	45.8	300	294.5	57.2
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 79 Degrees.

TABLE II. Difference of Latitude and Departure for 12 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.2	61	59.7	12.7	121	118.4	25.2	181	177.0	37.6	241	235.7	50.1
2	02.0	00.4	62	60.6	12.9	22	119.3	25.4	82	178.0	37.8	42	236.7	50.3
3	02.9	00.6	63	61.6	13.1	23	120.3	25.6	83	179.0	38.0	43	237.7	50.5
4	03.9	00.8	64	62.6	13.3	24	121.3	25.8	84	180.0	38.3	44	238.7	50.7
5	04.9	01.0	65	63.6	13.5	25	122.3	26.0	85	181.0	38.5	45	239.6	50.9
6	05.9	01.2	66	64.6	13.7	26	123.2	26.2	86	181.9	38.7	46	240.6	51.1
7	06.8	01.5	67	65.5	13.9	27	124.2	26.4	87	182.9	38.9	47	241.6	51.4
8	07.8	01.7	68	66.5	14.1	28	125.2	26.6	88	183.9	39.1	48	242.6	51.6
9	08.8	01.9	69	67.5	14.3	29	126.2	26.8	89	184.9	39.3	49	243.6	51.8
10	09.8	02.1	70	68.5	14.6	30	127.2	27.0	90	185.8	39.5	50	244.5	52.0
11	10.8	02.3	71	69.4	14.8	131	128.1	27.2	191	186.8	39.7	251	245.5	52.2
12	11.7	02.5	72	70.4	15.0	32	129.1	27.4	92	187.8	39.9	52	246.5	52.4
13	12.7	02.7	73	71.4	15.2	33	130.1	27.7	93	188.8	40.1	53	247.5	52.6
14	13.7	02.9	74	72.4	15.4	34	131.1	27.9	94	189.8	40.3	54	248.4	52.8
15	14.7	03.1	75	73.4	15.6	35	132.0	28.1	95	190.7	40.5	55	249.4	53.0
16	15.7	03.3	76	74.3	15.8	36	133.0	28.3	96	191.7	40.8	56	250.4	53.2
17	16.6	03.5	77	75.3	16.0	37	134.0	28.5	97	192.7	41.0	57	251.4	53.4
18	17.6	03.7	78	76.3	16.2	38	135.0	28.7	98	193.7	41.2	58	252.4	53.6
19	18.6	04.0	79	77.3	16.4	39	136.0	28.9	99	194.7	41.4	59	253.3	53.8
20	19.6	04.2	80	78.2	16.6	40	136.9	29.1	200	195.6	41.6	60	254.3	54.1
21	20.5	04.4	81	79.2	16.8	141	137.9	29.3	201	196.6	41.8	261	255.3	54.3
22	21.5	04.6	82	80.2	17.0	42	138.9	29.5	02	197.6	42.0	62	256.3	54.5
23	22.5	04.8	83	81.2	17.3	43	139.9	29.7	03	198.6	42.2	63	257.3	54.7
24	23.5	05.0	84	82.2	17.5	44	140.9	29.9	04	199.5	42.4	64	258.2	54.9
25	24.5	05.2	85	83.1	17.7	45	141.8	30.1	05	200.5	42.6	65	259.2	55.1
26	25.4	05.4	86	84.1	17.9	46	142.8	30.4	06	201.5	42.8	66	260.2	55.3
27	26.4	05.6	87	85.1	18.1	47	143.8	30.6	07	202.5	43.0	67	261.2	55.5
28	27.4	05.8	88	86.1	18.3	48	144.8	30.8	08	203.5	43.2	68	262.1	55.7
29	28.4	06.0	89	87.1	18.5	49	145.7	31.0	09	204.4	43.5	69	263.1	55.9
30	29.3	06.2	90	88.0	18.7	50	146.7	31.2	10	205.4	43.7	70	264.1	56.1
31	30.3	06.4	91	89.0	18.9	151	147.7	31.4	211	206.4	43.9	271	265.1	56.3
32	31.3	06.7	92	90.0	19.1	52	148.7	31.6	12	207.4	44.1	72	266.1	56.6
33	32.3	06.9	93	91.0	19.3	53	149.7	31.8	13	208.3	44.3	73	267.0	56.8
34	33.3	07.1	94	91.9	19.5	54	150.6	32.0	14	209.3	44.5	74	268.0	57.0
35	34.2	07.3	95	92.9	19.8	55	151.6	32.2	15	210.3	44.7	75	269.0	57.2
36	35.2	07.5	96	93.9	20.0	56	152.6	32.4	16	211.3	44.9	76	270.0	57.4
37	36.2	07.7	97	94.9	20.2	57	153.6	32.6	17	212.3	45.1	77	270.9	57.6
38	37.2	07.9	98	95.9	20.4	58	154.5	32.9	18	213.2	45.3	78	271.9	57.8
39	38.1	08.1	99	96.8	20.6	59	155.5	33.1	19	214.2	45.5	79	272.9	58.0
40	39.1	08.3	100	97.8	20.8	60	156.5	33.3	20	215.2	45.7	80	273.9	58.2
41	40.1	08.5	101	98.8	21.0	161	157.5	33.5	221	216.2	45.9	281	274.9	58.4
42	41.1	08.7	02	99.8	21.2	62	158.5	33.7	22	217.1	46.2	82	275.8	58.6
43	42.1	08.9	03	100.7	21.4	63	159.4	33.9	23	218.1	46.4	83	276.8	58.8
44	43.0	09.1	04	101.7	21.6	64	160.4	34.1	24	219.1	46.6	84	277.8	59.0
45	44.0	09.4	05	102.7	21.8	65	161.4	34.3	25	220.1	46.8	85	278.8	59.3
46	45.0	09.6	06	103.7	22.0	66	162.4	34.5	26	221.1	47.0	86	279.8	59.5
47	46.0	09.8	07	104.7	22.2	67	163.4	34.7	27	222.0	47.2	87	280.7	59.7
48	47.0	10.0	08	105.7	22.5	68	164.3	34.9	28	223.0	47.4	88	281.7	59.9
49	47.9	10.2	09	106.6	22.7	69	165.3	35.1	29	224.0	47.6	89	282.7	60.1
50	48.9	10.4	10	107.6	22.9	70	166.3	35.3	30	225.0	47.8	90	283.7	60.3
51	49.9	10.6	111	108.6	23.1	171	167.3	35.6	231	226.0	48.0	291	284.6	60.5
52	50.9	10.8	12	109.6	23.3	72	168.2	35.8	32	226.9	48.2	92	285.6	60.7
53	51.8	11.0	13	110.5	23.5	73	169.2	36.0	33	227.9	48.4	93	286.6	60.9
54	52.8	11.2	14	111.5	23.7	74	170.2	36.2	34	228.9	48.7	94	287.6	61.1
55	53.8	11.4	15	112.5	23.9	75	171.2	36.4	35	229.9	48.9	95	288.6	61.3
56	54.8	11.6	16	113.5	24.1	76	172.2	36.6	36	230.8	49.1	96	289.5	61.5
57	55.8	11.9	17	114.4	24.3	77	173.1	36.8	37	231.8	49.3	97	290.5	61.7
58	56.7	12.1	18	115.4	24.5	78	174.1	37.0	38	232.8	49.5	98	291.5	62.0
59	57.7	12.3	19	116.4	24.7	79	175.1	37.2	39	233.8	49.7	99	292.5	62.2
60	58.7	12.5	20	117.4	24.9	80	176.1	37.4	40	234.8	49.9	300	293.4	62.4
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 78 Degrees.

TABLE II. Difference of Latitude and Departure for 13 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.2	61	59.4	13.7	121	117.9	27.2	181	176.4	40.7	241	234.8	54.2
2	01.9	00.4	62	60.4	13.9	22	118.9	27.4	82	177.3	40.9	42	235.8	54.4
3	02.9	00.7	63	61.4	14.2	23	119.8	27.7	83	178.3	41.2	43	236.8	54.7
4	03.9	00.9	64	62.4	14.4	24	120.8	27.9	84	179.3	41.4	44	237.7	54.9
5	04.9	01.1	65	63.3	14.6	25	121.8	28.1	85	180.3	41.6	45	238.7	55.1
6	05.8	01.3	66	64.3	14.8	26	122.8	28.3	86	181.2	41.8	46	239.7	55.3
7	66.8	01.6	67	65.3	15.1	27	123.7	28.6	87	182.2	42.1	47	240.7	55.6
8	07.8	01.8	68	66.3	15.3	28	124.7	28.8	88	183.2	42.3	48	241.6	55.8
9	08.8	02.0	69	67.2	15.5	29	125.7	29.0	89	184.2	42.5	49	242.6	56.0
10	09.7	02.2	70	68.2	15.7	30	126.7	29.2	90	185.1	42.7	50	243.6	56.2
11	10.7	02.5	71	69.2	16.0	131	127.6	29.5	191	186.1	43.0	251	244.6	56.5
12	11.7	02.7	72	70.2	16.2	32	128.6	29.7	92	187.1	43.2	52	245.5	56.7
13	12.7	02.9	73	71.1	16.4	33	129.6	29.9	93	188.1	43.4	53	246.5	56.9
14	13.6	03.1	74	72.1	16.6	34	130.6	30.1	94	189.0	43.6	54	247.5	57.1
15	14.6	03.4	75	73.1	16.9	35	131.5	30.4	95	190.0	43.9	55	248.5	57.4
16	15.6	03.6	76	74.1	17.1	36	132.5	30.6	96	191.0	44.1	56	249.4	57.6
17	16.6	03.8	77	75.0	17.3	37	133.5	30.8	97	192.0	44.3	57	250.4	57.8
18	17.5	04.0	78	76.0	17.5	38	134.5	31.0	98	192.9	44.5	58	251.4	58.0
19	18.5	04.3	79	77.0	17.8	39	135.4	31.3	99	193.9	44.8	59	252.4	58.3
20	19.5	04.5	80	77.9	18.0	40	136.4	31.5	200	194.9	45.0	60	253.3	58.5
21	20.5	04.7	81	78.9	18.2	141	137.4	31.7	201	195.8	45.2	261	254.3	58.7
22	21.4	04.9	82	79.9	18.4	42	138.4	31.9	02	196.8	45.4	62	255.3	58.9
23	22.4	05.2	83	80.9	18.7	43	139.3	32.2	03	197.8	45.7	63	256.3	59.2
24	23.4	05.4	84	81.8	18.9	44	140.3	32.4	04	198.8	45.9	64	257.2	59.4
25	24.4	05.6	85	82.8	19.1	45	141.3	32.6	05	199.7	46.1	65	258.2	59.6
26	25.3	05.8	86	83.8	19.3	46	142.3	32.8	06	200.7	46.3	66	259.2	59.8
27	26.3	06.1	87	84.8	19.6	47	143.2	33.1	07	201.7	46.6	67	260.2	60.1
28	27.3	06.3	88	85.7	19.8	48	144.2	33.3	08	202.7	46.8	68	261.1	60.3
29	28.3	06.5	89	86.7	20.0	49	145.2	33.5	09	203.6	47.0	69	262.1	60.5
30	29.2	06.7	90	87.7	20.2	50	146.2	33.7	10	204.6	47.2	70	263.1	60.7
31	30.2	07.0	91	88.7	20.5	151	147.1	34.0	211	205.6	47.5	271	264.1	61.0
32	31.2	07.2	92	89.6	20.7	52	148.1	34.2	12	206.6	47.7	72	265.0	61.2
33	32.2	07.4	93	90.6	20.9	53	149.1	34.4	13	207.5	47.9	73	266.0	61.4
34	33.1	07.6	94	91.6	21.1	54	150.1	34.6	14	208.5	48.1	74	267.0	61.6
35	34.1	07.9	95	92.6	21.4	55	151.0	34.9	15	209.5	48.4	75	268.0	61.9
36	35.1	08.1	96	93.5	21.6	56	152.0	35.1	16	210.5	48.6	76	268.9	62.1
37	36.1	08.3	97	94.5	21.8	57	153.0	35.3	17	211.4	48.8	77	269.9	62.3
38	37.0	08.5	98	95.5	22.0	58	154.0	35.5	18	212.4	49.0	78	270.9	62.5
39	38.0	08.8	99	96.5	22.3	59	154.9	35.8	19	213.4	49.3	79	271.8	62.8
40	39.0	09.0	100	97.4	22.5	60	155.9	36.0	20	214.4	49.5	80	272.8	63.0
41	39.9	09.2	101	98.4	22.7	161	156.9	36.2	221	215.3	49.7	281	273.8	63.2
42	40.9	09.4	02	99.4	22.9	62	157.8	36.4	22	216.3	49.9	82	374.8	63.4
43	41.9	09.7	03	100.4	23.2	63	158.8	36.7	23	217.3	50.2	83	275.7	63.7
44	42.9	09.9	04	101.3	23.4	64	159.8	36.9	24	218.3	50.4	84	276.7	63.9
45	43.8	10.1	05	102.3	23.6	65	160.8	37.1	25	219.2	50.6	85	277.7	64.1
46	44.8	10.3	06	103.3	23.8	66	161.7	37.3	26	220.2	50.8	86	278.7	64.3
47	45.8	10.6	07	104.3	24.1	67	162.7	37.6	27	221.2	51.1	87	279.6	64.6
48	46.8	10.8	08	105.2	24.3	68	163.7	37.8	28	222.2	51.3	88	280.6	64.8
49	47.7	11.0	09	106.2	24.5	69	164.7	38.0	29	223.1	51.5	89	281.6	65.0
50	48.7	11.2	10	107.2	24.7	70	165.6	38.2	30	224.1	51.7	90	282.6	65.2
51	49.7	11.5	111	108.2	25.0	171	166.6	38.5	231	225.1	52.0	291	283.5	65.5
52	50.7	11.7	12	109.1	25.2	72	167.6	38.7	32	226.1	52.2	92	284.5	65.7
53	51.6	11.9	13	110.1	25.4	73	168.6	38.9	33	227.0	52.4	93	285.5	65.9
54	52.6	12.1	14	111.1	25.6	74	169.5	39.1	34	228.0	52.6	94	286.5	66.1
55	53.6	12.4	15	112.1	25.9	75	170.5	39.4	35	229.0	52.9	95	287.4	66.4
56	54.6	12.6	16	113.0	26.1	76	171.5	39.6	36	230.0	53.1	96	288.4	66.6
57	55.5	12.8	17	114.0	26.3	77	172.5	39.8	37	230.9	53.3	97	289.4	66.8
58	56.5	13.0	18	115.0	26.5	78	173.4	40.0	38	231.9	53.5	98	290.4	67.0
59	57.5	13.3	19	116.0	26.8	79	174.4	40.3	39	232.9	53.8	99	291.3	67.3
60	58.5	13.5	20	116.9	27.0	80	175.4	40.5	40	233.8	54.0	300	292.3	67.5
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 77 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.2	61	59.2	14.8	121	117.4	29.3	181	175.6	43.8	241	233.8	58.3
2	01.9	00.5	62	60.2	15.0	22	118.4	29.5	82	176.6	44.0	42	234.8	58.5
3	02.9	00.7	63	61.1	15.2	23	119.3	29.8	83	177.6	44.3	43	235.8	58.8
4	03.9	01.0	64	62.1	15.5	24	120.3	30.0	84	178.5	44.5	44	236.8	59.0
5	04.9	01.2	65	63.1	15.7	25	121.3	30.2	85	179.5	44.8	45	237.7	59.3
6	05.8	01.5	66	64.0	16.0	26	122.3	30.5	86	180.5	45.0	46	238.7	59.5
7	06.8	01.7	67	65.0	16.2	27	123.2	30.7	87	181.4	45.2	47	239.7	59.8
8	07.8	01.9	68	66.0	16.5	28	124.2	31.0	88	182.4	45.5	48	240.6	60.0
9	08.7	02.2	69	67.0	16.7	29	125.2	31.2	89	183.4	45.7	49	241.6	60.2
10	09.7	02.4	70	67.9	16.9	30	126.1	31.4	90	184.4	46.0	50	242.6	60.5
11	10.7	02.7	71	68.9	17.2	131	127.1	31.7	191	185.3	46.2	251	243.5	60.7
12	11.6	02.9	72	69.9	17.4	32	128.1	31.9	92	186.3	46.4	52	244.5	61.0
13	12.6	03.1	73	70.8	17.7	33	129.0	32.2	93	187.3	46.7	53	245.5	61.2
14	13.6	03.4	74	71.8	17.9	34	130.0	32.4	94	188.2	46.9	54	246.5	61.4
15	14.6	03.6	75	72.8	18.1	35	131.0	32.7	95	189.2	47.2	55	247.4	61.7
16	15.5	03.9	76	73.7	18.4	36	132.0	32.9	96	190.2	47.4	56	248.4	61.9
17	16.5	04.1	77	74.7	18.6	37	132.9	33.1	97	191.1	47.7	57	249.4	62.2
18	17.5	04.4	78	75.7	18.9	38	133.9	33.4	98	192.1	47.9	58	250.3	62.4
19	18.4	04.6	79	76.7	19.1	39	134.9	33.6	99	193.1	48.1	59	251.3	62.7
20	19.4	04.8	80	77.6	19.4	40	135.8	33.9	200	194.1	48.4	60	252.3	62.9
21	20.4	05.1	81	78.6	19.6	141	136.8	34.1	201	195.0	48.6	261	253.2	63.1
22	21.3	05.3	82	79.6	19.8	42	137.8	34.4	02	196.0	48.9	62	254.2	63.4
23	22.3	05.6	83	80.5	20.1	43	138.8	34.6	03	197.0	49.1	63	255.2	63.6
24	23.3	05.8	84	81.5	20.3	44	139.7	34.8	04	197.9	49.4	64	256.2	63.9
25	24.3	06.0	85	82.5	20.6	45	140.7	35.1	05	198.9	49.6	65	257.1	64.1
26	25.2	06.3	86	83.4	20.8	46	141.7	35.3	06	199.9	49.8	66	258.1	64.4
27	26.2	06.5	87	84.4	21.0	47	142.6	35.6	07	200.9	50.1	67	259.1	64.6
28	27.2	06.8	88	85.4	21.3	48	143.6	35.8	08	201.8	50.3	68	260.0	64.8
29	28.1	07.0	89	86.4	21.5	49	144.6	36.0	09	202.8	50.6	69	261.0	65.1
30	29.1	07.3	90	87.3	21.8	50	145.5	36.3	10	203.8	50.8	70	262.0	65.3
31	30.1	07.5	91	88.3	22.0	151	146.5	36.5	211	204.7	51.0	271	263.0	65.6
32	31.0	07.7	92	89.3	22.3	52	147.5	36.8	12	205.7	51.3	72	263.9	65.8
33	32.0	08.0	93	90.2	22.5	53	148.5	37.0	13	206.7	51.5	73	264.9	66.0
34	33.0	08.2	94	91.2	22.7	54	149.4	37.3	14	207.6	51.8	74	265.9	66.3
35	34.0	08.5	95	92.2	23.0	55	150.4	37.5	15	208.6	52.0	75	266.8	66.5
36	34.9	08.7	96	93.1	23.2	56	151.4	37.7	16	209.6	52.3	76	267.8	66.8
37	35.9	09.0	97	94.1	23.5	57	152.3	38.0	17	210.6	52.5	77	268.8	67.0
38	36.9	09.2	98	95.1	23.7	58	153.3	38.2	18	211.5	52.7	78	269.7	67.3
39	37.8	09.4	99	96.1	24.0	59	154.3	38.5	19	212.5	53.0	79	270.7	67.5
40	38.8	09.7	100	97.0	24.2	60	155.2	38.7	20	213.5	53.2	80	271.7	67.7
41	39.8	09.9	101	98.0	24.4	101	156.2	38.9	221	214.4	53.5	281	272.7	68.0
42	40.8	10.2	02	99.0	24.7	62	157.2	39.2	22	215.4	53.7	82	273.6	68.2
43	41.7	10.4	03	99.9	24.9	63	158.2	39.4	23	216.4	53.9	83	274.6	68.5
44	42.7	10.6	04	100.9	25.2	64	159.1	39.7	24	217.3	54.2	84	275.6	68.7
45	43.7	10.9	05	101.9	25.4	65	160.1	39.9	25	218.3	54.4	85	276.5	68.9
46	44.6	11.1	06	102.9	25.6	66	161.1	40.2	26	219.3	54.7	86	277.5	69.2
47	45.6	11.4	07	103.8	25.9	67	162.0	40.4	27	220.3	54.9	87	278.5	69.4
48	46.6	11.6	08	104.8	26.1	68	163.0	40.6	28	221.2	55.2	88	279.4	69.7
49	47.5	11.9	09	105.8	26.4	69	164.0	40.9	29	222.2	55.4	89	280.4	69.9
50	48.5	12.1	10	106.7	26.6	70	165.0	41.1	30	223.2	55.6	90	281.4	70.2
51	49.5	12.3	111	107.7	26.9	171	165.9	41.4	231	224.1	55.9	291	282.4	70.4
52	50.5	12.6	12	108.7	27.1	72	166.9	41.6	32	225.1	56.1	92	283.3	70.6
53	51.4	12.8	13	109.6	27.3	73	167.9	41.9	33	226.1	56.4	93	284.3	70.9
54	52.4	13.1	14	110.6	27.6	74	168.8	42.1	34	227.0	56.6	94	285.3	71.1
55	53.4	13.3	15	111.6	27.8	75	169.8	42.3	35	228.0	56.9	95	286.2	71.4
56	54.3	13.5	16	112.6	28.1	76	170.8	42.6	36	229.0	57.1	96	287.2	71.6
57	55.3	13.8	17	113.5	28.3	77	171.7	42.8	37	230.0	57.3	97	288.2	71.9
58	56.3	14.0	18	114.5	28.5	78	172.7	43.1	38	230.9	57.6	98	289.1	72.1
59	57.2	14.3	19	115.5	28.8	79	173.7	43.3	39	231.9	57.8	99	290.1	72.3
60	58.2	14.5	20	116.4	29.0	80	174.6	43.5	40	232.9	58.1	300	291.1	72.6
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 76 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.3	61	58.9	15.8	121	116.9	31.3	181	174.8	46.8	241	232.8	62.4
2	01.9	00.5	62	59.9	16.0	22	117.8	31.6	82	175.8	47.1	42	233.8	62.6
3	02.9	00.8	63	60.9	16.3	23	118.8	31.8	83	176.8	47.4	43	234.7	62.9
4	03.9	01.0	64	61.8	16.6	24	119.8	32.1	84	177.7	47.6	44	235.7	63.2
5	04.8	01.3	65	62.8	16.8	25	120.7	32.4	85	178.7	47.9	45	236.7	63.4
6	05.8	01.6	66	63.8	17.1	26	121.7	32.6	86	179.7	48.1	46	237.6	63.7
7	06.8	01.8	67	64.7	17.3	27	122.7	32.9	87	180.6	48.4	47	238.6	63.9
8	07.7	02.1	68	65.7	17.6	28	123.6	33.1	88	181.6	48.7	48	239.5	64.2
9	08.7	02.3	69	66.6	17.9	29	124.6	33.4	89	182.6	48.9	49	240.5	64.4
10	09.7	02.6	70	67.6	18.1	30	125.6	33.6	90	183.5	49.2	50	241.5	64.7
11	10.6	02.8	71	68.6	18.4	131	126.5	33.9	191	184.5	49.4	251	242.4	65.0
12	11.6	03.1	72	69.5	18.6	32	127.5	34.2	92	185.5	49.7	52	243.4	65.2
13	12.6	03.4	73	70.5	18.9	33	128.5	34.4	93	186.4	50.0	53	244.4	65.5
14	13.5	03.6	74	71.5	19.2	34	129.4	34.7	94	187.4	50.2	54	245.3	65.7
15	14.5	03.9	75	72.4	19.4	35	130.4	34.9	95	188.4	50.5	55	246.3	66.0
16	15.5	04.1	76	73.4	19.7	36	131.4	35.2	96	189.3	50.7	56	247.3	66.3
17	16.4	04.4	77	74.4	19.9	37	132.3	35.5	97	190.3	51.0	57	248.2	66.5
18	17.4	04.7	78	75.3	20.2	38	133.3	35.7	98	191.3	51.2	58	249.2	66.8
19	18.4	04.9	79	76.3	20.4	39	134.3	36.0	99	192.2	51.5	59	250.2	67.0
20	19.3	05.2	80	77.3	20.7	40	135.2	36.2	200	193.2	51.8	60	251.1	67.3
21	20.3	05.4	81	78.2	21.0	141	136.2	36.5	201	194.2	52.0	261	252.1	67.6
22	21.3	05.7	82	79.2	21.2	42	137.2	36.8	02	195.1	52.3	62	253.1	67.8
23	22.2	06.0	83	80.2	21.5	43	138.1	37.0	03	196.1	52.5	63	254.0	68.1
24	23.2	06.2	84	81.1	21.7	44	139.1	37.3	04	197.0	52.8	64	255.0	68.3
25	24.1	06.5	85	82.1	22.0	45	140.1	37.5	05	198.0	53.1	65	256.0	68.6
26	25.1	06.7	86	83.1	22.3	46	141.0	37.8	06	199.0	53.3	66	256.9	68.8
27	26.1	07.0	87	84.0	22.5	47	142.0	38.0	07	199.9	53.6	67	257.9	69.1
28	27.0	07.2	88	85.0	22.8	48	143.0	38.3	08	200.9	53.8	68	258.9	69.4
29	28.0	07.5	89	86.0	23.0	49	143.9	38.6	09	201.9	54.1	69	259.8	69.6
30	29.0	07.8	90	86.9	23.3	50	144.9	38.8	10	202.8	54.4	70	260.8	69.9
31	29.9	08.0	91	87.9	23.6	151	145.9	39.1	211	203.8	54.6	271	261.8	70.1
32	30.9	08.3	92	88.9	23.8	52	146.8	39.3	12	204.8	54.9	72	262.7	70.4
33	31.9	08.5	93	89.8	24.1	53	147.8	39.6	13	205.7	55.1	73	263.7	70.7
34	32.8	08.8	94	90.8	24.3	54	148.8	39.9	14	206.7	55.4	74	264.7	70.9
35	33.8	09.1	95	91.8	24.6	55	149.7	40.1	15	207.7	55.6	75	265.6	71.2
36	34.8	09.3	96	92.7	24.8	56	150.7	40.4	16	208.6	55.9	76	266.6	71.4
37	35.7	09.6	97	93.7	25.1	57	151.7	40.6	17	209.6	56.2	77	267.6	71.7
38	36.7	09.8	98	94.7	25.4	58	152.6	40.9	18	210.6	56.4	78	268.5	72.0
39	37.7	10.1	99	95.6	25.6	59	153.6	41.2	19	211.5	56.7	79	269.5	72.2
40	38.6	10.4	100	96.6	25.9	60	154.5	41.4	20	212.5	56.9	80	270.5	72.5
41	39.6	10.6	101	97.6	26.1	161	155.5	41.7	221	213.5	57.2	281	271.4	72.7
42	40.6	10.9	02	98.5	26.4	62	156.5	41.9	22	214.4	57.5	82	272.4	73.0
43	41.5	11.1	03	99.5	26.7	63	157.4	42.2	23	215.4	57.7	83	273.4	73.2
44	42.5	11.4	04	100.5	26.9	64	158.4	42.4	24	216.4	58.0	84	274.3	73.5
45	43.5	11.6	05	101.4	27.2	65	159.4	42.7	25	217.3	58.2	85	275.3	73.8
46	44.4	11.9	06	102.4	27.4	66	160.3	43.0	26	218.3	58.5	86	276.3	74.0
47	45.4	12.2	07	103.4	27.7	67	161.3	43.2	27	219.3	58.8	87	277.2	74.3
48	46.4	12.4	08	104.3	28.0	68	162.3	43.5	28	220.2	59.0	88	278.2	74.5
49	47.3	12.7	09	105.3	28.2	69	163.2	43.7	29	221.2	59.3	89	279.2	74.8
50	48.3	12.9	10	106.3	28.5	70	164.2	44.0	30	222.2	59.5	90	280.1	75.1
51	49.3	13.2	111	107.2	28.7	171	165.2	44.3	231	223.1	59.8	291	281.1	75.3
52	50.2	13.5	12	108.2	29.0	72	166.1	44.5	32	224.1	60.0	92	282.1	75.6
53	51.2	13.7	13	109.1	29.2	73	167.1	44.8	33	225.1	60.3	93	283.0	75.8
54	52.2	14.0	14	110.1	29.5	74	168.1	45.0	34	226.0	60.6	94	284.0	76.1
55	53.1	14.2	15	111.1	29.8	75	169.0	45.3	35	227.0	60.8	95	284.9	76.4
56	54.1	14.5	16	112.0	30.0	76	170.0	45.6	36	228.0	61.1	96	285.9	76.6
57	55.1	14.8	17	113.0	30.3	77	171.0	45.8	37	228.9	61.3	97	286.9	76.9
58	56.0	15.0	18	114.0	30.5	78	171.9	46.1	38	229.9	61.6	98	287.8	77.1
59	57.0	15.3	19	114.9	30.8	79	172.9	46.3	39	230.9	61.9	99	288.8	77.4
60	58.0	15.5	20	115.9	31.1	80	173.9	46.6	40	231.8	62.1	300	289.8	77.6
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	01.0	00.3	61	58.6	16.8	121	116.3	33.4	181	174.0	49.9	241	231.7	66.4
2	01.9	00.6	62	59.6	17.1	22	117.3	33.6	82	174.9	50.2	42	232.6	66.7
3	02.9	00.8	63	60.6	17.4	23	118.2	33.9	83	175.9	50.4	43	233.6	67.0
4	03.8	01.1	64	61.5	17.6	24	119.2	34.2	84	176.9	50.7	44	234.5	67.3
5	04.8	01.4	65	62.5	17.9	25	120.2	34.5	85	177.8	51.0	45	235.5	67.5
6	05.8	01.7	66	63.4	18.2	26	121.1	34.7	86	178.8	51.3	46	236.5	67.8
7	06.7	01.9	67	64.4	18.5	27	122.1	35.0	87	179.8	51.5	47	237.4	68.1
8	07.7	02.2	68	65.4	18.7	28	123.0	35.3	88	180.7	51.8	48	238.4	68.4
9	08.7	02.5	69	66.3	19.0	29	124.0	35.6	89	181.7	52.1	49	239.4	68.6
10	09.6	02.8	70	67.3	19.3	30	125.0	35.8	90	182.6	52.4	50	240.3	68.9
11	10.6	03.0	71	68.2	19.6	131	125.9	36.1	191	183.6	52.6	251	241.3	69.2
12	11.5	03.3	72	69.2	19.8	32	126.9	36.4	92	184.6	52.9	52	242.2	69.5
13	12.5	03.6	73	70.2	20.1	33	127.8	36.7	93	185.5	53.2	53	243.2	69.7
14	13.5	03.9	74	71.1	20.4	34	128.8	36.9	94	186.5	53.5	54	244.2	70.0
15	14.4	04.1	75	72.1	20.7	35	129.8	37.2	95	187.4	53.7	55	245.1	70.3
16	15.4	04.4	76	73.1	20.9	36	130.7	37.5	96	188.4	54.0	56	246.1	70.6
17	16.3	04.7	77	74.0	21.2	37	131.7	37.8	97	189.4	54.3	57	247.0	70.8
18	17.3	05.0	78	75.0	21.5	38	132.7	38.0	98	190.3	54.6	58	248.0	71.1
19	18.3	05.2	79	75.9	21.8	39	133.6	38.3	99	191.3	54.9	59	249.0	71.4
20	19.2	05.5	80	76.9	22.1	40	134.6	38.6	200	192.3	55.1	60	249.9	71.7
21	20.2	05.8	81	77.9	22.3	141	135.5	38.9	201	193.2	55.4	261	250.9	71.9
22	21.1	06.1	82	78.8	22.6	42	136.5	39.1	02	194.2	55.7	62	251.9	72.2
23	22.1	06.3	83	79.8	22.9	43	137.5	39.4	03	195.1	56.0	63	252.8	72.5
24	23.1	06.6	84	80.7	23.2	44	138.4	39.7	04	196.1	56.2	64	253.8	72.8
25	24.0	06.9	85	81.7	23.4	45	139.4	40.0	05	197.1	56.5	65	254.7	73.0
26	25.0	07.2	86	82.7	23.7	46	140.3	40.2	06	198.0	56.8	66	255.7	73.3
27	26.0	07.4	87	83.6	24.0	47	141.3	40.5	07	199.0	57.1	67	256.7	73.6
28	26.9	07.7	88	84.6	24.3	48	142.3	40.8	08	199.9	57.3	68	257.6	73.9
29	27.9	08.0	89	85.6	24.5	49	143.2	41.1	09	200.9	57.6	69	258.6	74.1
30	28.8	08.3	90	86.5	24.8	50	144.2	41.3	10	201.9	57.9	70	259.5	74.4
31	29.8	08.5	91	87.5	25.1	151	145.2	41.6	211	202.8	58.2	271	260.5	74.7
32	30.8	08.8	92	88.4	25.4	52	146.1	41.9	12	203.8	58.4	72	261.5	75.0
33	31.7	09.1	93	89.4	25.6	53	147.1	42.2	13	204.7	58.7	73	262.4	75.2
34	32.7	09.4	94	90.4	25.9	54	148.0	42.4	14	205.7	59.0	74	263.4	75.5
35	33.6	09.6	95	91.3	26.2	55	149.0	42.7	15	206.7	59.3	75	264.3	75.8
36	34.6	09.9	96	92.3	26.5	56	150.0	43.0	16	207.6	59.5	76	265.3	76.1
37	35.6	10.2	97	93.2	26.7	57	150.9	43.3	17	208.6	59.8	77	266.3	76.4
38	36.5	10.5	98	94.2	27.0	58	151.9	43.6	18	209.6	60.1	78	267.2	76.6
39	37.5	10.7	99	95.2	27.3	59	152.8	43.8	19	210.5	60.4	79	268.2	76.9
40	38.5	11.0	100	96.1	27.6	60	153.8	44.1	20	211.5	60.6	80	269.2	77.2
41	39.4	11.3	101	97.1	27.8	161	154.8	44.4	221	212.4	60.9	281	270.1	77.5
42	40.4	11.6	02	98.0	28.1	62	155.7	44.7	22	213.4	61.2	82	271.1	77.7
43	41.3	11.9	03	99.0	28.4	63	156.7	44.9	23	214.4	61.5	83	272.0	78.0
44	42.3	12.1	04	100.0	28.7	64	157.6	45.2	24	215.3	61.7	84	273.0	78.3
45	43.3	12.4	05	100.9	28.9	65	158.6	45.5	25	216.3	62.0	85	274.0	78.6
46	44.2	12.7	06	101.9	29.2	66	159.6	45.8	26	217.2	62.3	86	274.9	78.8
47	45.2	13.0	07	102.9	29.5	67	160.5	46.0	27	218.2	62.6	87	275.9	79.1
48	46.1	13.2	08	103.8	29.8	68	161.5	46.3	28	219.2	62.8	88	276.8	79.4
49	47.1	13.5	09	104.8	30.0	69	162.5	46.6	29	220.1	63.1	89	277.8	79.7
50	48.1	13.8	10	105.7	30.3	70	163.4	46.9	30	221.1	63.4	90	278.8	79.9
51	49.0	14.1	111	106.7	30.6	171	164.4	47.1	231	222.1	63.7	291	279.7	80.2
52	50.0	14.3	12	107.7	30.9	72	165.3	47.4	32	223.0	63.9	92	280.7	80.5
53	50.9	14.6	13	108.6	31.1	73	166.3	47.7	33	224.0	64.2	93	281.6	80.8
54	51.9	14.9	14	109.6	31.4	74	167.3	48.0	34	224.9	64.5	94	282.6	81.0
55	52.9	15.2	15	110.5	31.7	75	168.2	48.2	35	225.9	64.8	95	283.6	81.3
56	53.8	15.4	16	111.5	32.0	76	169.2	48.5	36	226.9	65.1	96	284.5	81.6
57	54.8	15.7	17	112.5	32.2	77	170.1	48.8	37	227.8	65.3	97	285.5	81.9
58	55.8	16.0	18	113.4	32.5	78	171.1	49.1	38	228.8	65.6	98	286.5	82.1
59	56.7	16.3	19	114.4	32.8	79	172.1	49.3	39	229.7	65.9	99	287.4	82.4
60	57.7	16.5	20	115.4	33.1	80	173.0	49.6	40	230.7	66.2	300	288.4	82.7
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.3	17.8	121	115.7	35.4	181	173.1	52.9	241	230.5	70.5
2	01.9	00.6	62	59.3	18.1	22	116.7	35.7	82	174.0	53.2	42	231.4	70.8
3	02.9	00.9	63	60.2	18.4	23	117.6	36.0	83	175.0	53.5	43	232.4	71.0
4	03.8	01.2	64	61,2	18.7	24	118.6	36.3	84	176.0	53.8	44	233.3	71.3
5	04.8	01.5	65	62.2	19.0	25	119.5	36.5	85	176.9	54.1	45	234.3	71.6
6	05.7	01.8	66	63.1	19.3	26	120.5	36.8	86	177.9	54.4	46	235.3	71.9
7	06.7	02.0	67	64.1	19.6	27	121.5	37.1	87	178.8	54.7	47	236.2	72.2
8	07.7	02.3	68	65.0	19.9	28	122.4	37.4	88	179.8	55.0	48	237.2	72.5
9	08.6	02.6	69	66.0	20.2	29	123.4	37.7	89	180.7	55.3	49	238.1	72.8
10	09.6	02.9	70	66.9	20.5	30	124.3	38.0	90	181.7	55.6	50	239.1	73.1
11	10.5	03.2	71	67.9	20.8	131	125.3	38.3	191	182.7	55.8	251	240.0	73.4
12	11.5	03.5	72	68.9	21.1	32	126.2	38.6	92	183.6	56.1	52	241.0	73.7
13	12.4	03.8	73	69.8	21.3	33	127.2	38.9	93	184.6	56.4	53	241.9	74.0
14	13.4	04.1	74	70.8	21.6	34	128.1	39.2	94	185.5	56.7	54	242.9	74.3
15	14.3	04.4	75	71.7	21.9	35	129.1	39.5	95	186.5	57.0	55	243.9	74.6
16	15.3	04.7	76	72.7	22.2	36	130.1	39.8	96	187.4	57.3	56	244.8	74.8
17	16.3	05.0	77	73.6	22.5	37	131.0	40.1	97	188.4	57.6	57	245.8	75.1
18	17.2	05.3	78	74.6	22.8	38	132.0	40.3	98	189.3	57.9	58	246.7	75.4
19	18.2	05.6	79	75.5	23.1	39	132.9	40.6	99	190.3	58.2	59	247.7	75.7
20	19.1	05.8	80	76.5	23.4	40	133.9	40.9	200	191.3	58.5	60	248.6	76.0
21	20.1	06.1	81	77.5	23.7	141	134.8	41.2	201	192.2	58.8	261	249.6	76.3
22	21.0	06.4	82	78.4	24.0	42	135.8	41.5	02	193.2	59.1	62	250.6	76.6
23	22.0	06.7	83	79.4	24.3	43	136.8	41.8	03	194.1	59.4	63	251.5	76.9
24	23.0	07.0	84	80.3	24.6	44	137.7	42.1	04	195.1	59.6	64	252.5	77.2
25	23.9	07.3	85	81.3	24.9	45	138.7	42.4	05	196.0	59.9	65	253.4	77.5
26	24.9	07.6	86	82.2	25.1	46	139.6	42.7	06	197.0	60.2	66	254.4	77.8
27	25.8	07.9	87	83.2	25.4	47	140.6	43.0	07	198.0	60.5	67	255.3	78.1
28	26.8	08.2	88	84.2	25.7	48	141.5	43.3	08	198.9	60.8	68	256.3	78.4
29	27.7	08.5	89	85.1	26.0	49	142.5	43.6	09	199.9	61.1	69	257.2	78.6
30	28.7	08.8	90	86.1	26.3	50	143.4	43.9	10	200.8	61.4	70	258.2	78.9
31	29.6	09.1	91	87.0	26.6	151	144.4	44.1	211	201.8	61.7	271	259.2	79.2
32	30.6	09.4	92	88.0	26.9	52	145.4	44.4	12	202.7	62.0	72	260.1	79.5
33	31.6	09.6	93	88.9	27.2	53	146.3	44.7	13	203.7	62.3	73	261.1	79.8
34	32.5	09.9	94	89.9	27.5	54	147.3	45.0	14	204.6	62.6	74	262.0	80.1
35	33.5	10.2	95	90.8	27.8	55	148.2	45.3	15	205.6	62.9	75	263.0	80.4
36	34.4	10.5	96	91.8	28.1	56	149.2	45.6	16	206.6	63.2	76	263.9	80.7
37	35.4	10.8	97	92.8	28.4	57	150.1	45.9	17	207.5	63.4	77	264.9	81.0
38	36.3	11.1	98	93.7	28.7	58	151.1	46.2	18	208.5	63.7	78	265.9	81.3
39	37.3	11.4	99	94.7	28.9	59	152.1	46.5	19	209.4	64.0	79	266.8	81.6
40	38.3	11.7	100	95.6	29.2	60	153.0	46.8	20	210.4	64.3	80	267.8	81.9
41	39.2	12.0	101	96.6	29.5	161	154.0	47.1	221	211.3	64.6	281	268.7	82.2
42	40.2	12.3	02	97.5	29.8	62	154.9	47.4	22	212.3	64.9	82	269.7	82.4
43	41.1	12.6	03	98.5	30.1	63	155.9	47.7	23	213.3	65.2	83	270.6	82.7
44	42.1	12.9	04	99.5	30.4	64	156.8	47.9	24	214.2	65.5	84	271.6	83.0
45	43.0	13.2	05	100.4	30.7	65	157.8	48.2	25	215.2	65.8	85	272.5	83.3
46	44.0	13.4	06	101.4	31.0	66	158.7	48.5	26	216.1	66.1	86	273.5	83.6
47	44.9	13.7	07	102.3	31.3	67	159.7	48.8	27	217.1	66.4	87	274.5	83.9
48	45.9	14.0	08	103.3	31.6	68	160.7	49.1	28	218.0	66.7	88	275.4	84.2
49	46.9	14.3	09	104.2	31.9	69	161.6	49.4	29	219.0	67.0	89	276.4	84.5
50	47.8	14.6	10	105.2	32.2	70	162.6	49.7	30	220.0	67.2	90	277.3	84.8
51	48.8	14.9	111	106.1	32.5	171	163.5	50.0	231	220.9	67.5	291	278.3	85.1
52	49.7	15.2	12	107.1	32.7	72	164.5	50.3	32	221.9	67.8	92	279.2	85.4
53	50.7	15.5	13	108.1	33.0	73	165.4	50.6	33	222.8	68.1	93	280.2	85.7
54	51.6	15.8	14	109.0	33.3	74	166.4	50.9	34	223.8	68.4	94	281.2	86.0
55	52.6	16.1	15	110.0	33.6	75	167.4	51.2	35	224.7	68.7	95	282.1	86.2
56	53.6	16.4	16	110.9	33.9	76	168.3	51.5	36	225.7	69.0	96	283.1	86.5
57	54.5	16.7	17	111.9	34.2	77	169.3	51.7	37	226.6	69.3	97	284.0	86.8
58	55.5	17.0	18	112.8	34.5	78	170.2	52.0	38	227.6	69.6	98	285.0	87.1
59	56.4	17.2	19	113.8	34.8	79	171.2	52.3	39	228.6	69.9	99	285.9	87.4
60	57.4	17.5	20	114.8	35.1	80	172.1	52.6	40	229.5	70.2	300	286.9	87.7
Dist	Dep.	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 73 Degrees.

TABLE II. Difference of Latitude and Departure for 18 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.0	18.9	121	115.1	37.4	181	172.1	55.9	241	229.2	74.5
2	01.9	00.6	62	59.0	19.2	22	116.0	37.7	82	173.1	56.2	42	230.2	74.8
3	02.9	00.9	63	59.9	19.5	23	117.0	38.0	83	174.0	56.6	43	231.1	75.1
4	03.8	01.2	64	60.9	19.8	24	117.9	38.3	84	175.0	56.9	44	232.1	75.4
5	04.8	01.5	65	61.8	20.1	25	118.9	38.6	85	175.9	57.2	45	233.0	75.7
6	05.7	01.9	66	62.8	20.4	26	119.8	38.9	86	176.9	57.5	46	234.0	76.0
7	06.7	02.2	67	63.7	20.7	27	120.8	39.2	87	177.8	57.8	47	234.9	76.3
8	07.6	02.5	68	64.7	21.0	28	121.7	39.6	88	178.8	58.1	48	235.9	76.6
9	08.6	02.8	69	65.6	21.3	29	122.7	39.9	89	179.7	58.4	49	236.8	76.9
10	09.5	03.1	70	66.6	21.6	30	123.6	40.2	90	180.7	58.7	50	237.8	77.3
11	10.5	03.4	71	67.5	21.9	131	124.6	40.5	191	181.7	59.0	251	238.7	77.6
12	11.4	03.7	72	68.5	22.2	32	125.5	40.8	92	182.6	59.3	52	239.7	77.9
13	12.4	04.0	73	69.4	22.6	33	126.5	41.1	93	183.6	59.6	53	240.6	78.2
14	13.3	04.3	74	70.4	22.9	34	127.4	41.4	94	184.5	59.9	54	241.6	78.5
15	14.3	04.6	75	71.3	23.2	35	128.4	41.7	95	185.5	60.3	55	242.5	78.8
16	15.2	04.9	76	72.3	23.5	36	129.3	42.0	96	186.4	60.6	56	243.5	79.1
17	16.2	05.3	77	73.2	23.8	37	130.3	42.3	97	187.4	60.9	57	244.4	79.4
18	17.1	05.6	78	74.2	24.1	38	131.2	42.6	98	188.3	61.2	58	245.4	79.7
19	18.1	05.9	79	75.1	24.4	39	132.2	43.0	99	189.3	61.5	59	246.3	80.0
20	19.0	06.2	80	76.1	24.7	40	133.1	43.3	200	190.2	61.8	60	247.3	80.3
21	20.0	06.5	81	77.0	25.0	141	134.1	43.6	201	191.2	62.1	261	248.2	80.7
22	20.9	06.8	82	78.0	25.3	42	135.1	43.9	02	192.1	62.4	62	249.2	81.0
23	21.9	07.1	83	78.9	25.6	43	136.0	44.2	03	193.1	62.7	63	250.1	81.3
24	22.8	07.4	84	79.9	26.0	44	137.0	44.5	04	194.0	63.0	64	251.1	81.6
25	23.8	07.7	85	80.8	26.3	45	137.9	44.8	05	195.0	63.3	65	252.0	81.9
26	24.7	08.0	86	81.8	26.6	46	138.9	45.1	06	195.9	63.7	66	253.0	82.2
27	25.7	08.3	87	82.7	26.9	47	139.8	45.4	07	196.9	64.0	67	253.9	82.5
28	26.6	08.7	88	83.7	27.2	48	140.8	45.7	08	197.8	64.3	68	254.9	82.8
29	27.6	09.0	89	84.6	27.5	49	141.7	46.0	09	198.8	64.6	69	255.8	83.1
30	28.5	09.3	90	85.6	27.8	50	142.7	46.4	10	199.7	64.9	70	256.8	83.4
31	29.5	09.6	91	86.5	28.1	151	143.6	46.7	211	200.7	65.2	271	257.7	83.7
32	30.4	09.9	92	87.5	28.4	52	144.6	47.0	12	201.6	65.5	72	258.7	84.1
33	31.4	10.2	93	88.4	28.7	53	145.5	47.3	13	202.6	65.8	73	259.6	84.4
34	32.3	10.5	94	89.4	29.0	54	146.5	47.6	14	203.5	66.1	74	260.6	84.7
35	33.3	10.8	95	90.4	29.4	55	147.4	47.9	15	204.5	66.4	75	261.5	85.0
36	34.2	11.1	96	91.3	29.7	56	148.4	48.2	16	205.4	66.7	76	262.5	85.3
37	35.2	11.4	97	92.3	30.0	57	149.3	48.5	17	206.4	67.1	77	263.4	85.6
38	36.1	11.7	98	93.2	30.3	58	150.3	48.8	18	207.3	67.4	78	264.4	85.9
39	37.1	12.1	99	94.2	30.6	59	151.2	49.1	19	208.3	67.7	79	265.3	86.2
40	38.0	12.4	100	95.1	30.9	60	152.2	49.4	20	209.2	68.0	80	266.3	86.5
41	39.0	12.7	101	96.1	31.2	161	153.1	49.8	221	210.2	68.3	281	267.2	86.8
42	39.9	13.0	02	97.0	31.5	62	154.1	50.1	22	211.1	68.6	82	268.2	87.1
43	40.9	13.3	03	98.0	31.8	63	155.0	50.4	23	212.1	68.9	83	269.1	87.5
44	41.8	13.6	04	98.9	32.1	64	156.0	50.7	24	213.0	69.2	84	270.1	87.8
45	42.8	13.9	05	99.9	32.4	65	156.9	51.0	25	214.0	69.5	85	271.1	88.1
46	43.7	14.2	06	100.8	32.8	66	157.9	51.3	26	214.9	69.8	86	272.0	88.4
47	44.7	14.5	07	101.8	33.1	67	158.8	51.6	27	215.9	70.1	87	273.0	88.7
48	45.7	14.8	08	102.7	33.4	68	159.8	51.9	28	216.8	70.5	88	273.9	89.0
49	46.6	15.1	09	103.7	33.7	69	160.7	52.2	29	217.8	70.8	89	274.9	89.3
50	47.6	15.5	10	104.6	34.0	70	161.7	52.5	30	218.7	71.1	90	275.8	89.6
51	48.5	15.8	111	105.6	34.3	171	162.6	52.8	231	219.7	71.4	291	276.8	89.9
52	49.5	16.1	12	106.5	34.6	72	163.6	53.2	32	220.6	71.7	92	277.7	90.2
53	50.4	16.4	13	107.5	34.9	73	164.5	53.5	33	221.6	72.0	93	278.7	90.5
54	51.4	16.7	14	108.4	35.2	74	165.5	53.8	34	222.5	72.3	94	279.6	90.9
55	52.3	17.0	15	109.4	35.5	75	166.4	54.1	35	223.5	72.6	95	280.6	91.2
56	53.3	17.3	16	110.3	35.8	76	167.4	54.4	36	224.4	72.9	96	281.5	91.5
57	54.2	17.6	17	111.3	36.2	77	168.3	54.7	37	225.4	73.2	97	282.5	91.8
58	55.2	17.9	18	112.2	36.5	78	169.3	55.0	38	226.4	73.5	98	283.4	92.1
59	56.1	18.2	19	113.2	36.8	79	170.2	55.3	39	227.3	73.9	99	284.4	92.4
60	57.1	18.5	20	114.1	37.1	80	171.2	55.6	40	228.3	74.2	300	285.3	92.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 72 Degrees.

TABLE II. Difference of Latitude and Departure for 19 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.3	61	57.7	19.9	121	114.4	39.4	181	171.1	58.9	241	227.9	78.5
2	01.9	00.7	62	58.6	20.2	22	115.4	39.7	82	172.1	59.3	42	228.8	78.8
3	02.8	01.0	63	59.6	20.5	23	116.3	40.0	83	173.0	59.6	43	229.8	79.1
4	03.8	01.3	64	60.5	20.8	24	117.2	40.4	84	174.0	59.9	44	230.7	79.4
5	04.7	01.6	65	61.5	21.2	25	118.2	40.7	85	174.9	60.2	45	231.7	79.8
6	05.7	02.0	66	62.4	21.5	26	119.1	41.0	86	175.9	60.6	46	232.6	80.1
7	06.6	02.3	67	63.3	21.8	27	120.1	41.3	87	176.8	60.9	47	233.5	80.4
8	07.6	02.6	68	64.3	22.1	28	121.0	41.7	88	177.8	61.2	48	234.5	80.7
9	08.5	02.9	69	65.2	22.5	29	122.0	42.0	89	178.7	61.5	49	235.4	81.1
10	09.5	03.3	70	66.2	22.8	30	122.9	42.3	90	179.6	61.9	50	236.4	81.4
11	10.4	03.6	71	67.1	23.1	131	123.9	42.6	191	180.6	62.2	251	237.3	81.7
12	11.3	03.9	72	68.1	23.4	32	124.8	43.0	92	181.5	62.5	52	238.3	82.0
13	12.3	04.2	73	69.0	23.8	33	125.8	43.3	93	182.5	62.8	53	239.2	82.4
14	13.2	04.6	74	70.0	24.1	34	126.7	43.6	94	183.4	63.2	54	240.2	82.7
15	14.2	04.9	75	70.9	24.4	35	127.6	44.0	95	184.4	63.5	55	241.1	83.0
16	15.1	05.2	76	71.9	24.7	36	128.6	44.3	96	185.3	63.8	56	242.1	83.3
17	16.1	05.5	77	72.8	25.1	37	129.5	44.6	97	186.3	64.1	57	243.0	83.7
18	17.0	05.9	78	73.8	25.4	38	130.5	44.9	98	187.2	64.5	58	243.9	84.0
19	18.0	06.2	79	74.7	25.7	39	131.4	45.3	99	188.2	64.8	59	244.9	84.3
20	18.9	06.5	80	75.6	26.0	40	132.4	45.6	200	189.1	65.1	60	245.8	84.6
21	19.9	06.8	81	76.6	26.4	141	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	07.2	82	77.5	26.7	42	134.3	46.2	02	191.0	65.8	62	247.7	85.3
23	21.7	07.5	83	78.5	27.0	43	135.2	46.6	03	191.9	66.1	63	248.7	85.6
24	22.7	07.8	84	79.4	27.3	44	136.2	46.9	04	192.9	66.4	64	249.6	86.0
25	23.6	08.1	85	80.4	27.7	45	137.1	47.2	05	193.8	66.7	65	250.6	86.3
26	24.6	08.5	86	81.3	28.0	46	138.0	47.5	06	194.8	67.1	66	251.5	86.6
27	25.5	08.8	87	82.3	28.3	47	139.0	47.9	07	195.7	67.4	67	252.5	86.9
28	26.5	09.1	88	83.2	28.7	48	139.9	48.2	08	196.7	67.7	68	253.4	87.3
29	27.4	09.4	89	84.2	29.0	49	140.9	48.5	09	197.6	68.0	69	254.3	87.6
30	28.4	09.8	90	85.1	29.3	50	141.8	48.8	10	198.6	68.4	70	255.3	87.9
31	29.3	10.1	91	86.0	29.6	151	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	52	143.7	49.5	12	200.4	69.0	72	257.2	88.6
33	31.2	10.7	93	87.9	30.3	53	144.7	49.8	13	201.4	69.3	73	258.1	88.9
34	32.1	11.1	94	88.9	30.6	54	145.6	50.1	14	202.3	69.7	74	259.1	89.2
35	33.1	11.4	95	89.8	30.9	55	146.6	50.5	15	203.3	70.0	75	260.0	89.5
36	34.0	11.7	96	90.8	31.3	56	147.5	50.8	16	204.2	70.3	76	261.0	89.9
37	35.0	12.0	97	91.7	31.6	57	148.4	51.1	17	205.2	70.6	77	261.9	90.2
38	35.9	12.4	98	92.7	31.9	58	149.4	51.4	18	206.1	71.0	78	262.9	90.5
39	36.9	12.7	99	93.6	32.2	59	150.3	51.8	19	207.1	71.3	79	263.8	90.8
40	37.8	13.0	100	94.6	32.6	60	151.3	52.1	20	208.0	71.6	80	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	209.0	72.0	281	265.7	91.5
42	39.7	13.7	02	96.4	33.2	62	153.2	52.7	22	209.9	72.3	82	266.6	91.8
43	40.7	14.0	03	97.4	33.5	63	154.1	53.1	23	210.9	72.6	83	267.6	92.1
44	41.6	14.3	04	98.3	33.9	64	155.1	53.4	24	211.8	72.9	84	268.5	92.5
45	42.5	14.7	05	99.3	34.2	65	156.0	53.7	25	212.7	73.3	85	269.5	92.8
46	43.5	15.0	06	100.2	34.5	66	157.0	54.0	26	213.7	73.6	86	270.4	93.1
47	44.4	15.3	07	101.2	34.8	67	157.9	54.4	27	214.6	73.9	87	271.4	93.4
48	45.4	15.6	08	102.1	35.2	68	158.8	54.7	28	215.6	74.2	88	272.3	93.8
49	46.3	16.0	09	103.1	35.5	69	159.8	55.0	29	216.5	74.6	89	273.3	94.1
50	47.3	16.3	10	104.0	35.8	70	160.7	55.3	30	217.5	74.9	90	274.2	94.4
51	48.2	16.6	111	105.0	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	12	105.9	36.5	72	162.6	56.0	32	219.4	75.5	92	276.1	95.1
53	50.1	17.3	13	106.8	36.8	73	163.6	56.3	33	220.3	75.9	93	277.0	95.4
54	51.1	17.6	14	107.8	37.1	74	164.5	56.6	34	221.3	76.2	94	278.0	95.7
55	52.0	17.9	15	108.7	37.4	75	165.5	57.0	35	222.2	76.5	95	278.9	96.0
56	52.9	18.2	16	109.7	37.8	76	166.4	57.3	36	223.1	76.8	96	279.9	96.4
57	53.9	18.6	17	110.6	38.1	77	167.4	57.6	37	224.1	77.2	97	280.8	96.7
58	54.8	18.9	18	111.6	38.4	78	168.3	58.0	38	225.0	77.5	98	281.8	97.0
59	55.8	19.2	19	112.5	38.7	79	169.2	58.3	39	226.0	77.8	99	282.7	97.3
60	56.7	19.5	20	113.5	39.1	80	170.2	58.6	40	226.9	78.1	300	283.7	97.7
Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 71 Degrees.

TABLE II. Difference of Latitude and Departure for 20 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.3	20.9	121	113.7	41.4	181	170.1	61.9	241	226.5	82.4
2	01.9	00.7	62	58.3	21.2	22	114.6	41.7	82	171.0	62.2	42	227.4	82.8
3	02.8	01.0	63	59.2	21.5	23	115.6	42.1	83	172.0	62.6	43	228.3	83.1
4	03.8	01.4	64	60.1	21.9	24	116.5	42.4	84	172.9	62.9	44	229.3	83.5
5	04.7	01.7	65	61.1	22.2	25	117.5	42.8	85	173.8	63.3	45	230.2	83.8
6	05.6	02.1	66	62.0	22.6	26	118.4	43.1	86	174.8	63.6	46	231.2	84.1
7	06.6	02.4	67	63.0	22.9	27	119.3	43.4	87	175.7	64.0	47	232.1	84.5
8	07.5	02.7	68	63.9	23.3	28	120.3	43.8	88	176.7	64.3	48	233.0	84.8
9	08.5	03.1	69	64.8	23.6	29	121.2	44.1	89	177.6	64.6	49	234.0	85.2
10	09.4	03.4	70	65.8	23.9	30	122.2	44.5	90	178.5	65.0	50	234.9	85.5
11	10.3	03.8	71	66.7	24.3	131	123.1	44.8	191	179.5	65.3	251	235.9	85.8
12	11.3	04.1	72	67.7	24.6	32	124.0	45.1	92	180.4	65.7	52	236.8	86.2
13	12.2	04.4	73	68.6	25.0	33	125.0	45.5	93	181.4	66.0	53	237.7	86.5
14	13.2	04.8	74	69.5	25.3	34	125.9	45.8	94	182.3	66.4	54	238.7	86.9
15	14.1	05.1	75	70.5	25.7	35	126.9	46.2	95	183.2	66.7	55	239.6	87.2
16	15.0	05.5	76	71.4	26.0	36	127.8	46.5	96	184.2	67.0	56	240.6	87.6
17	16.0	05.8	77	72.4	26.3	37	128.7	46.9	97	185.1	67.4	57	241.5	87.9
18	16.9	06.2	78	73.3	26.7	38	129.7	47.2	98	186.1	67.7	58	242.4	88.2
19	17.9	06.5	79	74.2	27.0	39	130.6	47.5	99	187.0	68.1	59	243.4	88.6
20	18.8	06.8	80	75.2	27.4	40	131.6	47.9	200	187.9	68.4	60	244.3	88.9
21	19.7	07.2	81	76.1	27.7	141	132.5	48.2	201	188.9	68.7	261	245.3	89.3
22	20.7	07.5	82	77.1	28.0	42	133.4	48.6	02	189.8	69.1	62	246.2	89.6
23	21.6	07.9	83	78.0	28.4	43	134.4	48.9	03	190.8	69.4	63	247.1	90.0
24	22.6	08.2	84	78.9	28.7	44	135.3	49.3	04	191.7	69.8	64	248.1	90.3
25	23.5	08.6	85	79.9	29.1	45	136.3	49.6	05	192.6	70.1	65	249.0	90.6
26	24.4	08.9	86	80.8	29.4	46	137.2	49.9	06	193.6	70.5	66	250.0	91.0
27	25.4	09.2	87	81.8	29.8	47	138.1	50.3	07	194.5	70.8	67	250.9	91.3
28	26.3	09.6	88	82.7	30.1	48	139.1	50.6	08	195.5	71.1	68	251.8	91.7
29	27.3	09.9	89	83.6	30.4	49	140.0	51.0	09	196.4	71.5	69	252.8	92.0
30	28.2	10.3	90	84.6	30.8	50	141.0	51.3	10	197.3	71.8	70	253.7	92.3
31	29.1	10.6	91	85.5	31.1	151	141.9	51.6	211	198.3	72.2	271	254.7	92.7
32	30.1	10.9	92	86.5	31.5	52	142.8	52.0	12	199.2	72.5	72	255.6	93.0
33	31.0	11.3	93	87.4	31.8	53	143.8	52.3	13	200.2	72.9	73	256.5	93.4
34	31.9	11.6	94	88.3	32.1	54	144.7	52.7	14	201.1	73.2	74	257.5	93.7
35	32.9	12.0	95	89.3	32.5	55	145.7	53.0	15	202.0	73.5	75	258.4	94.1
36	33.8	12.3	96	90.2	32.8	56	146.6	53.4	16	203.0	73.9	76	259.4	94.4
37	34.8	12.7	97	91.2	33.2	57	147.5	53.7	17	203.9	74.2	77	260.3	94.7
38	35.7	13.0	98	92.1	33.5	58	148.5	54.0	18	204.9	74.6	78	261.2	95.1
39	36.6	13.3	99	93.0	33.9	59	149.4	54.4	19	205.8	74.9	79	262.2	95.4
40	37.6	13.7	100	94.0	34.2	60	150.4	54.7	20	206.7	75.2	80	263.1	95.8
41	38.5	14.0	101	94.9	34.5	161	151.3	55.1	221	207.7	75.6	281	264.1	96.1
42	39.5	14.4	02	95.8	34.9	62	152.2	55.4	22	208.6	75.9	82	265.0	96.4
43	40.4	14.7	03	96.8	35.2	63	153.2	55.7	23	209.6	76.3	83	265.9	96.8
44	41.3	15.0	04	97.7	35.6	64	154.1	56.1	24	210.5	76.6	84	266.9	97.1
45	42.3	15.4	05	98.7	35.9	65	155.0	56.4	25	211.4	77.0	85	267.8	97.5
46	43.2	15.7	06	99.6	36.3	66	156.0	56.8	26	212.4	77.3	86	268.8	97.8
47	44.2	16.1	07	100.5	36.6	67	156.9	57.1	27	213.3	77.6	87	269.7	98.2
48	45.1	16.4	08	101.5	36.9	68	157.9	57.5	28	214.2	78.0	88	270.6	98.5
49	46.0	16.8	09	102.4	37.3	69	158.8	57.8	29	215.2	78.3	89	271.6	98.8
50	47.0	17.1	10	103.4	37.6	70	159.7	58.1	30	216.1	78.7	90	272.5	99.2
51	47.9	17.4	111	104.3	38.0	171	160.7	58.5	231	217.1	79.0	291	273.5	99.5
52	48.9	17.8	12	105.2	38.3	72	161.6	58.8	32	218.0	79.3	92	274.4	99.9
53	49.8	18.1	13	106.2	38.6	73	162.6	59.2	33	218.9	79.7	93	275.3	100.2
54	50.7	18.5	14	107.1	39.0	74	163.5	59.5	34	219.9	80.0	94	276.3	100.6
55	51.7	18.8	15	108.1	39.3	75	164.4	59.9	35	220.8	80.4	95	277.2	100.9
56	52.6	19.2	16	109.0	39.7	76	165.4	60.2	36	221.8	80.7	96	278.1	101.2
57	53.6	19.5	17	109.9	40.0	77	166.3	60.5	37	222.7	81.1	97	279.1	101.6
58	54.5	19.8	18	110.9	40.4	78	167.3	60.9	38	223.6	81.4	98	280.0	101.9
59	55.4	20.2	19	111.8	40.7	79	168.2	61.2	39	224.6	81.7	99	281.0	102.3
60	56.4	20.5	20	112.8	41.0	80	169.1	61.6	40	225.5	82.1	300	281.9	102.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 70 Degrees.

Table II. Difference of Latitude and Departure for 21 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.9	21.9	121	113.0	43.4	181	169.0	64.9	241	225.0	86.4
2	01.9	00.7	62	57.9	22.2	22	113.9	43.7	82	169.9	65.2	42	225.9	86.7
3	02.8	01.1	63	58.8	22.6	23	114.8	44.1	83	170.8	65.6	43	226.9	87.1
4	03.7	01.4	64	59.7	22.9	24	115.8	44.4	84	171.8	65.9	44	227.8	87.4
5	04.7	01.8	65	60.7	23.3	25	116.7	44.8	85	172.7	66.3	45	228.7	87.8
6	05.6	02.2	66	61.6	23.7	26	117.6	45.2	86	173.6	66.7	46	229.7	88.2
7	06.5	02.5	67	62.5	24.0	27	118.6	45.5	87	174.6	67.0	47	230.6	88.5
8	07.5	02.9	68	63.5	24.4	28	119.5	45.9	88	175.5	67.4	48	231.5	88.9
9	08.4	03.2	69	64.4	24.7	29	120.4	46.2	89	176.4	67.7	49	232.5	89.2
10	09.3	03.6	70	65.4	25.1	30	121.4	46.6	90	177.4	68.1	50	233.4	89.6
11	10.3	03.9	71	66.3	25.4	131	122.3	46.9	191	178.3	68.4	251	234.3	90.0
12	11.2	04.3	72	67.2	25.8	32	123.2	47.3	92	179.2	68.8	52	235.3	90.3
13	12.1	04.7	73	68.2	26.2	33	124.2	47.7	93	180.2	69.2	53	236.2	90.7
14	13.1	05.0	74	69.1	26.5	34	125.1	48.0	94	181.1	69.5	54	237.1	91.0
15	14.0	05.4	75	70.0	26.9	35	126.0	48.4	95	182.0	69.9	55	238.1	91.4
16	14.9	05.7	76	71.0	27.2	36	127.0	48.7	96	183.0	70.2	56	239.0	91.7
17	15.9	06.1	77	71.9	27.6	37	127.9	49.1	97	183.9	70.6	57	239.9	92.1
18	16.8	06.5	78	72.8	28.0	38	128.8	49.5	98	184.8	71.0	58	240.9	92.5
19	17.7	06.8	79	73.8	28.3	39	129.8	49.8	99	185.8	71.3	59	241.8	92.8
20	18.7	07.2	80	74.7	28.7	40	130.7	50.2	200	186.7	71.7	60	242.7	93.2
21	19.6	07.5	81	75.6	29.0	141	131.6	50.5	201	187.6	72.0	261	243.7	93.5
22	20.5	07.9	82	76.6	29.4	42	132.6	50.9	02	188.6	72.4	62	244.6	93.9
23	21.5	08.2	83	77.5	29.7	43	133.5	51.2	03	189.5	72.7	63	245.5	94.3
24	22.4	08.6	84	78.4	30.1	44	134.4	51.6	04	190.5	73.1	64	246.5	94.6
25	23.3	09.0	85	79.4	30.5	45	135.4	52.0	05	191.4	73.5	65	247.4	95.0
26	24.3	09.3	86	80.3	30.8	46	136.3	52.3	06	192.3	73.8	66	248.3	95.3
27	25.2	09.7	87	81.2	31.2	47	137.2	52.7	07	193.3	74.2	67	249.3	95.7
28	26.1	10.0	88	82.2	31.5	48	138.2	53.0	08	194.2	74.5	68	250.2	96.0
29	27.1	10.4	89	83.1	31.9	49	139.1	53.4	09	195.1	74.9	69	251.1	96.4
30	28.0	10.8	90	84.0	32.3	50	140.0	53.8	10	196.1	75.3	70	252.1	96.8
31	28.9	11.1	91	85.0	32.6	151	141.0	54.1	211	197.0	75.6	271	253.0	97.1
32	29.9	11.5	92	85.9	33.0	52	141.9	54.5	12	197.9	76.0	72	253.9	97.5
33	30.8	11.8	93	86.8	33.3	53	142.8	54.8	13	198.9	76.3	73	254.9	97.8
34	31.7	12.2	94	87.8	33.7	54	143.8	55.2	14	199.8	76.7	74	255.8	98.2
35	32.7	12.5	95	88.7	34.0	55	144.7	55.5	15	200.7	77.0	75	256.7	98.6
36	33.6	12.9	96	89.6	34.4	56	145.6	55.9	16	201.7	77.4	76	257.7	98.9
37	34.5	13.3	97	90.6	34.8	57	146.6	56.3	17	202.6	77.8	77	258.6	99.3
38	35.5	13.6	98	91.5	35.1	58	147.5	56.6	18	203.5	78.1	78	259.5	99.6
39	36.4	14.0	99	92.4	35.5	59	148.4	57.0	19	204.5	78.5	79	260.5	100.0
40	37.3	14.3	100	93.4	35.8	60	149.4	57.3	20	205.4	78.8	80	261.4	100.3
41	38.3	14.7	101	94.3	36.2	161	150.3	57.7	221	206.3	79.2	281	262.3	100.7
42	39.2	15.1	02	95.2	36.6	62	151.2	58.1	22	207.3	79.6	82	263.3	101.1
43	40.1	15.4	03	96.2	36.9	63	152.2	58.4	23	208.2	79.9	83	264.2	101.4
44	41.1	15.8	04	97.1	37.3	64	153.1	58.8	24	209.1	80.3	84	265.1	101.8
45	42.0	16.1	05	98.0	37.6	65	154.0	59.1	25	210.1	80.6	85	266.1	102.1
46	42.9	16.5	06	99.0	38.0	66	155.0	59.5	26	211.0	81.0	86	267.0	102.5
47	43.9	16.8	07	99.9	38.3	67	155.9	59.8	27	211.9	81.3	87	267.9	102.9
48	44.8	17.2	08	100.8	38.7	68	156.8	60.2	28	212.9	81.7	88	268.9	103.2
49	45.7	17.6	09	101.8	39.1	69	157.8	60.6	29	213.8	82.1	89	269.8	103.6
50	46.7	17.9	10	102.7	39.4	70	158.7	60.9	30	214.7	82.4	90	270.7	103.9
51	47.6	18.3	111	103.6	39.8	171	159.6	61.3	231	215.7	82.8	291	271.7	104.3
52	48.5	18.6	12	104.6	40.1	72	160.6	61.6	32	216.6	83.1	92	272.6	104.6
53	49.5	19.0	13	105.5	40.5	73	161.5	62.0	33	217.5	83.5	93	273.5	105.0
54	50.4	19.4	14	106.4	40.9	74	162.4	62.4	34	218.5	83.9	94	274.5	105.4
55	51.3	19.7	15	107.4	41.2	75	163.4	62.7	35	219.4	84.2	95	275.4	105.7
56	52.3	20.1	16	108.3	41.6	76	164.3	63.1	36	220.3	84.6	96	276.3	106.1
57	53.2	20.4	17	109.2	41.9	77	165.2	63.4	37	221.3	84.9	97	277.3	106.4
58	54.1	20.8	18	110.2	42.3	78	166.2	63.8	38	222.2	85.3	98	278.2	106.8
59	55.1	21.1	19	111.1	42.6	79	167.1	64.1	39	223.1	85.6	99	279.1	107.2
60	56.0	21.5	20	112.0	43.0	80	168.0	64.5	40	224.1	86.0	300	280.1	107.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 69 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.6	22.9	121	112.2	45.3	181	167.8	67.8	241	223.5	90.3
2	01.9	00.7	62	57.5	23.2	22	113.1	45.7	82	168.7	68.2	42	224.4	90.7
3	02.8	01.1	63	58.4	23.6	23	114.0	46.1	83	169.7	68.6	43	225.3	91.0
4	03.7	01.5	64	59.3	24.0	24	115.0	46.5	84	170.6	68.9	44	226.2	91.4
5	04.6	01.9	65	60.3	24.3	25	115.9	46.8	85	171.5	69.3	45	227.2	91.8
6	05.6	02.2	66	61.2	24.7	26	116.8	47.2	86	172.5	69.7	46	228.1	92.2
7	06.5	02.6	67	62.1	25.1	27	117.8	47.6	87	173.4	70.1	47	229.0	92.5
8	07.4	03.0	68	63.0	25.5	28	118.7	47.9	88	174.3	70.4	48	229.9	92.9
9	08.3	03.4	69	64.0	25.8	29	119.6	48.3	89	175.2	70.8	49	230.9	93.3
10	09.3	03.7	70	64.9	26.2	30	120.5	48.7	90	176.2	71.2	50	231.8	93.7
11	10.2	04.1	71	65.8	26.6	131	121.5	49.1	191	177.1	71.5	251	232.7	94.0
12	11.1	04.5	72	66.8	27.0	32	122.4	49.4	92	178.0	71.9	52	233.7	94.4
13	12.1	04.9	73	67.7	27.3	33	123.3	49.8	93	178.9	72.3	53	234.6	94.8
14	13.0	05.2	74	68.6	27.7	34	124.2	50.2	94	179.9	72.7	54	235.5	95.2
15	13.9	05.6	75	69.5	28.1	35	125.2	50.6	95	180.8	73.0	55	236.4	95.5
16	14.8	06.0	76	70.5	28.5	36	126.1	50.9	96	181.7	73.4	56	237.4	95.9
17	15.8	06.4	77	71.4	28.8	37	127.0	51.3	97	182.7	73.8	57	238.3	96.3
18	16.7	06.7	78	72.3	29.2	38	128.0	51.7	98	183.6	74.2	58	239.2	96.6
19	17.6	07.1	79	73.2	29.6	39	128.9	52.1	99	184.5	74.5	59	240.1	97.0
20	18.5	07.5	80	74.2	30.0	40	129.8	52.4	200	185.4	74.9	60	241.1	97.4
21	19.5	07.9	81	75.1	30.3	141	130.7	52.8	201	186.4	75.3	261	242.0	97.8
22	20.4	08.2	82	76.0	30.7	42	131.7	53.2	02	187.3	75.7	62	242.9	98.1
23	21.3	08.6	83	77.0	31.1	43	132.6	53.6	03	188.2	76.0	63	243.8	98.5
24	22.3	09.0	84	77.9	31.5	44	133.5	53.9	04	189.1	76.4	64	244.8	98.9
25	23.2	09.4	85	78.8	31.8	45	134.4	54.3	05	190.1	76.8	65	245.7	99.3
26	24.1	09.7	86	79.7	32.2	46	135.4	54.7	06	191.0	77.2	66	246.6	99.6
27	25.0	10.1	87	80.7	32.6	47	136.3	55.1	07	191.9	77.5	67	247.6	100.0
28	26.0	10.5	88	81.6	33.0	48	137.2	55.4	08	192.9	77.9	68	248.5	100.4
29	26.9	10.9	89	82.5	33.3	49	138.2	55.8	09	193.8	78.3	69	249.4	100.8
30	27.8	11.2	90	83.4	33.7	50	139.1	56.2	10	194.7	78.7	70	250.3	101.1
31	28.7	11.6	91	84.4	34.1	151	140.0	56.6	211	195.6	79.0	271	251.3	101.5
32	29.7	12.0	92	85.3	34.5	52	140.9	56.9	12	196.6	79.4	72	252.2	101.9
33	30.6	12.4	93	86.2	34.8	53	141.9	57.3	13	197.5	79.8	73	253.1	102.3
34	31.5	12.7	94	87.2	35.2	54	142.8	57.7	14	198.4	80.2	74	254.0	102.6
35	32.5	13.1	95	88.1	35.6	55	143.7	58.1	15	199.3	80.5	75	255.0	103.0
36	33.4	13.5	96	89.0	36.0	56	144.6	58.4	16	200.3	80.9	76	255.9	103.4
37	34.3	13.9	97	89.9	36.3	57	145.6	58.8	17	201.2	81.3	77	256.8	103.8
38	35.2	14.2	98	90.9	36.7	58	146.5	59.2	18	202.1	81.7	78	257.8	104.1
39	36.2	14.6	99	91.8	37.1	59	147.4	59.6	19	203.1	82.0	79	258.7	104.5
40	37.1	15.0	100	92.7	37.5	60	148.3	59.9	20	204.0	82.4	80	259.6	104.9
41	38.0	15.4	101	93.6	37.8	161	149.3	60.3	221	204.9	82.8	281	260.5	105.3
42	38.9	15.7	02	94.6	38.2	62	150.2	60.7	22	205.8	83.2	82	261.5	105.6
43	39.9	16.1	03	95.5	38.6	63	151.1	61.1	23	206.8	83.5	83	262.4	106.0
44	40.8	16.5	04	96.4	39.0	64	152.1	61.4	24	207.7	83.9	84	263.3	106.4
45	41.7	16.9	05	97.4	39.3	65	153.0	61.8	25	208.6	84.3	85	264.2	106.8
46	42.7	17.2	06	98.3	39.7	66	153.9	62.2	26	209.5	84.7	86	265.2	107.1
47	43.6	17.6	07	99.2	40.1	67	154.8	62.6	27	210.5	85.0	87	266.1	107.5
48	44.5	18.0	08	100.1	40.5	68	155.8	62.9	28	211.4	85.4	88	267.0	107.9
49	45.4	18.4	09	101.1	40.8	69	156.7	63.3	29	212.3	85.8	89	268.0	108.3
50	46.4	18.7	10	102.0	41.2	70	157.6	63.7	30	213.3	86.2	90	268.9	108.6
51	47.3	19.1	111	102.9	41.6	171	158.5	64.1	231	214.2	86.5	291	269.8	109.0
52	48.2	19.5	12	103.8	42.0	72	159.5	64.4	32	215.1	86.9	92	270.7	109.4
53	49.1	19.9	13	104.8	42.3	73	160.4	64.8	33	216.0	87.3	93	271.7	109.8
54	50.1	20.2	14	105.7	42.7	74	161.3	65.2	34	217.0	87.7	94	272.6	110.1
55	51.0	20.6	15	106.6	43.1	75	162.3	65.6	35	217.9	88.0	95	273.5	110.5
56	51.9	21.0	16	107.6	43.5	76	163.2	65.9	36	218.8	88.4	96	274.4	110.9
57	52.8	21.4	17	108.5	43.8	77	164.1	66.3	37	219.7	88.8	97	275.4	111.3
58	53.8	21.7	18	109.4	44.2	78	165.0	66.7	38	220.7	89.2	98	276.3	111.6
59	54.7	22.1	19	110.3	44.6	79	166.0	67.1	39	221.6	89.5	99	277.2	112.0
60	55.6	22.5	20	111.3	45.0	80	166.9	67.4	40	222.5	89.9	300	278.2	112.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Table II. Difference of Latitude and Departure for 23 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.2	23.8	121	111.4	47.3	181	166.6	70.7	241	221.8	94.2
2	01.8	00.8	62	57.1	24.2	22	112.3	47.7	82	167.5	71.1	42	222.8	94.6
3	02.8	01.2	63	58.0	24.6	23	113.2	48.1	83	168.5	71.5	43	223.7	94.9
4	03.7	01.6	64	58.9	25.0	24	114.1	48.5	84	169.4	71.9	44	224.6	95.3
5	04.6	02.0	65	59.8	25.4	25	115.1	48.8	85	170.3	72.3	45	225.5	95.7
6	05.5	02.3	66	60.8	25.8	26	116.0	49.2	86	171.2	72.7	46	226.4	96.1
7	06.4	02.7	67	61.7	26.2	27	116.9	49.6	87	172.1	73.1	47	227.4	96.5
8	07.4	03.1	68	62.6	26.6	28	117.8	50.0	88	173.1	73.5	48	228.3	96.9
9	08.3	03.5	69	63.5	27.0	29	118.7	50.4	89	174.0	73.8	49	229.2	97.3
10	09.2	03.9	70	64.4	27.4	30	119.7	50.8	90	174.9	74.2	50	230.1	97.7
11	10.1	04.3	71	65.4	27.7	131	120.6	51.2	191	175.8	74.6	251	231.0	98.1
12	11.0	04.7	72	66.3	28.1	32	121.5	51.6	92	176.7	75.0	52	232.0	98.5
13	12.0	05.1	73	67.2	28.5	33	122.4	52.0	93	177.7	75.4	53	232.9	98.9
14	12.9	05.5	74	68.1	28.9	34	123.3	52.4	94	178.6	75.8	54	233.8	99.2
15	13.8	05.9	75	69.0	29.3	35	124.3	52.7	95	179.5	76.2	55	234.7	99.6
16	14.7	06.3	76	70.0	29.7	36	125.2	53.1	96	180.4	76.6	56	235.6	100.0
17	15.6	06.6	77	70.9	30.1	37	126.1	53.5	97	181.3	77.0	57	236.6	100.4
18	16.6	07.0	78	71.8	30.5	38	127.0	53.9	98	182.3	77.4	58	237.5	100.8
19	17.5	07.4	79	72.7	30.9	39	128.0	54.3	99	183.2	77.8	59	238.4	101.2
20	18.4	07.8	80	73.6	31.3	40	128.9	54.7	200	184.1	78.1	60	239.3	101.6
21	19.3	08.2	81	74.6	31.6	141	129.8	55.1	201	185.0	78.5	261	240.3	102.0
22	20.3	08.6	82	75.5	32.0	42	130.7	55.5	02	185.9	78.9	62	241.2	102.4
23	21.2	09.0	83	76.4	32.4	43	131.6	55.9	03	186.9	79.3	63	242.1	102.8
24	22.1	09.4	84	77.3	32.8	44	132.6	56.3	04	187.8	79.7	64	243.0	103.2
25	23.0	09.8	85	78.2	33.2	45	133.5	56.7	05	188.7	80.1	65	243.9	103.5
26	23.9	10.2	86	79.2	33.6	46	134.4	57.0	06	189.6	80.5	66	244.9	103.9
27	24.9	10.5	87	80.1	34.0	47	135.3	57.4	07	190.5	80.9	67	245.8	104.3
28	25.8	10.9	88	81.0	34.4	48	136.2	57.8	08	191.5	81.3	68	246.7	104.7
29	26.7	11.3	89	81.9	34.8	49	137.2	58.2	09	192.4	81.7	69	247.6	105.1
30	27.6	11.7	90	82.8	35.2	50	138.1	58.6	10	193.3	82.1	70	248.5	105.5
31	28.5	12.1	91	83.8	35.6	151	139.0	59.0	211	194.2	82.4	271	249.5	105.9
32	29.5	12.5	92	84.7	35.9	52	139.9	59.4	12	195.1	82.8	72	250.4	106.3
33	30.4	12.9	93	85.6	36.3	53	140.8	59.8	13	196.1	83.2	73	251.3	106.7
34	31.3	13.3	94	86.5	36.7	54	141.8	60.2	14	197.0	83.6	74	252.2	107.1
35	32.2	13.7	95	87.4	37.1	55	142.7	60.6	15	197.9	84.0	75	253.1	107.5
36	33.1	14.1	96	88.4	37.5	56	143.6	61.0	16	198.8	84.4	76	254.1	107.8
37	34.1	14.5	97	89.3	37.9	57	144.5	61.3	17	199.7	84.8	77	255.0	108.2
38	35.0	14.8	98	90.2	38.3	58	145.4	61.7	18	200.7	85.2	78	255.9	108.6
39	35.9	15.2	99	91.1	38.7	59	146.4	62.1	19	201.6	85.6	79	256.8	109.0
40	36.8	15.6	100	92.1	39.1	60	147.3	62.5	20	202.5	86.0	80	257.7	109.4
41	37.7	16.0	101	93.0	39.5	161	148.2	62.9	221	203.4	86.4	281	258.7	109.8
42	38.7	16.4	02	93.9	39.9	62	149.1	63.3	22	204.4	86.7	82	259.6	110.2
43	39.6	16.8	03	94.8	40.2	63	150.0	63.7	23	205.3	87.1	83	260.5	110.6
44	40.5	17.2	04	95.7	40.6	64	151.0	64.1	24	206.2	87.5	84	261.4	111.0
45	41.4	17.6	05	96.7	41.0	65	151.9	64.5	25	207.1	87.9	85	262.3	111.4
46	42.3	18.0	06	97.6	41.4	66	152.8	64.9	26	208.0	88.3	86	263.3	111.7
47	43.3	18.4	07	98.5	41.8	67	153.7	65.3	27	209.0	88.7	87	264.2	112.1
48	44.2	18.8	08	99.4	42.2	68	154.6	65.6	28	209.9	89.1	88	265.1	112.5
49	45.1	19.1	09	100.3	42.6	69	155.6	66.0	29	210.8	89.5	89	266.0	112.9
50	46.0	19.5	10	101.3	43.0	70	156.5	66.4	30	211.7	89.9	90	266.9	113.3
51	46.9	19.9	111	102.2	43.4	171	157.4	66.8	231	212.6	90.3	291	267.9	113.7
52	47.9	20.3	12	103.1	43.8	72	158.3	67.2	32	213.6	90.6	92	268.8	114.1
53	48.8	20.7	13	104.0	44.2	73	159.2	67.6	33	214.5	91.0	93	269.7	114.5
54	49.7	21.1	14	104.9	44.5	74	160.2	68.0	34	215.4	91.4	94	270.6	114.9
55	50.6	21.5	15	105.9	44.9	75	161.1	68.4	35	216.3	91.8	95	271.5	115.3
56	51.5	21.9	16	106.8	45.3	76	162.0	68.8	36	217.2	92.2	96	272.5	115.7
57	52.5	22.3	17	107.7	45.7	77	162.9	69.2	37	218.2	92.6	97	273.4	116.0
58	53.4	22.7	18	108.6	46.1	78	163.8	69.6	38	219.1	93.0	98	274.3	116.4
59	54.3	23.1	19	109.5	46.5	79	164.8	69.9	39	220.0	93.4	99	275.2	116.8
60	55.2	23.4	20	110.5	46.9	80	165.7	70.3	40	220.9	93.8	300	276.2	117.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 67 Degrees.

Table II. Difference of Latitude and Departure for 24 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.7	24.8	121	110.5	49.2	181	165.4	73.6	241	220.2	98.0
2	01.8	00.8	62	56.6	25.2	22	111.5	49.6	82	166.3	74.0	42	221.1	98.4
3	02.7	01.2	63	57.6	25.6	23	112.4	50.0	83	167.2	74.4	43	222.0	98.8
4	03.7	01.6	64	58.5	26.0	24	113.3	50.4	84	168.1	74.8	44	222.9	99.2
5	04.6	02.0	65	59.4	26.4	25	114.2	50.8	85	169.0	75.2	45	223.8	99.7
6	05.5	02.4	66	60.3	26.8	26	115.1	51.2	86	169.9	75.7	46	224.7	100.1
7	06.4	02.8	67	61.2	27.3	27	116.0	51.7	87	170.8	76.1	47	225.6	100.5
8	07.3	03.3	68	62.1	27.7	28	116.9	52.1	88	171.7	76.5	48	226.6	100.9
9	08.2	03.7	69	63.0	28.1	29	117.8	52.5	89	172.7	76.9	49	227.5	101.3
10	09.1	04.1	70	63.9	28.5	30	118.8	52.9	90	173.6	77.3	50	228.4	101.7
11	10.0	04.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	229.3	102.1
12	11.0	04.9	72	65.8	29.3	32	120.6	53.7	92	175.4	78.1	52	230.2	102.5
13	11.9	05.3	73	66.7	29.7	33	121.5	54.1	93	176.3	78.5	53	231.1	102.9
14	12.8	05.7	74	67.6	30.1	34	122.4	54.5	94	177.2	78.9	54	232.0	103.3
15	13.7	06.1	75	68.5	30.5	35	123.3	54.9	95	178.1	79.3	55	233.0	103.7
16	14.6	06.5	76	69.4	30.9	36	124.2	55.3	96	179.1	79.7	56	233.9	104.1
17	15.5	06.9	77	70.3	31.3	37	125.2	55.7	97	180.0	80.1	57	234.8	104.5
18	16.4	07.3	78	71.3	31.7	38	126.1	56.1	98	180.9	80.5	58	235.7	104.9
19	17.4	07.7	79	72.2	32.1	39	127.0	56.5	99	181.8	80.9	59	236.6	105.3
20	18.3	08.1	80	73.1	32.5	40	127.9	56.9	200	182.7	81.3	60	237.5	105.8
21	19.2	08.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.8	261	238.4	106.2
22	20.1	08.9	82	74.9	33.4	42	129.7	57.8	02	184.5	82.2	62	239.3	106.6
23	21.0	09.4	83	75.8	33.8	43	130.6	58.2	03	185.4	82.6	63	240.3	107.0
24	21.9	09.8	84	76.7	34.2	44	131.6	58.6	04	186.4	83.0	64	241.2	107.4
25	22.8	10.2	85	77.7	34.6	45	132.5	59.0	05	187.3	83.4	65	242.1	107.8
26	23.8	10.6	86	78.6	35.0	46	133.4	59.4	06	188.2	83.8	66	243.0	108.2
27	24.7	11.0	87	79.5	35.4	47	134.3	59.8	07	189.1	84.2	67	243.9	108.6
28	25.6	11.4	88	80.4	35.8	48	135.2	60.2	08	190.0	84.6	68	244.8	109.0
29	26.5	11.8	89	81.3	36.2	49	136.1	60.6	09	190.9	85.0	69	245.7	109.4
30	27.4	12.2	90	82.2	36.6	50	137.0	61.0	10	191.8	85.4	70	246.7	109.8
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.8	85.8	271	247.6	110.2
32	29.2	13.0	92	84.0	37.4	52	138.9	61.8	12	193.7	86.2	72	248.5	110.6
33	30.1	13.4	93	85.0	37.8	53	139.8	62.2	13	194.6	86.6	73	249.4	111.0
34	31.1	13.8	94	85.9	38.2	54	140.7	62.6	14	195.5	87.0	74	250.3	111.4
35	32.0	14.2	95	86.8	38.6	55	141.6	63.0	15	196.4	87.4	75	251.2	111.9
36	32.9	14.6	96	87.7	39.0	56	142.5	63.5	16	197.3	87.9	76	252.1	112.3
37	33.8	15.0	97	88.6	39.5	57	143.4	63.9	17	198.2	88.3	77	253.1	112.7
38	34.7	15.5	98	89.5	39.9	58	144.3	64.3	18	199.2	88.7	78	254.0	113.1
39	35.6	15.9	99	90.4	40.3	59	145.3	64.7	19	200.1	89.1	79	254.9	113.5
40	36.5	16.3	100	91.4	40.7	60	146.2	65.1	20	201.0	89.5	80	255.8	113.9
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	221	201.9	89.9	281	256.7	114.3
42	38.4	17.1	02	93.2	41.5	62	148.0	65.9	22	202.8	90.3	82	257.6	114.7
43	39.3	17.5	03	94.1	41.9	63	148.9	66.3	23	203.7	90.7	83	258.5	115.1
44	40.2	17.9	04	95.0	42.3	64	149.8	66.7	24	204.6	91.1	84	259.4	115.5
45	41.1	18.3	05	95.9	42.7	65	150.7	67.1	25	205.5	91.5	85	260.4	115.9
46	42.0	18.7	06	96.8	43.1	66	151.6	67.5	26	206.5	91.9	86	261.3	116.3
47	42.9	19.1	07	97.7	43.5	67	152.6	67.9	27	207.4	92.3	87	262.2	116.7
48	43.9	19.5	08	98.7	43.9	68	153.5	68.3	28	208.3	92.7	88	263.1	117.1
49	44.8	19.9	09	99.6	44.3	69	154.4	68.7	29	209.2	93.1	89	264.0	117.5
50	45.7	20.3	10	100.5	44.7	70	155.3	69.1	30	210.1	93.5	90	264.9	118.0
51	46.6	20.7	111	101.4	45.1	171	156.2	69.6	231	211.0	94.0	291	265.8	118.4
52	47.5	21.2	12	102.3	45.6	72	157.1	70.0	32	211.9	94.4	92	266.8	118.8
53	48.4	21.6	13	103.2	46.0	73	158.0	70.4	33	212.9	94.8	93	267.7	119.2
54	49.3	22.0	14	104.1	46.4	74	159.0	70.8	34	213.8	95.2	94	268.6	119.6
55	50.2	22.4	15	105.1	46.8	75	159.9	71.2	35	214.7	95.6	95	269.5	120.0
56	51.2	23.8	16	106.0	47.2	76	160.8	71.6	36	215.6	96.0	96	270.4	120.4
57	52.1	23.2	17	106.9	47.6	77	161.7	72.0	37	216.5	96.4	97	271.3	120.8
58	53.0	23.6	18	107.8	48.0	78	162.6	72.4	38	217.4	96.8	98	272.2	121.2
59	53.9	24.0	19	108.7	48.4	79	163.5	72.8	39	218.3	97.2	99	273.2	121.6
60	54.8	24.4	20	109.6	48.8	80	164.4	73.2	40	219.3	97.6	300	274.1	122.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 66 Degrees.

TABLE II. Difference of Latitude and Departure for 25 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.3	25.8	121	109.7	51.1	181	164.0	76.5	241	218.4	101.9
2	01.8	00.8	62	56.2	26.2	22	110.6	51.6	82	164.9	76.9	42	219.3	102.3
3	02.7	01.3	63	57.1	26.6	23	111.5	52.0	83	165.9	77.3	43	220.2	102.7
4	03.6	01.7	64	58.0	27.0	24	112.4	52.4	84	166.8	77.8	44	221.1	103.1
5	04.5	02.1	65	58.9	27.5	25	113.3	52.8	85	167.7	78.2	45	222.0	103.5
6	05.4	02.5	66	59.8	27.9	26	114.2	53.2	86	168.6	78.6	46	223.0	104.0
7	06.3	03.0	67	60.7	28.3	27	115.1	53.7	87	169.5	79.0	47	223.9	104.4
8	07.3	03.4	68	61.6	28.7	28	116.0	54.1	88	170.4	79.5	48	224.8	104.8
9	08.2	03.8	69	62.5	29.2	29	116.9	54.5	89	171.3	79.9	49	225.7	105.2
10	09.1	04.2	70	63.4	29.6	30	117.8	54.9	90	172.2	80.3	50	226.6	105.7
11	10.0	04.6	71	64.3	30.0	131	118.7	55.4	191	173.1	80.7	251	227.5	106.1
12	10.9	05.1	72	65.3	30.4	32	119.6	55.8	92	174.0	81.1	52	228.4	106.5
13	11.8	05.5	73	66.2	30.9	33	120.5	56.2	93	174.9	81.6	53	229.3	106.9
14	12.7	05.9	74	67.1	31.3	34	121.4	56.6	94	175.8	82.0	54	230.2	107.3
15	13.6	06.3	75	68.0	31.7	35	122.4	57.1	95	176.7	82.4	55	231.1	107.8
16	14.5	06.8	76	68.9	32.1	36	123.3	57.5	96	177.6	82.8	56	232.0	108.2
17	15.4	07.2	77	69.8	32.5	37	124.2	57.9	97	178.5	83.3	57	232.9	108.6
18	16.3	07.6	78	70.7	33.0	38	125.1	58.3	98	179.4	83.7	58	233.8	109.0
19	17.2	08.0	79	71.6	33.4	39	126.0	58.7	99	180.4	84.1	59	234.7	109.5
20	18.1	08.5	80	72.5	33.8	40	126.9	59.2	200	181.3	84.5	60	235.6	109.9
21	19.0	08.9	81	73.4	34.2	141	127.8	59.6	201	182.2	84.9	261	236.5	110.3
22	19.9	09.3	82	74.3	34.7	42	128.7	60.0	02	183.1	85.4	62	237.5	110.7
23	20.8	09.7	83	75.2	35.1	43	129.6	60.4	03	184.0	85.8	63	238.4	111.1
24	21.8	10.1	84	76.1	35.5	44	130.5	60.9	04	184.9	86.2	64	239.3	111.6
25	22.7	10.6	85	77.0	35.9	45	131.4	61.3	05	185.8	86.6	65	240.2	112.0
26	23.6	11.0	86	77.9	36.3	46	132.3	61.7	06	186.7	87.1	66	241.1	112.4
27	24.5	11.4	87	78.8	36.8	47	133.2	62.1	07	187.6	87.5	67	242.0	112.8
28	25.4	11.8	88	79.8	37.2	48	134.1	62.5	08	188.5	87.9	68	242.9	113.3
29	26.3	12.3	89	80.7	37.6	49	135.0	63.0	09	189.4	88.3	69	243.8	113.7
30	27.2	12.7	90	81.6	38.0	50	135.9	63.4	10	190.3	88.7	70	244.7	114.1
31	28.1	13.1	91	82.5	38.5	151	136.9	63.8	211	191.2	89.2	271	245.6	114.5
32	29.0	13.5	92	83.4	38.9	52	137.8	64.2	12	192.1	89.6	72	246.5	115.0
33	29.9	13.9	93	84.3	39.3	53	138.7	64.7	13	193.0	90.0	73	247.4	115.4
34	30.8	14.4	94	85.2	39.7	54	139.6	65.1	14	193.9	90.4	74	248.3	115.8
35	31.7	14.8	95	86.1	40.1	55	140.5	65.5	15	194.9	90.9	75	249.2	116.2
36	32.6	15.2	96	87.0	40.6	56	141.4	65.9	16	195.8	91.3	76	250.1	116.6
37	33.5	15.6	97	87.9	41.0	57	142.3	66.4	17	196.7	91.7	77	251.0	117.1
38	34.4	16.1	98	88.8	41.4	58	143.2	66.8	18	197.6	92.1	78	252.0	117.5
39	35.3	16.5	99	89.7	41.8	59	144.1	67.2	19	198.5	92.6	79	252.9	117.9
40	36.3	16.9	100	90.6	42.3	60	145.0	67.6	20	199.4	93.0	80	253.8	118.3
41	37.2	17.3	101	91.5	42.7	161	145.9	68.0	221	200.3	93.4	281	254.7	118.8
42	38.1	17.7	02	92.4	43.1	62	146.8	68.5	22	201.2	93.8	82	255.6	119.2
43	39.0	18.2	03	93.3	43.5	63	147.7	68.9	23	202.1	94.2	83	256.5	119.6
44	39.9	18.6	04	94.3	44.0	64	148.6	69.3	24	203.0	94.7	84	257.4	120.0
45	40.8	19.0	05	95.2	44.4	65	149.5	69.7	25	203.9	95.1	85	258.3	120.4
46	41.7	19.4	06	96.1	44.8	66	150.4	70.2	26	204.8	95.5	86	259.2	120.9
47	42.6	19.9	07	97.0	45.2	67	151.4	70.6	27	205.7	95.9	87	260.1	121.3
48	43.5	20.3	08	97.9	45.6	68	152.3	71.0	28	206.6	96.4	88	261.0	121.7
49	44.4	20.7	09	98.8	46.1	69	153.2	71.4	29	207.5	96.8	89	261.9	122.1
50	45.3	21.1	10	99.7	46.5	70	154.1	71.8	30	208.5	97.2	90	262.8	122.6
51	46.2	21.6	111	100.6	46.9	171	155.0	72.3	231	209.4	97.6	291	263.7	123.0
52	47.1	22.0	12	101.5	47.3	72	155.9	72.7	32	210.3	98.0	92	264.6	123.4
53	48.0	22.4	13	102.4	47.8	73	156.8	73.1	33	211.2	98.5	93	265.5	123.8
54	48.9	22.8	14	103.3	48.2	74	157.7	73.5	34	212.1	98.9	94	266.5	124.2
55	49.8	23.2	15	104.2	48.6	75	158.6	74.0	35	213.0	99.3	95	267.4	124.7
56	50.8	23.7	16	105.1	49.0	76	159.5	74.4	36	213.9	99.7	96	268.3	125.1
57	51.7	24.1	17	106.0	49.4	77	160.4	74.8	37	214.8	100.2	97	269.2	125.5
58	52.6	24.5	18	106.9	49.9	78	161.3	75.2	38	215.7	100.6	98	270.1	125.9
59	53.5	24.9	19	107.9	50.3	79	162.2	75.6	39	216.6	101.0	99	271.0	126.4
60	54.4	25.4	20	108.8	50.7	80	163.1	76.1	40	217.5	101.4	300	271.9	126.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 65 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	54.8	26.7	121	108.8	53.0	181	162.7	79.3	241	216.6	105.6
2	01.8	00.9	62	55.7	27.2	22	109.7	53.5	82	163.6	79.8	42	217.5	106.1
3	02.7	01.3	63	56.6	27.6	23	110.6	53.9	83	164.5	80.2	43	218.4	106.5
4	03.6	01.8	64	57.5	28.1	24	111.5	54.4	84	165.4	80.7	44	219.3	107.0
5	04.5	02.2	65	58.4	28.5	25	112.3	54.8	85	166.3	81.1	45	220.2	107.4
6	05.4	02.6	66	59.3	28.9	26	113.2	55.2	86	167.2	81.5	46	221.1	107.8
7	06.3	03.1	67	60.2	29.4	27	114.1	55.7	87	168.1	82.0	47	222.0	108.3
8	07.2	03.5	68	61.1	29.8	28	115.0	56.1	88	169.0	82.4	48	222.9	108.7
9	08.1	03.9	69	62.0	30.2	29	115.9	56.5	89	169.9	82.9	49	223.8	109.2
10	09.0	04.4	70	62.9	30.7	30	116.8	57.0	90	170.8	83.3	50	224.7	109.6
11	09.9	04.8	71	63.8	31.1	131	117.7	57.4	191	171.7	83.7	251	225.6	110.0
12	10.8	05.3	72	64.7	31.6	32	118.6	57.9	92	172.6	84.2	52	226.5	110.5
13	11.7	05.7	73	65.6	32.0	33	119.5	58.3	93	173.5	84.6	53	227.4	110.9
14	12.6	06.1	74	66.5	32.4	34	120.4	58.7	94	174.4	85.0	54	228.3	111.3
15	13.5	06.6	75	67.4	32.9	35	121.3	59.2	95	175.3	85.5	55	229.2	111.8
16	14.4	07.0	76	68.3	33.3	36	122.2	59.6	96	176.2	85.9	56	230.1	112.2
17	15.3	07.5	77	69.2	33.8	37	123.1	60.1	97	177.1	86.4	57	231.0	112.7
18	16.2	07.9	78	70.1	34.2	38	124.0	60.5	98	178.0	86.8	58	231.9	113.1
19	17.1	08.3	79	71.0	34.6	39	124.9	60.9	99	178.9	87.2	59	232.8	113.5
20	18.0	08.8	80	71.9	35.1	40	125.8	61.4	200	179.8	87.7	60	233.7	114.0
21	18.9	09.2	81	72.8	35.5	141	126.7	61.8	201	180.7	88.1	261	234.6	114.4
22	19.8	09.6	82	73.7	35.9	42	127.6	62.2	02	181.6	88.6	62	235.5	114.9
23	20.7	10.1	83	74.6	36.4	43	128.5	62.7	03	182.5	89.0	63	236.4	115.3
24	21.6	10.5	84	75.5	36.8	44	129.4	63.1	04	183.4	89.4	64	237.3	115.7
25	22.5	11.0	85	76.4	37.3	45	130.3	63.6	05	184.3	89.9	65	238.2	116.2
26	23.4	11.4	86	77.3	37.7	46	131.2	64.0	06	185.2	90.3	66	239.1	116.6
27	24.3	11.8	87	78.2	38.1	47	132.1	64.4	07	186.1	90.7	67	240.0	117.0
28	25.2	12.3	88	79.1	38.6	48	133.0	64.9	08	186.9	91.2	68	240.9	117.5
29	26.1	12.7	89	80.0	39.0	49	133.9	65.3	09	187.8	91.6	69	241.8	117.9
30	27.0	13.2	90	80.9	39.5	50	134.8	65.8	10	188.7	92.1	70	242.7	118.4
31	27.9	13.6	91	81.8	39.9	151	135.7	66.2	211	189.6	92.5	271	243.6	118.8
32	28.8	14.0	92	82.7	40.3	52	136.6	66.6	12	190.5	92.9	72	244.5	119.2
33	29.7	14.5	93	83.6	40.8	53	137.5	67.1	13	191.4	93.4	73	245.4	119.7
34	30.6	14.9	94	84.5	41.2	54	138.4	67.5	14	192.3	93.8	74	246.3	120.1
35	31.5	15.3	95	85.4	41.6	55	139.3	67.9	15	193.2	94.2	75	247.2	120.6
36	32.4	15.8	96	86.3	42.1	56	140.2	68.4	16	194.1	94.7	76	248.1	121.0
37	33.3	16.2	97	87.2	42.5	57	141.1	68.8	17	195.0	95.1	77	249.0	121.4
38	34.2	16.7	98	88.1	43.0	58	142.0	69.3	18	195.9	95.6	78	249.9	121.9
39	35.1	17.1	99	89.0	43.4	59	142.9	69.7	19	196.8	96.0	79	250.8	122.3
40	36.0	17.5	100	89.9	43.8	60	143.8	70.1	20	197.7	96.4	80	251.7	122.7
41	36.9	18.0	101	90.8	44.3	161	144.7	70.6	221	198.6	96.9	281	252.6	123.2
42	37.7	18.4	02	91.7	44.7	62	145.6	71.0	22	199.5	97.3	82	253.5	123.6
43	38.6	18.8	03	92.6	45.2	63	146.5	71.5	23	200.4	97.8	83	254.4	124.1
44	39.5	19.3	04	93.5	45.6	64	147.4	71.9	24	201.3	98.2	84	255.3	124.5
45	40.4	19.7	05	94.4	46.0	65	148.3	72.3	25	202.2	98.6	85	256.2	124.9
46	41.3	20.2	06	95.3	46.5	66	149.2	72.8	26	203.1	99.1	86	257.1	125.4
47	42.2	20.6	07	96.2	46.9	67	150.1	73.2	27	204.0	99.5	87	258.0	125.8
48	43.1	21.0	08	97.1	47.3	68	151.0	73.6	28	204.9	99.9	88	258.9	126.3
49	44.0	21.5	09	98.0	47.8	69	151.9	74.1	29	205.8	100.4	89	259.8	126.7
50	44.9	21.9	10	98.9	48.2	70	152.8	74.5	30	206.7	100.8	90	260.7	127.1
51	45.8	22.4	111	99.8	48.7	171	153.7	75.0	231	207.6	101.3	291	261.5	127.6
52	46.7	22.8	12	100.7	49.1	72	154.6	75.4	32	208.5	101.7	92	262.4	128.0
53	47.6	23.2	13	101.6	49.5	73	155.5	75.8	33	209.4	102.1	93	263.3	128.4
54	48.5	23.7	14	102.5	50.0	74	156.4	76.3	34	210.3	102.6	94	264.2	128.9
55	49.4	24.1	15	103.4	50.4	75	157.3	76.7	35	211.2	103.0	95	265.1	129.3
56	50.3	24.5	16	104.3	50.9	76	158.2	77.2	36	212.1	103.5	96	266.0	129.8
57	51.2	25.0	17	105.2	51.3	77	159.1	77.6	37	213.0	103.9	97	266.9	130.2
58	52.1	25.4	18	106.1	51.7	78	160.0	78.0	38	213.9	104.3	98	267.8	130.6
59	53.0	25.9	19	107.0	52.2	79	160.9	78.5	39	214.8	104.8	99	268.7	131.1
60	53.9	26.3	20	107.9	52.6	80	161.8	78.9	40	215.7	105.2	300	269.6	131.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 64 Degrees.

TABLE II. Difference of Latitude and Departure for 27 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	01.8	00.9	62	55.2	28.1	22	108.7	55.4	82	162.2	82.6	42	215.6	109.9
3	02.7	01.4	63	56.1	28.6	23	109.6	55.8	83	163.1	83.1	43	216.5	110.3
4	03.6	01.8	64	57.0	29.1	24	110.5	56.3	84	163.9	83.5	44	217.4	110.8
5	04.5	02.3	65	57.9	29.5	25	111.4	56.7	85	164.8	84.0	45	218.3	111.2
6	05.3	02.7	66	58.8	30.0	26	112.3	57.2	86	165.7	84.4	46	219.2	111.7
7	06.2	03.2	67	59.7	30.4	27	113.2	57.7	87	166.6	84.9	47	220.1	112.1
8	07.1	03.6	68	60.6	30.9	28	114.0	58.1	88	167.5	85.4	48	221.0	112.6
9	08.0	04.1	69	61.5	31.3	29	114.9	58.6	89	168.4	85.8	49	221.9	113.0
10	08.9	04.5	70	62.4	31.8	30	115.8	59.0	90	169.3	86.3	50	222.8	113.5
11	09.8	05.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	05.4	72	64.2	32.7	32	117.6	59.9	92	171.1	87.2	52	224.5	114.4
13	11.6	05.9	73	65.0	33.1	33	118.5	60.4	93	172.0	87.6	53	225.4	114.9
14	12.5	06.4	74	65.9	33.6	34	119.4	60.8	94	172.9	88.1	54	226.3	115.3
15	13.4	06.8	75	66.8	34.0	35	120.3	61.3	95	173.7	88.5	55	227.2	115.8
16	14.3	07.3	76	67.7	34.5	36	121.2	61.7	96	174.6	89.0	56	228.1	116.2
17	15.1	07.7	77	68.6	35.0	37	122.1	62.2	97	175.5	89.4	57	229.0	116.7
18	16.0	08.2	78	69.5	35.4	38	123.0	62.7	98	176.4	89.9	58	229.9	117.1
19	16.9	08.6	79	70.4	35.9	39	123.8	63.1	99	177.3	90.3	59	230.8	117.6
20	17.8	09.1	80	71.3	36.3	40	124.7	63.6	200	178.2	90.8	60	231.7	118.0
21	18.7	09.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	42	126.5	64.5	02	180.0	91.7	62	233.4	118.9
23	20.5	10.4	83	74.0	37.7	43	127.4	64.9	03	180.9	92.2	63	234.3	119.4
24	21.4	10.9	84	74.8	38.1	44	128.3	65.4	04	181.8	92.6	64	235.2	119.9
25	22.3	11.3	85	75.7	38.6	45	129.2	65.8	05	182.7	93.1	65	236.1	120.3
26	23.2	11.8	86	76.6	39.0	46	130.1	66.3	06	183.5	93.5	66	237.0	120.8
27	24.1	12.3	87	77.5	39.5	47	131.0	66.7	07	184.4	94.0	67	237.9	121.2
28	24.9	12.7	88	78.4	40.0	48	131.9	67.2	08	185.3	94.4	68	238.8	121.7
29	25.8	13.2	89	79.3	40.4	49	132.8	67.6	09	186.2	94.9	69	239.7	122.1
30	26.7	13.6	90	80.2	40.9	50	133.7	68.1	10	187.1	95.3	70	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.0
32	28.5	14.5	92	82.0	41.8	52	135.4	69.0	12	188.9	96.2	72	242.4	123.5
33	29.4	15.0	93	82.9	42.2	53	136.3	69.5	13	189.8	96.7	73	243.2	123.9
34	30.3	15.4	94	83.8	42.7	54	137.2	69.9	14	190.7	97.2	74	244.1	124.4
35	31.2	15.9	95	84.6	43.1	55	138.1	70.4	15	191.6	97.6	75	245.0	124.8
36	32.1	16.3	96	85.5	43.6	56	139.0	70.8	16	192.5	98.1	76	245.9	125.3
37	33.0	16.8	97	86.4	44.0	57	139.9	71.3	17	193.3	98.5	77	246.8	125.8
38	33.9	17.3	98	87.3	44.5	58	140.8	71.7	18	194.2	99.0	78	247.7	126.2
39	34.7	17.7	99	88.2	44.9	59	141.7	72.2	19	195.1	99.4	79	248.6	126.7
40	35.6	18.2	100	89.1	45.4	60	142.6	72.6	20	196.0	99.9	80	249.5	127.1
41	36.5	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
42	37.4	19.1	02	90.9	46.3	62	144.3	73.5	22	197.8	100.8	82	251.3	128.0
43	38.3	19.5	03	91.8	46.8	63	145.2	74.0	23	198.7	101.2	83	252.2	128.5
44	39.2	20.0	04	92.7	47.2	64	146.1	74.5	24	199.6	101.7	84	253.0	128.9
45	40.1	20.4	05	93.6	47.7	65	147.0	74.9	25	200.5	102.1	85	253.9	129.4
46	41.0	20.9	06	94.4	48.1	66	147.9	75.4	26	201.4	102.6	86	254.8	129.8
47	41.9	21.3	07	95.3	48.6	67	148.8	75.8	27	202.3	103.1	87	255.7	130.3
48	42.8	21.8	08	96.2	49.0	68	149.7	76.3	28	203.1	103.5	88	256.6	130.7
49	43.7	22.2	09	97.1	49.5	69	150.6	76.7	29	204.0	104.0	89	257.5	131.2
50	44.6	22.7	10	98.0	49.9	70	151.5	77.2	30	204.9	104.4	90	258.4	131.7
51	45.4	23.2	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
52	46.3	23.6	12	99.8	50.8	72	153.3	78.1	32	206.7	105.3	92	260.2	132.6
53	47.2	24.1	13	100.7	51.3	73	154.1	78.5	33	207.6	105.8	93	261.1	133.0
54	48.1	24.5	14	101.6	51.8	74	155.0	79.0	34	208.5	106.2	94	262.0	133.5
55	49.0	25.0	15	102.5	52.2	75	155.9	79.4	35	209.4	106.7	95	262.8	133.9
56	49.9	25.4	16	103.4	52.7	76	156.8	79.9	36	210.3	107.1	96	263.7	134.4
57	50.8	25.9	17	104.2	53.1	77	157.7	80.4	37	211.2	107.6	97	264.6	134.8
58	51.7	26.3	18	105.1	53.6	78	158.6	80.8	38	212.1	108.0	98	265.5	135.3
59	52.6	26.8	19	106.0	54.0	79	159.5	81.3	39	213.0	108.5	99	266.4	135.7
60	53.5	27.2	20	106.9	54.5	80	160.4	81.7	40	213.8	109.0	300	267.3	136.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 63 Degrees.

TABLE II. Difference of Latitude and Departure for 28 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.9	28.6	121	106.8	56.8	181	159.8	85.0	241	212.8	113.1
2	01.8	00.9	62	54.7	29.1	22	107.7	57.3	82	160.7	85.4	42	213.7	113.6
3	02.6	01.4	63	55.6	29.6	23	108.6	57.7	83	161.6	85.9	43	214.6	114.1
4	03.5	01.9	64	56.5	30.0	24	109.5	58.2	84	162.5	86.4	44	215.4	114.6
5	04.4	02.3	65	57.4	30.5	25	110.4	58.7	85	163.3	86.9	45	216.3	115.0
6	05.3	02.8	66	58.3	31.0	26	111.3	59.2	86	164.2	87.3	46	217.2	115.5
7	06.2	03.3	67	59.2	31.5	27	112.1	59.6	87	165.1	87.8	47	218.1	116.0
8	07.1	03.8	68	60.0	31.9	28	113.0	60.1	88	166.0	88.3	48	219.0	116.4
9	07.9	04.2	69	60.9	32.4	29	113.9	60.6	89	166.9	88.7	49	219.9	116.9
10	08.8	04.7	70	61.8	32.9	30	114.8	61.0	90	167.8	89.2	50	220.7	117.4
11	09.7	05.2	71	62.7	33.3	131	115.7	61.5	191	168.6	89.7	251	221.6	117.8
12	10.6	05.6	72	63.6	33.8	32	116.5	62.0	92	169.5	90.1	52	222.5	118.3
13	11.5	06.1	73	64.5	34.3	33	117.4	62.4	93	170.4	90.6	53	223.4	118.8
14	12.4	06.6	74	65.3	34.7	34	118.3	62.9	94	171.3	91.1	54	224.3	119.2
15	13.2	07.0	75	66.2	35.2	35	119.2	63.4	95	172.2	91.5	55	225.2	119.7
16	14.1	07.5	76	67.1	35.7	36	120.1	63.8	96	173.1	92.0	56	226.0	120.2
17	15.0	08.0	77	68.0	36.1	37	121.0	64.3	97	173.9	92.5	57	226.9	120.7
18	15.9	08.5	78	68.9	36.6	38	121.8	64.8	98	174.8	93.0	58	227.8	121.1
19	16.8	08.9	79	69.8	37.1	39	122.7	65.3	99	175.7	93.4	59	228.7	121.6
20	17.7	09.4	80	70.6	37.6	40	123.6	65.7	200	176.6	93.9	60	229.6	122.1
21	18.5	09.9	81	71.5	38.0	141	124.5	66.2	201	177.5	94.4	261	230.4	122.5
22	19.4	10.3	82	72.4	38.5	42	125.4	66.7	02	178.4	94.8	62	231.3	123.0
23	20.3	10.8	83	73.3	39.0	43	126.3	67.1	03	179.2	95.3	63	232.2	123.5
24	21.2	11.3	84	74.2	39.4	44	127.1	67.6	04	180.1	95.8	64	233.1	123.9
25	22.1	11.7	85	75.1	39.9	45	128.0	68.1	05	181.0	96.2	65	234.0	124.4
26	23.0	12.2	86	75.9	40.4	46	128.9	68.5	06	181.9	96.7	66	254.9	124.9
27	23.8	12.7	87	76.8	40.8	47	129.8	69.0	07	182.8	97.2	67	235.7	125.3
28	24.7	13.1	88	77.7	41.3	48	130.7	69.5	08	183.7	97.7	68	236.6	125.8
29	25.6	13.6	89	78.6	41.8	49	131.6	70.0	09	184.5	98.1	69	237.5	126.3
30	26.5	14.1	90	79.5	42.3	50	132.4	70.4	10	185.4	98.6	70	238.4	126.8
31	27.4	14.6	91	80.3	42.7	151	133.3	70.9	211	186.3	99.1	271	239.3	127.2
32	28.3	15.0	92	81.2	43.2	52	134.2	71.4	12	187.2	99.5	72	240.2	127.7
33	29.1	15.5	93	82.1	43.7	53	135.1	71.8	13	188.1	100.0	73	241.0	128.2
34	30.0	16.0	94	83.0	44.1	54	136.0	72.3	14	189.0	100.5	74	241.9	128.6
35	30.9	16.4	95	83.9	44.6	55	136.9	72.8	15	189.8	100.9	75	242.8	129.1
36	31.8	16.9	96	84.8	45.1	56	137.7	73.2	16	190.7	101.4	76	243.7	129.6
37	32.7	17.4	97	85.6	45.5	57	138.6	73.7	17	191.6	101.9	77	244.6	130.0
38	33.6	17.8	98	86.5	46.0	58	139.5	74.2	18	192.5	102.3	78	245.5	130.5
39	34.4	18.3	99	87.4	46.5	59	140.4	74.6	19	193.4	102.8	79	246.3	131.0
40	35.3	18.8	100	88.3	46.9	60	141.3	75.1	20	194.2	103.3	80	247.2	131.5
41	36.2	19.2	101	89.2	47.4	161	142.2	75.6	221	195.1	103.8	281	248.1	131.9
42	37.1	19.7	02	90.1	47.9	62	143.0	76.1	22	196.0	104.2	82	249.0	132.4
43	38.0	20.2	03	90.9	48.4	63	143.9	76.5	23	196.9	104.7	83	249.9	132.9
44	38.8	20.7	04	91.8	48.8	64	144.8	77.0	24	197.8	105.2	84	250.8	133.3
45	39.7	21.1	05	92.7	49.3	65	145.7	77.5	25	198.7	105.6	85	251.6	133.8
46	40.6	21.6	06	93.6	49.8	66	146.6	77.9	26	199.5	106.1	86	252.5	134.3
47	41.5	22.1	07	94.5	50.2	67	147.5	78.4	27	200.4	106.6	87	253.4	134.7
48	42.4	22.5	08	95.4	50.7	68	148.3	78.9	28	201.3	107.0	88	254.3	135.2
49	43.3	23.0	09	96.2	51.2	69	149.2	79.3	29	202.2	107.5	89	255.2	135.7
50	44.1	23.5	10	97.1	51.6	70	150.1	79.8	30	203.1	108.0	90	256.1	136.1
51	45.0	23.9	111	98.0	52.1	171	151.0	80.3	231	204.0	108.4	291	256.9	136.6
52	45.9	24.4	12	98.9	52.6	72	151.9	80.7	32	204.8	108.9	92	257.8	137.1
53	46.8	24.9	13	99.8	53.1	73	152.7	81.2	33	205.7	109.4	93	258.7	137.6
54	47.7	25.4	14	100.7	53.5	74	153.6	81.7	34	206.6	109.9	94	259.6	138.0
55	48.6	25.8	15	101.5	54.0	75	154.5	82.2	35	207.5	110.3	95	260.5	138.5
56	49.4	26.3	16	102.4	54.5	76	155.4	82.6	36	208.4	110.8	96	261.4	139.0
57	50.3	26.8	17	103.3	54.9	77	156.3	83.1	37	209.3	111.3	97	262.2	139.4
58	51.2	27.2	18	104.2	55.4	78	157.2	83.6	38	210.1	111.7	98	263.1	139.9
59	52.1	27.7	19	105.1	55.9	79	158.0	84.0	39	211.0	112.2	99	264.0	140.4
60	53.0	28.2	20	106.0	56.3	80	158.9	84.5	40	211.9	112.7	300	264.9	140.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 62 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.4	29.6	121	105.8	58.7	181	158.3	87.8	241	210.8	116.8
2	01.7	01.0	62	54.2	30.1	22	106.7	59.1	82	159.2	88.2	42	211.7	117.3
3	02.6	01.5	63	55.1	30.5	23	107.6	59.6	83	160.1	88.7	43	212.5	117.8
4	03.5	01.9	64	56.0	31.0	24	108.5	60.1	84	160.9	89.2	44	213.4	118.3
5	04.4	02.4	65	56.9	31.5	25	109.3	60.6	85	161.8	89.7	45	214.3	118.8
6	05.2	02.9	66	57.7	32.0	26	110.2	61.1	86	162.7	90.2	46	215.2	119.3
7	06.1	03.4	67	58.6	32.5	27	111.1	61.6	87	163.6	90.7	47	216.0	119.7
8	07.0	03.9	68	59.5	33.0	28	112.0	62.1	88	164.4	91.1	48	216.9	120.2
9	07.9	04.4	69	60.3	33.5	29	112.8	62.5	89	165.3	91.6	49	217.8	120.7
10	08.7	04.8	70	61.2	33.9	30	113.7	63.0	90	166.2	92.1	50	218.7	121.2
11	09.6	05.3	71	62.1	34.4	131	114.6	63.5	191	167.1	92.6	251	219.5	121.7
12	10.5	05.8	72	63.0	34.9	32	115.4	64.0	92	167.9	93.1	52	220.4	122.2
13	11.4	06.3	73	63.8	35.4	33	116.3	64.5	93	168.8	93.6	53	221.3	122.7
14	12.2	06.8	74	64.7	35.9	34	117.2	65.0	94	169.7	94.1	54	222.2	123.1
15	13.1	07.3	75	65.6	36.4	35	118.1	65.4	95	170.6	94.5	55	223.0	123.6
16	14.0	07.8	76	66.5	36.8	36	118.9	65.9	96	171.4	95.0	56	223.9	124.1
17	14.9	08.2	77	67.3	37.3	37	119.8	66.4	97	172.3	95.5	57	224.8	124.6
18	15.7	08.7	78	68.2	37.8	38	120.7	66.9	98	173.2	96.0	58	225.7	125.1
19	16.6	09.2	79	69.1	38.3	39	121.6	67.4	99	174.0	96.5	59	226.5	125.6
20	17.5	09.7	80	70.0	38.8	40	122.4	67.9	200	174.9	97.0	60	227.4	126.1
21	18.4	10.2	81	70.8	39.3	141	123.3	68.4	201	175.8	97.4	261	228.3	126.5
22	19.2	10.7	82	71.7	39.8	42	124.2	68.8	02	176.7	97.9	62	229.2	127.0
23	20.1	11.2	83	72.6	40.2	43	125.1	69.3	03	177.5	98.4	63	230.0	127.5
24	21.0	11.6	84	73.5	40.7	44	125.9	69.8	04	178.4	98.9	64	230.9	128.0
25	21.9	12.1	85	74.3	41.2	45	126.8	70.3	05	179.3	99.4	65	231.8	128.5
26	22.7	12.6	86	75.2	41.7	46	127.7	70.8	06	180.2	99.9	66	232.6	129.0
27	23.6	13.1	87	76.1	42.2	47	128.6	71.3	07	181.0	100.4	67	233.5	129.4
28	24.5	13.6	88	77.0	42.7	48	129.4	71.8	08	181.9	100.8	68	234.4	129.9
29	25.4	14.1	89	77.8	43.1	49	130.3	72.2	09	182.8	101.3	69	235.3	130.4
30	26.2	14.5	90	78.7	43.6	50	131.2	72.7	10	183.7	101.8	70	236.1	130.9
31	27.1	15.0	91	79.6	44.1	151	132.1	73.2	211	184.5	102.3	271	237.0	131.4
32	28.0	15.5	92	80.5	44.6	52	132.9	73.7	12	185.4	102.8	72	237.9	131.9
33	28.9	16.0	93	81.3	45.1	53	133.8	74.2	13	186.3	103.3	73	238.8	132.4
34	29.7	16.5	94	82.2	45.6	54	134.7	74.7	14	187.2	103.7	74	239.6	132.8
35	30.6	17.0	95	83.1	46.1	55	135.6	75.1	15	188.0	104.2	75	240.5	133.3
36	31.5	17.5	96	84.0	46.5	56	136.4	75.6	16	188.9	104.7	76	241.4	133.8
37	32.4	17.9	97	84.8	47.0	57	137.3	76.1	17	189.8	105.2	77	242.3	134.3
38	33.2	18.4	98	85.7	47.5	58	138.2	76.6	18	190.7	105.7	78	243.1	134.8
39	34.1	18.9	99	86.6	48.0	59	139.1	77.1	19	191.5	106.2	79	244.0	135.3
40	35.0	19.4	100	87.5	48.5	60	139.9	77.6	20	192.4	106.7	80	244.9	135.7
41	35.9	19.9	101	88.3	49.0	161	140.8	78.1	221	193.3	107.1	281	245.8	136.2
42	36.7	20.4	02	89.2	49.5	62	141.7	78.5	22	194.2	107.6	82	246.6	136.7
43	37.6	20.8	03	90.1	49.9	63	142.6	79.0	23	195.0	108.1	83	247.5	137.2
44	38.5	21.3	04	91.0	50.4	64	143.4	79.5	24	195.9	108.6	84	248.4	137.7
45	39.4	21.8	05	91.8	50.9	65	144.3	80.0	25	196.8	109.1	85	249.3	138.2
46	40.2	22.3	06	92.7	51.4	66	145.2	80.5	26	197.7	109.6	86	250.1	138.7
47	41.1	22.8	07	93.6	51.9	67	146.1	81.0	27	198.5	110.1	87	251.0	139.1
48	42.0	23.3	08	94.5	52.4	68	146.9	81.4	28	199.4	110.5	88	251.9	139.6
49	42.9	23.8	09	95.3	52.8	69	147.8	81.9	29	200.3	111.0	89	252.8	140.1
50	43.7	24.2	10	96.2	53.3	70	148.7	82.4	30	201.2	111.5	90	253.6	140.6
51	44.6	24.7	111	97.1	53.8	171	149.6	82.9	231	202.0	112.0	291	254.5	141.1
52	45.5	25.2	12	98.0	54.3	72	150.4	83.4	32	202.9	112.5	92	255.4	141.6
53	46.4	25.7	13	98.8	54.8	73	151.3	83.9	33	203.8	113.0	93	256.3	142.0
54	47.2	26.2	14	99.7	55.3	74	152.2	84.4	34	204.7	113.4	94	257.1	142.5
55	48.1	26.7	15	100.6	55.8	75	153.1	84.8	35	205.5	113.9	95	258.0	143.0
56	49.0	27.1	16	101.5	56.2	76	153.9	85.3	36	206.4	114.4	96	258.9	143.5
57	49.9	27.6	17	102.3	56.7	77	154.8	85.8	37	207.3	114.9	97	259.8	144.0
58	50.7	28.1	18	103.2	57.2	78	155.7	86.3	38	208.2	115.4	98	260.6	144.5
59	51.6	28.6	19	104.1	57.7	79	156.6	86.8	39	209.0	115.9	99	261.5	145.0
60	52.5	29.1	20	105.0	58.2	80	157.4	87.3	40	209.9	116.4	300	262.4	145.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 61 Degrees.

TABLE II. Difference of Latitude and Departure for 30 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.8	30.5	121	104.8	60.5	181	156.8	90.5	241	208.7	120.5
2	01.7	01.0	62	53.7	31.0	22	105.7	61.0	82	157.6	91.0	42	209.6	121.0
3	02.6	01.5	63	54.6	31.5	23	106.5	61.5	83	158.5	91.5	43	210.4	121.5
4	03.5	02.0	64	55.4	32.0	24	107.4	62.0	84	159.3	92.0	44	211.3	122.0
5	04.3	02.5	65	56.3	32.5	25	108.3	62.5	85	160.2	92.5	45	212.2	122.5
6	05.2	03.0	66	57.2	33.0	26	109.1	63.0	86	161.1	93.0	46	213.0	123.0
7	06.1	03.5	67	58.0	33.5	27	110.0	63.5	87	161.9	93.5	47	213.9	123.5
8	06.9	04.0	68	58.9	34.0	28	110.9	64.0	88	162.8	94.0	48	214.8	124.0
9	07.8	04.5	69	59.8	34.5	29	111.7	64.5	89	163.7	94.5	49	215.6	124.5
10	08.7	05.0	70	60.6	35.0	30	112.6	65.0	90	164.5	95.0	50	216.5	125.0
11	09.5	05.5	71	61.5	35.5	131	113.4	65.5	191	165.4	95.5	251	217.4	125.5
12	10.4	06.0	72	62.4	36.0	32	114.3	66.0	92	166.3	96.0	52	218.2	126.0
13	11.3	06.5	73	63.2	36.5	33	115.2	66.5	93	167.1	96.5	53	219.1	126.5
14	12.1	07.0	74	64.1	37.0	34	116.0	67.0	94	168.0	97.0	54	220.0	127.0
15	13.0	07.5	75	65.0	37.5	35	116.9	67.5	95	168.9	97.5	55	220.8	127.5
16	13.9	08.0	76	65.8	38.0	36	117.8	68.0	96	169.7	98.0	56	221.7	128.0
17	14.7	08.5	77	66.7	38.5	37	118.6	68.5	97	170.6	98.5	57	222.6	128.5
18	15.6	09.0	78	67.5	39.0	38	119.5	69.0	98	171.5	99.0	58	223.4	129.0
19	16.5	09.5	79	68.4	39.5	39	120.4	69.5	99	172.3	99.5	59	224.3	129.5
20	17.3	10.0	80	69.3	40.0	40	121.2	70.0	200	173.2	100.0	60	225.2	130.0
21	18.2	10.5	81	70.1	40.5	141	122.1	70.5	201	174.1	100.5	261	226.0	130.5
22	19.1	11.0	82	71.0	41.0	42	123.0	71.0	02	174.9	101.0	62	226.9	131.0
23	19.9	11.5	83	71.9	41.5	43	123.8	71.5	03	175.8	101.5	63	227.8	131.5
24	20.8	12.0	84	72.7	42.0	44	124.7	72.0	04	176.7	102.0	64	228.6	132.0
25	21.7	12.5	85	73.6	42.5	45	125.6	72.5	05	177.5	102.5	65	229.5	132.5
26	22.5	13.0	86	74.5	43.0	46	126.4	73.0	06	178.4	103.0	66	230.4	133.0
27	23.4	13.5	87	75.3	43.5	47	127.3	73.5	07	179.3	103.5	67	231.2	133.5
28	24.2	14.0	88	76.2	44.0	48	128.2	74.0	08	180.1	104.0	68	232.1	134.0
29	25.1	14.5	89	77.1	44.5	49	129.0	74.5	09	181.0	104.5	69	233.0	134.5
30	26.0	15.0	90	77.9	45.0	50	129.9	75.0	10	181.9	105.0	70	233.8	135.0
31	26.8	15.5	91	78.8	45.5	151	130.8	75.5	211	182.7	105.5	271	234.7	135.5
32	27.7	16.0	92	79.7	46.0	52	131.6	76.0	12	183.6	106.0	72	235.6	136.0
33	28.6	16.5	93	80.5	46.5	53	132.5	76.5	13	184.5	106.5	73	236.4	136.5
34	29.4	17.0	94	81.4	47.0	54	133.4	77.0	14	185.3	107.0	74	237.3	137.0
35	30.3	17.5	95	82.3	47.5	55	134.2	77.5	15	186.2	107.5	75	238.2	137.5
36	31.2	18.0	96	83.1	48.0	56	135.1	78.0	16	187.1	108.0	76	239.0	138.0
37	32.0	18.5	97	84.0	48.5	57	136.0	78.5	17	187.9	108.5	77	239.9	138.5
38	32.9	19.0	98	84.9	49.0	58	136.8	79.0	18	188.8	109.0	78	240.8	139.0
39	33.8	19.5	99	85.7	49.5	59	137.7	79.5	19	189.7	109.5	79	241.6	139.5
40	34.6	20.0	100	86.6	50.0	60	138.6	80.0	20	190.5	110.0	80	242.5	140.0
41	35.5	20.5	101	87.5	50.5	161	139.4	80.5	221	191.4	110.5	281	243.4	140.5
42	36.4	21.0	02	88.3	51.0	62	140.3	81.0	22	192.3	111.0	82	244.2	141.0
43	37.2	21.5	03	89.2	51.5	63	141.2	81.5	23	193.1	111.5	83	245.1	141.5
44	38.1	22.0	04	90.1	52.0	64	142.0	82.0	24	194.0	112.0	84	246.0	142.0
45	39.0	22.5	05	90.9	52.5	65	142.9	82.5	25	194.9	112.5	85	246.8	142.5
46	39.8	23.0	06	91.8	53.0	66	143.8	83.0	26	195.7	113.0	86	247.7	143.0
47	40.7	23.5	07	92.7	53.5	67	144.6	83.5	27	196.6	113.5	87	248.5	143.5
48	41.6	24.0	08	93.5	54.0	68	145.5	84.0	28	197.5	114.0	88	249.4	144.0
49	42.4	24.5	09	94.4	54.5	69	146.4	84.5	29	198.3	114.5	89	250.3	144.5
50	43.3	25.0	10	95.3	55.0	70	147.2	85.0	30	199.2	115.0	90	251.1	145.0
51	44.2	25.5	111	96.1	55.5	171	148.1	85.5	231	200.1	115.5	291	252.0	145.5
52	45.0	26.0	12	97.0	56.0	72	149.0	86.0	32	200.9	116.0	92	252.9	146.0
53	45.9	26.5	13	97.9	56.5	73	149.8	86.5	33	201.8	116.5	93	253.7	146.5
54	46.8	27.0	14	98.7	57.0	74	150.7	87.0	34	202.6	117.0	94	254.6	147.0
55	47.6	27.5	15	99.6	57.5	75	151.6	87.5	35	203.5	117.5	95	255.5	147.5
56	48.5	28.0	16	100.5	58.0	76	152.4	88.0	36	204.4	118.0	96	256.3	148.0
57	49.4	28.5	17	101.3	58.5	77	153.3	88.5	37	205.2	118.5	97	257.2	148.5
58	50.2	29.0	18	102.2	59.0	78	154.2	89.0	38	206.1	119.0	98	258.1	149.0
59	51.1	29.5	19	103.1	59.5	79	155.0	89.5	39	207.0	119.5	99	258.9	149.5
60	52.0	30.0	20	103.9	60.0	80	155.9	90.0	40	207.8	120.0	300	259.8	150.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 60 Degrees.

TABLE II. Difference of Latitude and Departure for 31 Degrees.

Dist.	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.7	62.3	181	155.1	93.2	241	206.6	124.1
2	01.7	01.0	62	53.1	31.9	22	104.6	62.8	82	156.0	93.7	42	207.4	124.6
3	02.6	01.5	63	54.0	32.4	23	105.4	63.3	83	156.9	94.3	43	208.3	125.2
4	03.4	02.1	64	54.9	33.0	24	106.3	63.9	84	157.7	94.8	44	209.1	125.7
5	04.3	02.6	65	55.7	33.5	25	107.1	64.4	85	158.6	95.3	45	210.0	126.2
6	05.1	03.1	66	56.6	34.0	26	108.0	64.9	86	159.4	95.8	46	210.9	126.7
7	06.0	03.6	67	57.4	34.5	27	108.9	65.4	87	160.3	96.3	47	211.7	127.2
8	06.9	04.1	68	58.3	35.0	28	109.7	65.9	88	161.1	96.8	48	212.6	127.7
9	07.7	04.6	69	59.1	35.5	29	110.6	66.4	89	162.0	97.3	49	213.4	128.2
10	08.6	05.2	70	60.0	36.1	30	111.4	67.0	90	162.9	97.9	50	214.3	128.8
11	09.4	05.7	71	60.9	36.6	131	112.3	67.5	191	163.7	98.4	251	215.1	129.3
12	10.3	06.2	72	61.7	37.1	32	113.1	68.0	92	164.6	98.9	52	216.0	129.8
13	11.1	06.7	73	62.6	37.6	33	114.0	68.5	93	165.4	99.4	53	216.9	130.3
14	12.0	07.2	74	63.4	38.1	34	114.9	69.0	94	166.3	99.9	54	217.7	130.8
15	12.9	07.7	75	64.3	38.6	35	115.7	69.5	95	167.1	100.4	55	218.6	131.3
16	13.7	08.2	76	65.1	39.1	36	116.6	70.0	96	168.0	100.9	56	219.4	131.8
17	14.6	08.8	77	66.0	39.7	37	117.4	70.6	97	168.9	101.5	57	220.3	132.4
18	15.4	09.3	78	66.9	40.2	38	118.3	71.1	98	169.7	102.0	58	221.1	132.9
19	16.3	09.8	79	67.7	40.7	39	119.1	71.6	99	170.6	102.5	59	222.0	133.4
20	17.1	10.3	80	68.6	41.2	40	120.0	72.1	200	171.4	103.0	60	222.9	133.9
21	18.0	10.8	81	69.4	41.7	141	120.9	72.6	201	172.3	103.5	261	223.7	134.4
22	18.9	11.3	82	70.3	42.2	42	121.7	73.1	02	173.1	104.0	62	224.6	134.9
23	19.7	11.8	83	71.1	42.7	43	122.6	73.7	03	174.0	104.6	63	225.4	135.5
24	20.6	12.4	84	72.0	43.3	44	123.4	74.2	04	174.9	105.1	64	226.3	136.0
25	21.4	12.9	85	72.9	43.8	45	124.3	74.7	05	175.7	105.6	65	227.1	136.5
26	22.3	13.4	86	73.7	44.3	46	125.1	75.2	06	176.6	106.1	66	228.0	137.0
27	23.1	13.9	87	74.6	44.8	47	126.0	75.7	07	177.4	106.6	67	228.9	137.5
28	24.0	14.4	88	75.4	45.3	48	126.9	76.2	08	178.3	107.1	68	229.7	138.0
29	24.9	14.9	89	76.3	45.8	49	127.7	76.7	09	179.1	107.6	69	230.6	138.5
30	25.7	15.5	90	77.1	46.4	50	128.6	77.3	10	180.0	108.2	70	231.4	139.1
31	26.6	16.0	91	78.0	46.9	151	129.4	77.8	211	180.9	108.7	271	232.3	139.6
32	27.4	16.5	92	78.9	47.4	52	130.3	78.3	12	181.7	109.2	72	233.1	140.1
33	28.3	17.0	93	79.7	47.9	53	131.1	78.8	13	182.6	109.7	73	234.0	140.6
34	29.1	17.5	94	80.6	48.4	54	132.0	79.3	14	183.4	110.2	74	234.9	141.1
35	30.0	18.0	95	81.4	48.9	55	132.9	79.8	15	184.3	110.7	75	235.7	141.6
36	30.9	18.5	96	82.3	49.4	56	133.7	80.3	16	185.1	111.2	76	236.6	142.2
37	31.7	19.1	97	83.1	50.0	57	134.6	80.9	17	186.0	111.8	77	237.4	142.7
38	32.6	19.6	98	84.0	50.5	58	135.4	81.4	18	186.9	112.3	78	238.3	143.2
39	33.4	20.1	99	84.9	51.0	59	136.3	81.9	19	187.7	112.8	79	239.1	143.7
40	34.3	20.6	100	85.7	51.5	60	137.1	82.4	20	188.6	113.3	80	240.0	144.2
41	35.1	21.1	101	86.6	52.0	161	138.0	82.9	221	189.4	113.8	281	240.9	144.7
42	36.0	21.6	02	87.4	52.5	62	138.9	83.4	22	190.3	114.3	82	241.7	145.2
43	36.9	22.1	03	88.3	53.0	63	139.7	84.0	23	191.1	114.9	83	242.6	145.8
44	37.7	22.7	04	89.1	53.6	64	140.6	84.5	24	192.0	115.4	84	243.4	146.3
45	38.6	23.2	05	90.0	54.1	65	141.4	85.0	25	192.9	115.9	85	244.3	146.8
46	39.4	23.7	06	90.9	54.6	66	142.3	85.5	26	193.7	116.4	86	245.1	147.3
47	40.3	24.2	07	91.7	55.1	67	143.1	86.0	27	194.6	116.9	87	246.0	147.8
48	41.1	24.7	08	92.6	55.6	68	144.0	86.5	28	195.4	117.4	88	246.9	148.3
49	42.0	25.2	09	93.4	56.1	69	144.9	87.0	29	196.3	117.9	89	247.7	148.8
50	42.9	25.8	10	94.3	56.7	70	145.7	87.6	30	197.1	118.5	90	248.6	149.4
51	43.7	26.3	111	95.1	57.2	171	146.6	88.1	231	198.0	119.0	291	249.4	149.9
52	44.6	26.8	12	96.0	57.7	72	147.4	88.6	32	198.9	119.5	92	250.3	150.4
53	45.4	27.3	13	96.9	58.2	73	148.3	89.1	33	199.7	120.0	93	251.2	150.9
54	46.3	27.8	14	97.7	58.7	74	149.1	89.6	34	200.6	120.5	94	252.0	151.4
55	47.1	28.3	15	98.6	59.2	75	150.0	90.1	35	201.4	121.0	95	252.9	151.9
56	48.0	28.8	16	99.4	59.7	76	150.9	90.6	36	202.3	121.5	96	253.7	152.5
57	48.9	29.4	17	100.3	60.3	77	151.7	91.2	37	203.1	122.1	97	254.6	153.0
58	49.7	29.9	18	101.1	60.8	78	152.6	91.7	38	204.0	122.6	98	255.4	153.5
59	50.6	30.4	19	102.0	61.3	79	153.4	92.2	39	204.9	123.1	99	256.3	154.0
60	51.4	30.9	20	102.9	61.8	80	154.3	92.7	40	205.7	123.6	300	257.1	154.5
Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 59 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.5	61	51.7	32.3	121	102.6	64.1	181	153.5	95.9	241	204.4	127.7
2	01.7	01.1	62	52.6	32.9	22	103.5	64.7	82	154.3	96.4	42	205.2	128.2
3	02.5	01.6	63	53.4	33.4	23	104.3	65.2	83	155.2	97.0	43	206.1	128.8
4	03.4	02.1	64	54.3	33.9	24	105.2	65.7	84	156.0	97.5	44	206.9	129.3
5	04.2	02.6	65	55.1	34.4	25	106.0	66.2	85	156.9	98.0	45	207.8	129.8
6	05.1	03.2	66	56.0	35.0	26	106.9	66.8	86	157.7	98.6	46	208.6	130.4
7	05.9	03.7	67	56.8	35.5	27	107.7	67.3	87	158.6	99.1	47	209.5	130.9
8	06.8	04.2	68	57.7	36.0	28	108.6	67.8	88	159.4	99.6	48	210.3	131.4
9	07.6	04.8	69	58.5	36.6	29	109.4	68.4	89	160.3	100.2	49	211.2	131.9
10	08.5	05.3	70	59.4	37.1	30	110.2	68.9	90	161.1	100.7	50	212.0	132.5
11	09.3	05.8	71	60.2	37.6	131	111.1	69.4	191	162.0	101.2	251	212.9	133.0
12	10.2	06.4	72	61.1	38.2	32	111.9	69.9	92	162.8	101.7	52	213.7	133.5
13	11.0	06.9	73	61.9	38.7	33	112.8	70.5	93	163.7	102.3	53	214.6	134.1
14	11.9	07.4	74	62.8	39.2	34	113.6	71.0	94	164.5	102.8	54	215.4	134.6
15	12.7	07.9	75	63.6	39.7	35	114.5	71.5	95	165.4	103.3	55	216.3	135.1
16	13.6	08.5	76	64.5	40.3	36	115.3	72.1	96	166.2	103.9	56	217.1	135.7
17	14.4	09.0	77	65.3	40.8	37	116.2	72.6	97	167.1	104.4	57	217.9	136.2
18	15.3	09.5	78	66.1	41.3	38	117.0	73.1	98	167.9	104.9	58	218.8	136.7
19	16.1	10.1	79	67.0	41.9	39	117.9	73.7	99	168.8	105.5	59	219.6	137.2
20	17.0	10.6	80	67.8	42.4	40	118.7	74.2	200	169.6	106.0	60	220.5	137.8
21	17.8	11.1	81	68.7	42.9	141	119.6	74.7	201	170.5	106.5	261	221.3	138.3
22	18.7	11.7	82	69.5	43.5	42	120.4	75.2	02	171.3	107.0	62	222.2	138.8
23	19.5	12.2	83	70.4	44.0	43	121.3	75.8	03	172.2	107.6	63	223.0	139.4
24	20.4	12.7	84	71.2	44.5	44	122.1	76.3	04	173.0	108.1	64	223.9	139.9
25	21.2	13.2	85	72.1	45.0	45	123.0	76.8	05	173.8	108.6	65	224.7	140.4
26	22.0	13.8	86	72.9	45.6	46	123.8	77.4	06	174.7	109.2	66	225.6	141.0
27	22.9	14.3	87	73.8	46.1	47	124.7	77.9	07	175.5	109.7	67	226.4	141.5
28	23.7	14.8	88	74.6	46.6	48	125.5	78.4	08	176.4	110.2	68	227.3	142.0
29	24.6	15.4	89	75.5	47.2	49	126.4	79.0	09	177.2	110.8	69	228.1	142.5
30	25.4	15.9	90	76.3	47.7	50	127.2	79.5	10	178.1	111.3	70	229.0	143.1
31	26.3	16.4	91	77.2	48.2	151	128.1	80.0	211	178.9	111.8	271	229.8	143.6
32	27.1	17.0	92	78.0	48.8	52	128.9	80.5	12	179.8	112.3	72	230.7	144.1
33	28.0	17.5	93	78.9	49.3	53	129.8	81.1	13	180.6	112.9	73	231.5	144.7
34	28.8	18.0	94	79.7	49.8	54	130.6	81.6	14	181.5	113.4	74	232.4	145.2
35	29.7	18.5	95	80.6	50.3	55	131.4	82.1	15	182.3	113.9	75	233.2	145.7
36	30.5	19.1	96	81.4	50.9	56	132.3	82.7	16	183.2	114.5	76	234.1	146.3
37	31.4	19.6	97	82.3	51.4	57	133.1	83.2	17	184.0	115.0	77	234.9	146.8
38	32.2	20.1	98	83.1	51.9	58	134.0	83.7	18	184.9	115.5	78	235.8	147.3
39	33.1	20.7	99	84.0	52.5	59	134.8	84.3	19	185.7	116.1	79	236.6	147.8
40	33.9	21.2	100	84.8	53.0	60	135.7	84.8	20	186.6	116.6	80	237.5	148.4
41	34.8	21.7	101	85.7	53.5	161	136.5	85.3	221	187.4	117.1	281	238.3	148.9
42	35.6	22.3	02	86.5	54.1	62	137.4	85.8	22	188.3	117.6	82	239.1	149.4
43	36.5	22.8	03	87.3	54.6	63	138.2	86.4	23	189.1	118.2	83	240.0	150.0
44	37.3	23.3	04	88.2	55.1	64	139.1	86.9	24	190.0	118.7	84	240.8	150.5
45	38.2	23.8	05	89.0	55.6	65	139.9	87.4	25	190.8	119.2	85	241.7	151.0
46	39.0	24.4	06	89.9	56.2	66	140.8	88.0	26	191.7	119.8	86	242.5	151.6
47	39.9	24.9	07	90.7	56.7	67	141.6	88.5	27	192.5	120.3	87	243.4	152.1
48	40.7	25.4	08	91.6	57.2	68	142.5	89.0	28	193.4	120.8	88	244.2	152.6
49	41.6	26.0	09	92.4	57.8	69	143.3	89.6	29	194.2	121.4	89	245.1	153.1
50	42.4	26.5	10	93.3	58.3	70	144.2	90.1	30	195.1	121.9	90	245.9	153.7
51	43.3	27.0	111	94.1	58.8	171	145.0	90.6	231	195.9	122.4	291	246.8	154.2
52	44.1	27.6	12	95.0	59.4	72	145.9	91.1	32	196.7	122.9	92	247.6	154.7
53	44.9	28.1	13	95.8	59.9	73	146.7	91.7	33	197.6	123.5	93	248.5	155.3
54	45.8	28.6	14	96.7	60.4	74	147.6	92.2	34	198.4	124.0	94	249.3	155.8
55	46.6	29.1	15	97.5	60.9	75	148.4	92.7	35	199.3	124.5	95	250.2	156.3
56	47.5	29.7	16	98.4	61.5	76	149.3	93.3	36	200.1	125.1	96	251.0	156.9
57	48.3	30.2	17	99.2	62.0	77	150.1	93.8	37	201.0	125.6	97	251.9	157.4
58	49.2	30.7	18	100.1	62.5	78	151.0	94.3	38	201.8	126.1	98	252.7	157.9
59	50.0	31.3	19	100.9	63.1	79	151.8	94.9	39	202.7	126.7	99	253.6	158.4
60	50.9	31.8	20	101.8	63.6	80	152.6	95.4	40	203.5	127.2	300	254.4	159.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 58 Degrees.

Table II. Difference of Latitude and Departure for 33 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.5	61	51.2	33.2	121	101.5	65.9	181	151.8	98.6	241	202.1	131.3
2	01.7	01.1	62	52.0	33.8	22	102.3	66.4	82	152.6	99.1	42	203.0	131.8
3	02.5	01.6	63	52.8	34.3	23	103.2	67.0	83	153.5	99.7	43	203.8	132.3
4	03.4	02.2	64	53.7	34.9	24	104.0	67.5	84	154.3	100.2	44	204.6	132.9
5	04.2	02.7	65	54.5	35.4	25	104.8	68.1	85	155.2	100.8	45	205.5	133.4
6	05.0	03.3	66	55.4	35.9	26	105.7	68.6	86	156.0	101.3	46	206.3	134.0
7	05.9	03.8	67	56.2	36.5	27	106.5	69.2	87	156.8	101.8	47	207.2	134.5
8	06.7	04.4	68	57.0	37.0	28	107.3	69.7	88	157.7	102.4	48	208.0	135.1
9	07.5	04.9	69	57.9	37.6	29	108.2	70.3	89	158.5	102.9	49	208.8	135.6
10	08.4	05.4	70	58.7	38.1	30	109.0	70.8	90	159.3	103.5	50	209.7	136.2
11	09.2	06.0	71	59.5	38.7	131	109.9	71.3	191	160.2	104.0	251	210.5	136.7
12	10.1	06.5	72	60.4	39.2	32	110.7	71.9	92	161.0	104.6	52	211.3	137.2
13	10.9	07.1	73	61.2	39.8	33	111.5	72.4	93	161.9	105.1	53	212.2	137.8
14	11.7	07.6	74	62.1	40.3	34	112.4	73.0	94	162.7	105.7	54	213.0	138.3
15	12.6	08.2	75	62.9	40.8	35	113.2	73.5	95	163.5	106.2	55	213.9	138.9
16	13.4	08.7	76	63.7	41.4	36	114.1	74.1	96	164.4	106.7	56	214.7	139.4
17	14.3	09.3	77	64.6	41.9	37	114.9	74.6	97	165.2	107.3	57	215.5	140.0
18	15.1	09.8	78	65.4	42.5	38	115.7	75.2	98	166.1	107.8	58	216.4	140.5
19	15.9	10.3	79	66.3	43.0	39	116.6	75.7	99	166.9	108.4	59	217.2	141.1
20	16.8	10.9	80	67.1	43.6	40	117.4	76.2	200	167.7	108.9	60	218.1	141.6
21	17.6	11.4	81	67.9	44.1	141	118.3	76.8	201	168.6	109.5	261	218.9	142.2
22	18.5	12.0	82	68.8	44.7	42	119.1	77.3	02	169.4	110.0	62	219.7	142.7
23	19.3	12.5	83	69.6	45.2	43	119.9	77.9	03	170.3	110.6	63	220.6	143.2
24	20.1	13.1	84	70.4	45.7	44	120.8	78.4	04	171.1	111.1	64	221.4	143.8
25	21.0	13.6	85	71.3	46.3	45	121.6	79.0	05	171.9	111.7	65	222.2	144.3
26	21.8	14.2	86	72.1	46.8	46	122.4	79.5	06	172.8	112.2	66	223.1	144.9
27	22.6	14.7	87	73.0	47.4	47	123.3	80.1	07	173.6	112.7	67	223.9	145.4
28	23.5	15.2	88	73.8	47.9	48	124.1	80.6	08	174.4	113.3	68	224.8	146.0
29	24.3	15.8	89	74.6	48.5	49	125.0	81.2	09	175.3	113.8	69	225.6	146.5
30	25.2	16.3	90	75.5	49.0	50	125.8	81.7	10	176.1	114.4	70	226.4	147.1
31	26.0	16.9	91	76.3	49.6	151	126.6	82.2	211	177.0	114.9	271	227.3	147.6
32	26.8	17.4	92	77.2	50.1	52	127.5	82.8	12	177.8	115.5	72	228.1	148.1
33	27.7	18.0	93	78.0	50.7	53	128.3	83.3	13	178.6	116.0	73	229.0	148.7
34	28.5	18.5	94	78.8	51.2	54	129.2	83.9	14	179.5	116.6	74	229.8	149.2
35	29.4	19.1	95	79.7	51.7	55	130.0	84.4	15	180.3	117.1	75	230.6	149.8
36	30.2	19.6	96	80.5	52.3	56	130.8	85.0	16	181.2	117.6	76	231.5	150.3
37	31.0	20.2	97	81.4	52.8	57	131.7	85.5	17	182.0	118.2	77	232.3	150.9
38	31.9	20.7	98	82.2	53.4	58	132.5	86.1	18	182.8	118.7	78	233.2	151.4
39	32.7	21.2	99	83.0	53.9	59	133.3	86.6	19	183.7	119.3	79	234.0	152.0
40	33.5	21.8	100	83.9	54.5	60	134.2	87.1	20	184.5	119.8	80	234.8	152.5
41	34.4	22.3	101	84.7	55.0	161	135.0	87.7	221	185.3	120.4	281	235.7	153.0
42	35.2	22.9	02	85.5	55.6	62	135.9	88.2	22	186.2	120.9	82	236.5	153.6
43	36.1	23.4	03	86.4	56.1	63	136.7	88.8	23	187.0	121.5	83	237.3	154.1
44	36.9	24.0	04	87.2	56.6	64	137.5	89.3	24	187.9	122.0	84	238.2	154.7
45	37.7	24.5	05	88.1	57.2	65	138.4	89.9	25	188.7	122.5	85	239.0	155.2
46	38.6	25.1	06	88.9	57.7	66	139.2	90.4	26	189.5	123.1	86	239.9	155.8
47	39.4	25.6	07	89.7	58.3	67	140.1	91.0	27	190.4	123.6	87	240.7	156.3
48	40.3	26.1	08	90.6	58.8	68	140.9	91.5	28	191.2	124.2	88	241.5	156.9
49	41.1	26.7	09	91.4	59.4	69	141.7	92.0	29	192.1	124.7	89	242.4	157.4
50	41.9	27.2	10	92.3	59.9	70	142.6	92.6	30	192.9	125.3	90	243.2	157.9
51	42.8	27.8	111	93.1	60.5	171	143.4	93.1	231	193.7	125.8	291	244.1	158.5
52	43.6	28.3	12	93.9	61.0	72	144.3	93.7	32	194.6	126.4	92	244.9	159.0
53	44.4	28.9	13	94.8	61.5	73	145.1	94.2	33	195.4	126.9	93	245.7	159.6
54	45.3	29.4	14	95.6	62.1	74	145.9	94.8	34	196.2	127.4	94	246.6	160.1
55	46.1	30.0	15	96.4	62.6	75	146.8	95.3	35	197.1	128.0	95	247.4	160.7
56	47.0	30.5	16	97.3	63.2	76	147.6	95.9	36	197.9	128.5	96	248.2	161.2
57	47.8	31.0	17	98.1	63.7	77	148.4	96.4	37	198.8	129.1	97	249.1	161.8
58	48.6	31.6	18	99.0	64.3	78	149.3	96.9	38	199.6	129.6	98	249.9	162.3
59	49.5	32.1	19	99.8	64.8	79	150.1	97.5	39	200.4	130.2	99	250.8	162.8
60	50.3	32.7	20	100.6	65.4	80	151.0	98.0	40	201.3	130.7	300	251.6	163.4
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 57 Degrees.

TABLE II. Difference of Latitude and Departure for 34 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	50.6	34.1	121	100.3	67.7	181	150.1	101.2	241	199.8	134.8
2	01.7	01.1	62	51.4	34.7	22	101.1	68.2	82	150.9	101.8	42	200.6	135.3
3	02.5	01.7	63	52.2	35.2	23	102.0	68.8	83	151.7	102.3	43	201.5	135.9
4	03.3	02.2	64	53.1	35.8	24	102.8	69.3	84	152.5	102.9	44	202.3	136.4
5	04.1	02.8	65	53.9	36.3	25	103.6	69.9	85	153.4	103.5	45	203.1	137.0
6	05.0	03.4	66	54.7	36.9	26	104.5	70.5	86	154.2	104.0	46	203.9	137.6
7	05.8	03.9	67	55.5	37.5	27	105.3	71.0	87	155.0	104.6	47	204.8	138.1
8	06.6	04.5	68	56.4	38.0	28	106.1	71.6	88	155.9	105.1	48	205.6	138.7
9	07.5	05.0	69	57.2	38.6	29	106.9	72.1	89	156.7	105.7	49	206.4	139.2
10	08.3	05.6	70	58.0	39.1	30	107.8	72.7	90	157.5	106.2	50	207.3	139.8
11	09.1	06.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	09.9	06.7	72	59.7	40.3	32	109.4	73.8	92	159.2	107.4	52	208.9	140.9
13	10.8	07.3	73	60.5	40.8	33	110.3	74.4	93	160.0	107.9	53	209.7	141.5
14	11.6	07.8	74	61.3	41.4	34	111.1	74.9	94	160.8	108.5	54	210.6	142.0
15	12.4	08.4	75	62.2	41.9	35	111.9	75.5	95	161.7	109.0	55	211.4	142.6
16	13.3	08.9	76	63.0	42.5	36	112.7	76.1	96	162.5	109.6	56	212.2	143.2
17	14.1	09.5	77	63.8	43.1	37	113.6	76.6	97	163.3	110.2	57	213.1	143.7
18	14.9	10.1	78	64.7	43.6	38	114.4	77.2	98	164.1	110.7	58	213.9	144.3
19	15.8	10.6	79	65.5	44.2	39	115.2	77.7	99	165.0	111.3	59	214.7	144.8
20	16.6	11.2	80	66.3	44.7	40	116.1	78.3	200	165.8	111.8	60	215.5	145.4
21	17.4	11.7	81	67.2	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	145.9
22	18.2	12.3	82	68.0	45.9	42	117.7	79.4	02	167.5	113.0	62	217.2	146.5
23	19.1	12.9	83	68.8	46.4	43	118.6	80.0	03	168.3	113.5	63	218.0	147.1
24	19.9	13.4	84	69.6	47.0	44	119.4	80.5	04	169.1	114.1	64	218.9	147.6
25	20.7	14.0	85	70.5	47.5	45	120.2	81.1	05	170.0	114.6	65	219.7	148.2
26	21.6	14.5	86	71.3	48.1	46	121.0	81.6	06	170.8	115.2	66	220.5	148.7
27	22.4	15.1	87	72.1	48.6	47	121.9	82.2	07	171.6	115.8	67	221.4	149.3
28	23.2	15.7	88	73.0	49.2	48	122.7	82.8	08	172.4	116.3	68	222.2	149.9
29	24.0	16.2	89	73.8	49.8	49	123.5	83.3	09	173.3	116.9	69	223.0	150.4
30	24.9	16.8	90	74.6	50.3	50	124.4	83.9	10	174.1	117.4	70	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	52	126.0	85.0	12	175.8	118.5	72	225.5	152.1
33	27.4	18.5	93	77.1	52.0	53	126.8	85.6	13	176.6	119.1	73	226.3	152.7
34	28.2	19.0	94	77.9	52.6	54	127.7	86.1	14	177.4	119.7	74	227.2	153.2
35	29.0	19.6	95	78.8	53.1	55	128.5	86.7	15	178.2	120.2	75	228.0	153.8
36	29.8	20.1	96	79.6	53.7	56	129.3	87.2	16	179.1	120.8	76	228.8	154.3
37	30.7	20.7	97	80.4	54.2	57	130.2	87.8	17	179.9	121.3	77	229.6	154.9
38	31.5	21.2	98	81.2	54.8	58	131.0	88.4	18	180.7	121.9	78	230.5	155.5
39	32.3	21.8	99	82.1	55.4	59	131.8	88.9	19	181.6	122.5	79	231.3	156.0
40	33.2	22.4	100	82.9	55.9	60	132.6	89.5	20	182.4	123.0	80	232.1	156.6
41	34.0	22.9	101	83.7	56.5	161	133.5	90.0	221	183.2	123.6	281	233.0	157.1
42	34.8	23.5	02	84.6	57.0	62	134.3	90.6	22	184.0	124.1	82	233.8	157.7
43	35.6	24.0	03	85.4	57.6	63	135.1	91.1	23	184.9	124.7	83	234.6	158.3
44	36.5	24.6	04	86.2	58.2	64	136.0	91.7	24	185.7	125.3	84	235.4	158.8
45	37.3	25.2	05	87.0	58.7	65	136.8	92.3	25	186.5	125.8	85	236.3	159.4
46	38.1	25.7	06	87.9	59.3	66	137.6	92.8	26	187.4	126.4	86	237.1	159.9
47	39.0	26.3	07	88.7	59.8	67	138.4	93.4	27	188.2	126.9	87	237.9	160.5
48	39.8	26.8	08	89.5	60.4	68	139.3	93.9	28	189.0	127.5	88	238.8	161.0
49	40.6	27.4	09	90.4	61.0	69	140.1	94.5	29	189.8	128.1	89	239.6	161.6
50	41.4	28.0	10	91.2	61.5	70	140.9	95.1	30	190.7	128.6	90	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	12	92.9	62.6	72	142.6	96.2	32	192.3	129.7	92	242.1	163.3
53	43.9	29.6	13	93.7	63.2	73	143.4	96.7	33	193.2	130.3	93	242.9	163.8
54	44.8	30.2	14	94.5	63.7	74	144.3	97.3	34	194.0	130.9	94	243.7	164.4
55	45.6	30.8	15	95.3	64.3	75	145.1	97.9	35	194.8	131.4	95	244.6	165.0
56	46.4	31.3	16	96.2	64.9	76	145.9	98.4	36	195.7	132.0	96	245.4	165.5
57	47.3	31.9	17	97.0	65.4	77	146.7	99.0	37	196.5	132.5	97	246.2	166.1
58	48.1	32.4	18	97.8	66.0	78	147.6	99.5	38	197.3	133.1	98	247.1	166.6
59	48.9	33.0	19	98.7	66.5	79	148.4	100.1	39	198.1	133.6	99	247.9	167.2
60	49.7	33.6	20	99.5	67.1	80	149.2	100.7	40	199.0	134.2	300	248.7	167.8
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 56 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.0	35.0	121	99.1	69.4	181	148.3	103.8	241	197.4	138.2
2	01.6	01.1	62	50.8	35.6	22	99.9	70.0	82	149.1	104.4	42	198.2	138.8
3	02.5	01.7	63	51.6	36.1	23	100.8	70.5	83	149.9	105.0	43	199.1	139.4
4	03.3	02.3	64	52.4	36.7	24	101.6	71.1	84	150.7	105.5	44	199.9	140.0
5	04.1	02.9	65	53.2	37.3	25	102.4	71.7	85	151.5	106.1	45	200.7	140.5
6	04.9	03.4	66	54.1	37.9	26	103.2	72.3	86	152.4	106.7	46	201.5	141.1
7	05.7	04.0	67	54.9	38.4	27	104.0	72.8	87	153.2	107.3	47	202.3	141.7
8	06.6	04.6	68	55.7	39.0	28	104.9	73.4	88	154.0	107.8	48	203.1	142.2
9	07.4	05.2	69	56.5	39.6	29	105.7	74.0	89	154.8	108.4	49	204.0	142.8
10	08.2	05.7	70	57.3	40.2	30	106.5	74.6	90	155.6	109.0	50	204.8	143.4
11	09.0	06.3	71	58.2	40.7	131	107.3	75.1	191	156.5	109.6	251	205.6	144.0
12	09.8	06.9	72	59.0	41.3	32	108.1	75.7	92	157.3	110.1	52	206.4	144.5
13	10.6	07.5	73	59.8	41.9	33	108.9	76.3	93	158.1	110.7	53	207.2	145.1
14	11.5	08.0	74	60.6	42.4	34	109.8	76.9	94	158.9	111.3	54	208.1	145.7
15	12.3	08.6	75	61.4	43.0	35	110.6	77.4	95	159.7	111.8	55	208.9	146.3
16	13.1	09.2	76	62.3	43.6	36	111.4	78.0	96	160.6	112.4	56	209.7	146.8
17	13.9	09.8	77	63.1	44.2	37	112.2	78.6	97	161.4	113.0	57	210.5	147.4
18	14.7	10.3	78	63.9	44.7	38	113.0	79.2	98	162.2	113.6	58	211.3	148.0
19	15.6	10.9	79	64.7	45.3	39	113.9	79.7	99	163.0	114.1	59	212.2	148.6
20	16.4	11.5	80	65.5	45.9	40	114.7	80.3	200	163.8	114.7	60	213.0	149.1
21	17.2	12.0	81	66.4	46.5	141	115.5	80.9	201	164.6	115.3	261	213.8	149.7
22	18.0	12.6	82	67.2	47.0	42	116.3	81.4	02	165.5	115.9	62	214.6	150.3
23	18.8	13.2	83	68.0	47.6	43	117.1	82.0	03	166.3	116.4	63	215.4	150.9
24	19.7	13.8	84	68.8	48.2	44	118.0	82.6	04	167.1	117.0	64	216.3	151.4
25	20.5	14.3	85	69.6	48.8	45	118.8	83.2	05	167.9	117.6	65	217.1	152.0
26	21.3	14.9	86	70.4	49.3	46	119.6	83.7	06	168.7	118.2	66	217.9	152.6
27	22.1	15.5	87	71.3	49.9	47	120.4	84.3	07	169.6	118.7	67	218.7	153.1
28	22.9	16.1	88	72.1	50.5	48	121.2	84.9	08	170.4	119.3	68	219.5	153.7
29	23.8	16.6	89	72.9	51.0	49	122.1	85.5	09	171.2	119.9	69	220.4	154.3
30	24.6	17.2	90	73.7	51.6	50	122.9	86.0	10	172.0	120.5	70	221.2	154.9
31	25.4	17.8	91	74.5	52.2	151	123.7	86.6	211	172.8	121.0	271	222.0	155.4
32	26.2	18.4	92	75.4	52.8	52	124.5	87.2	12	173.7	121.6	72	222.8	156.0
33	27.0	18.9	93	76.2	53.3	53	125.3	87.8	13	174.5	122.2	73	223.6	156.6
34	27.9	19.5	94	77.0	53.9	54	126.1	88.3	14	175.3	122.7	74	224.4	157.2
35	28.7	20.1	95	77.8	54.5	55	127.0	88.9	15	176.1	123.3	75	225.3	157.7
36	29.5	20.6	96	78.6	55.1	56	127.8	89.5	16	176.9	123.9	76	226.1	158.3
37	30.3	21.2	97	79.5	55.6	57	128.6	90.1	17	177.8	124.5	77	226.9	158.9
38	31.1	21.8	98	80.3	56.2	58	129.4	90.6	18	178.6	125.0	78	227.7	159.5
39	31.9	22.4	99	81.1	56.8	59	130.2	91.2	19	179.4	125.6	79	228.5	160.0
40	32.8	22.9	100	81.9	57.4	60	131.1	91.8	20	180.2	126.2	80	229.4	160.6
41	33.6	23.5	101	82.7	57.9	101	131.9	92.3	221	181.0	126.8	281	230.2	161.2
42	34.4	24.1	02	83.6	58.5	62	132.7	92.9	22	181.9	127.3	82	231.0	161.7
43	35.2	24.7	03	84.4	59.1	63	133.5	93.5	23	182.7	127.9	83	231.8	162.3
44	36.0	25.2	04	85.2	59.7	64	134.3	94.1	24	183.5	128.5	84	232.6	162.9
45	36.9	25.8	05	86.0	60.2	65	135.2	94.6	25	184.3	129.1	85	233.5	163.5
46	37.7	26.4	06	86.8	60.8	66	136.0	95.2	26	185.1	129.6	86	234.3	164.0
47	38.5	27.0	07	87.6	61.4	67	136.8	95.8	27	185.9	130.2	87	235.1	164.6
48	39.3	27.5	08	88.5	61.9	68	137.6	96.4	28	186.8	130.8	88	235.9	165.2
49	40.1	28.1	09	89.3	62.5	69	138.4	96.9	29	187.6	131.3	89	236.7	165.8
50	41.0	28.7	10	90.1	63.1	70	139.3	97.5	30	188.4	131.9	90	237.6	166.3
51	41.8	29.3	111	90.9	63.7	171	140.1	98.1	231	189.2	132.5	291	238.4	166.9
52	42.6	29.8	12	91.7	64.2	72	140.9	98.7	32	190.0	133.1	92	239.2	167.5
53	43.4	30.4	13	92.6	64.8	73	141.7	99.2	33	190.9	133.6	93	240.0	168.1
54	44.2	31.0	14	93.4	65.4	74	142.5	99.8	34	191.7	134.2	94	240.8	168.6
55	45.1	31.5	15	94.2	66.0	75	143.4	100.4	35	192.5	134.8	95	241.6	169.2
56	45.9	32.1	16	95.0	66.5	76	144.2	100.9	36	193.3	135.4	96	242.5	169.8
57	46.7	32.7	17	95.8	67.1	77	145.0	101.5	37	194.1	135.9	97	243.3	170.4
58	47.5	33.3	18	96.7	67.7	78	145.8	102.1	38	195.0	136.5	98	244.1	170.9
59	48.3	33.8	19	97.5	68.3	79	146.6	102.7	39	195.8	137.1	99	244.9	171.5
60	49.1	34.4	20	98.3	68.8	80	147.4	103.2	40	196.6	137.7	300	245.7	172.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	49.4	35.9	121	97.9	71.1	181	146.4	106.4	241	195.0	141.7
2	01.6	01.2	62	50.2	36.4	22	98.7	71.7	82	147.2	107.0	42	195.8	142.2
3	02.4	01.8	63	51.0	37.0	23	99.5	72.3	83	148.1	107.6	43	196.6	142.8
4	03.2	02.4	64	51.8	37.6	24	100.3	72.9	84	148.9	108.2	44	197.4	143.4
5	04.0	02.9	65	52.6	38.2	25	101.1	73.5	85	149.7	108.7	45	198.2	144.0
6	04.9	03.5	66	53.4	38.8	26	101.9	74.1	86	150.5	109.3	46	199.0	144.6
7	05.7	04.1	67	54.2	39.4	27	102.7	74.6	87	151.3	109.9	47	199.8	145.2
8	06.5	04.7	68	55.0	40.0	28	103.6	75.2	88	152.1	110.5	48	200.6	145.8
9	07.3	05.3	69	55.8	40.6	29	104.4	75.8	89	152.9	111.1	49	201.4	146.4
10	08.1	05.9	70	56.6	41.1	30	105.2	76.4	90	153.7	111.7	50	202.3	146.9
11	08.9	06.5	71	57.4	41.7	131	106.0	77.0	191	154.5	112.3	251	203.1	147.5
12	09.7	07.1	72	58.2	42.3	32	106.8	77.6	92	155.3	112.9	52	203.9	148.1
13	10.5	07.6	73	59.1	42.9	33	107.6	78.2	93	156.1	113.4	53	204.7	148.7
14	11.3	08.2	74	59.9	43.5	34	108.4	78.8	94	156.9	114.0	54	205.5	149.3
15	12.1	08.8	75	60.7	44.1	35	109.2	79.4	95	157.8	114.6	55	206.3	149.9
16	12.9	09.4	76	61.5	44.7	36	110.0	79.9	96	158.6	115.2	56	207.1	150.5
17	13.8	10.0	77	62.3	45.3	37	110.8	80.5	97	159.4	115.8	57	207.9	151.1
18	14.6	10.6	78	63.1	45.8	38	111.6	81.1	98	160.2	116.4	58	208.7	151.6
19	15.4	11.2	79	63.9	46.4	39	112.5	81.7	99	161.0	117.0	59	209.5	152.2
20	16.2	11.8	80	64.7	47.0	40	113.3	82.3	200	161.8	117.6	60	210.3	152.8
21	17.0	12.3	81	65.5	47.6	141	114.1	82.9	201	162.6	118.1	261	211.2	153.4
22	17.8	12.9	82	66.3	48.2	42	114.9	83.5	02	163.4	118.7	62	212.0	154.0
23	18.6	13.5	83	67.1	48.8	43	115.7	84.1	03	164.2	119.3	63	212.8	154.6
24	19.4	14.1	84	68.0	49.4	44	116.5	84.6	04	165.0	119.9	64	213.6	155.2
25	20.2	14.7	85	68.8	50.0	45	117.3	85.2	05	165.8	120.5	65	214.4	155.8
26	21.0	15.3	86	69.6	50.5	46	118.1	85.8	06	166.7	121.1	66	215.2	156.4
27	21.8	15.9	87	70.4	51.1	47	118.9	86.4	07	167.5	121.7	67	216.0	156.9
28	22.7	16.5	88	71.2	51.7	48	119.7	87.0	08	168.3	122.3	68	216.8	157.5
29	23.5	17.0	89	72.0	52.3	49	120.5	87.6	09	169.1	122.8	69	217.6	158.1
30	24.3	17.6	90	72.8	52.9	50	121.4	88.2	10	169.9	123.4	70	218.4	158.7
31	25.1	18.2	91	73.6	53.5	151	122.2	88.8	211	170.7	124.0	271	219.2	159.3
32	25.9	18.8	92	74.4	54.1	52	123.0	89.3	12	171.5	124.6	72	220.1	159.9
33	26.7	19.4	93	75.2	54.7	53	123.8	89.9	13	172.3	125.2	73	220.9	160.5
34	27.5	20.0	94	76.0	55.3	54	124.6	90.5	14	173.1	125.8	74	221.7	161.1
35	28.3	20.6	95	76.9	55.8	55	125.4	91.1	15	173.9	126.4	75	222.5	161.6
36	29.1	21.2	96	77.7	56.4	56	126.2	91.7	16	174.7	127.0	76	223.3	162.2
37	29.9	21.7	97	78.5	57.0	57	127.0	92.3	17	175.6	127.5	77	224.1	162.8
38	30.7	22.3	98	79.3	57.6	58	127.8	92.9	18	176.4	128.1	78	224.9	163.4
39	31.6	22.9	99	80.1	58.2	59	128.6	93.5	19	177.2	128.7	79	225.7	164.0
40	32.4	23.5	100	80.9	58.8	60	129.4	94.0	20	178.0	129.3	80	226.5	164.6
41	33.2	24.1	101	81.7	59.4	161	130.3	94.6	221	178.8	129.9	281	227.3	165.2
42	34.0	24.7	02	82.5	60.0	62	131.1	95.2	22	179.6	130.5	82	228.1	165.8
43	34.8	25.3	03	83.3	60.5	63	131.9	95.8	23	180.4	131.1	83	229.0	166.3
44	35.6	25.9	04	84.1	61.1	64	132.7	96.4	24	181.2	131.7	84	229.8	166.9
45	36.4	26.5	05	84.9	61.7	65	133.5	97.0	25	182.0	132.3	85	230.6	167.5
46	37.2	27.0	06	85.8	62.3	66	134.3	97.6	26	182.8	132.8	86	231.4	168.1
47	38.0	27.6	07	86.6	62.9	67	135.1	98.2	27	183.6	133.4	87	232.2	168.7
48	38.8	28.2	08	87.4	63.5	68	135.9	98.7	28	184.5	134.0	88	233.0	169.3
49	39.6	28.8	09	88.2	64.1	69	136.7	99.3	29	185.3	134.6	89	233.8	169.9
50	40.5	29.4	10	89.0	64.7	70	137.5	99.9	30	186.1	135.2	90	234.6	170.5
51	41.3	30.0	111	89.8	65.2	171	138.3	100.5	231	186.9	135.8	291	235.4	171.0
52	42.1	30.6	12	90.6	65.8	72	139.2	101.1	32	187.7	136.4	92	236.2	171.6
53	42.9	31.2	13	91.4	66.4	73	140.0	101.7	33	188.5	137.0	93	237.0	172.2
54	43.7	31.7	14	92.2	67.0	74	140.8	102.3	34	189.3	137.5	94	237.9	172.8
55	44.5	32.3	15	93.0	67.6	75	141.6	102.9	35	190.1	138.1	95	238.7	173.4
56	45.3	32.9	16	93.8	68.2	76	142.4	103.5	36	190.9	138.7	96	239.5	174.0
57	46.1	33.5	17	94.7	68.8	77	143.2	104.0	37	191.7	139.3	97	240.3	174.6
58	46.9	34.1	18	95.5	69.4	78	144.0	104.6	38	192.5	139.9	98	241.1	175.2
59	47.7	34.7	19	96.3	69.9	79	144.8	105.2	39	193.4	140.5	99	241.9	175.7
60	48.5	35.3	20	97.1	70.5	80	145.6	105.8	40	194.2	141.1	300	242.7	176.3
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 54 Degrees.

TABLE II. Difference of Latitude and Departure for 37 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	48.7	36.7	121	96.6	72.8	181	144.6	108.9	241	192.5	145.0
2	01.6	01.2	62	49.5	37.3	22	97.4	73.4	82	145.4	109.5	42	193.3	145.6
3	02.4	01.8	63	50.3	37.9	23	98.2	74.0	83	146.2	110.1	43	194.1	146.2
4	03.2	02.4	64	51.1	38.5	24	99.0	74.6	84	146.9	110.7	44	194.9	146.8
5	04.0	03.0	65	51.9	39.1	25	99.8	75.2	85	147.7	111.3	45	195.7	147.4
6	04.8	03.6	66	52.7	39.7	26	100.6	75.8	86	148.5	111.9	46	196.5	148.0
7	05.6	04.2	67	53.5	40.3	27	101.4	76.4	87	149.3	112.5	47	197.3	148.6
8	06.4	04.8	68	54.3	40.9	28	102.2	77.0	88	150.1	113.1	48	198.1	149.3
9	07.2	05.4	69	55.1	41.5	29	103.0	77.6	89	150.9	113.7	49	198.9	149.9
10	08.0	06.0	70	55.9	42.1	30	103.8	78.2	90	151.7	114.3	50	199.7	150.5
11	08.8	06.6	71	56.7	42.7	131	104.6	78.8	191	152.5	114.9	251	200.5	151.1
12	09.6	07.2	72	57.5	43.3	32	105.4	79.4	92	153.3	115.5	52	201.3	151.7
13	10.4	07.8	73	58.3	43.9	33	106.2	80.0	93	154.1	116.2	53	202.1	152.3
14	11.2	08.4	74	59.1	44.5	34	107.0	80.6	94	154.9	116.8	54	202.9	152.9
15	12.0	09.0	75	59.9	45.1	35	107.8	81.2	95	155.7	117.4	55	203.7	153.5
16	12.8	09.6	76	60.7	45.7	36	108.6	81.8	96	156.5	118.0	56	204.5	154.1
17	13.6	10.2	77	61.5	46.3	37	109.4	82.4	97	157.3	118.6	57	205.2	154.7
18	14.4	10.8	78	62.3	46.9	38	110.2	83.1	98	158.1	119.2	58	206.0	155.3
19	15.2	11.4	79	63.1	47.5	39	111.0	83.7	99	158.9	119.8	59	206.8	155.9
20	16.0	12.0	80	63.9	48.1	40	111.8	84.3	200	159.7	120.4	60	207.6	156.5
21	16.8	12.6	81	64.7	48.7	141	112.6	84.9	201	160.5	121.0	261	208.4	157.1
22	17.6	13.2	82	65.5	49.3	42	113.4	85.5	02	161.3	121.6	62	209.2	157.7
23	18.4	13.8	83	66.3	50.0	43	114.2	86.1	03	162.1	122.2	63	210.0	158.3
24	19.2	14.4	84	67.1	50.6	44	115.0	86.7	04	162.9	122.8	64	210.8	158.9
25	20.0	15.0	85	67.9	51.2	45	115.8	87.3	05	163.7	123.4	65	211.6	159.5
26	20.8	15.6	86	68.7	51.8	46	116.6	87.9	06	164.5	124.0	66	212.4	160.1
27	21.6	16.2	87	69.5	52.4	47	117.4	88.5	07	165.3	124.6	67	213.2	160.7
28	22.4	16.9	88	70.3	53.0	48	118.2	89.1	08	166.1	125.2	68	214.0	161.3
29	23.2	17.5	89	71.1	53.6	49	119.0	89.7	09	166.9	125.8	69	214.8	161.9
30	24.0	18.1	90	71.9	54.2	50	119.8	90.3	10	167.7	126.4	70	215.6	162.5
31	24.8	18.7	91	72.7	54.8	151	120.6	90.9	211	168.5	127.0	271	216.4	163.1
32	25.6	19.3	92	73.5	55.4	52	121.4	91.5	12	169.3	127.6	72	217.2	163.7
33	26.4	19.9	93	74.3	56.0	53	122.2	92.1	13	170.1	128.2	73	218.0	164.3
34	27.2	20.5	94	75.1	56.6	54	123.0	92.7	14	170.9	128.8	74	218.8	164.9
35	28.0	21.1	95	75.9	57.2	55	123.8	93.3	15	171.7	129.4	75	219.6	165.5
36	28.8	21.7	96	76.7	57.8	56	124.6	93.9	16	172.5	130.0	76	220.4	166.1
37	29.5	22.3	97	77.5	58.4	57	125.4	94.5	17	173.3	130.6	77	221.2	166.7
38	30.3	22.9	98	78.3	59.0	58	126.2	95.1	18	174.1	131.2	78	222.0	167.3
39	31.1	23.5	99	79.1	59.6	59	127.0	95.7	19	174.9	131.8	79	222.8	167.9
40	31.9	24.1	100	79.9	60.2	60	127.8	96.3	20	175.7	132.4	80	223.6	168.5
41	32.7	24.7	101	80.7	60.8	161	128.6	96.9	221	176.5	133.0	281	224.4	169.1
42	33.5	25.3	02	81.5	61.4	62	129.4	97.5	22	177.3	133.6	82	225.2	169.7
43	34.3	25.9	03	82.3	62.0	63	130.2	98.1	23	178.1	134.2	83	226.0	170.3
44	35.1	26.5	04	83.1	62.6	64	131.0	98.7	24	178.9	134.8	84	226.8	170.9
45	35.9	27.1	05	83.9	63.2	65	131.8	99.3	25	179.7	135.4	85	227.6	171.5
46	36.7	27.7	06	84.7	63.8	66	132.6	99.9	26	180.5	136.0	86	228.4	172.1
47	37.5	28.3	07	85.5	64.4	67	133.4	100.5	27	181.3	136.6	87	229.2	172.7
48	38.3	28.9	08	86.3	65.0	68	134.2	101.1	28	182.1	137.2	88	230.0	173.3
49	39.1	29.5	09	87.1	65.6	69	135.0	101.7	29	182.9	137.8	89	230.8	173.9
50	39.9	30.1	10	87.8	66.2	70	135.8	102.3	30	183.7	138.4	90	231.6	174.5
51	40.7	30.7	111	88.6	66.8	171	136.6	102.9	231	184.5	139.0	291	232.4	175.1
52	41.5	31.3	12	89.4	67.4	72	137.4	103.5	32	185.3	139.6	92	233.2	175.7
53	42.3	31.9	13	90.2	68.0	73	138.2	104.1	33	186.1	140.2	93	234.0	176.3
54	43.1	32.5	14	91.0	68.6	74	139.0	104.7	34	186.9	140.8	94	234.8	176.9
55	43.9	33.1	15	91.8	69.2	75	139.8	105.3	35	187.7	141.4	95	235.6	177.5
56	44.7	33.7	16	92.6	69.8	76	140.6	105.9	36	188.5	142.0	96	236.4	178.1
57	45.5	34.3	17	93.4	70.4	77	141.4	106.5	37	189.3	142.6	97	237.2	178.7
58	46.3	34.9	18	94.2	71.0	78	142.2	107.1	38	190.1	143.2	98	238.0	179.3
59	47.1	35.5	19	95.0	71.6	79	143.0	107.7	39	190.9	143.8	99	238.8	179.9
60	47.9	36.1	20	95.8	72.2	80	143.8	108.3	40	191.7	144.4	300	239.6	180.5
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 53 Degrees.

Table II. Difference of Latitude and Departure for 38 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	48.1	37.6	121	95.3	74.5	181	142.6	111.4	241	189.9	148.4
2	01.6	01.2	62	48.9	38.2	22	96.1	75.1	82	143.4	112.1	42	190.7	149.0
3	02.4	01.8	63	49.6	38.8	23	96.9	75.7	83	144.2	112.7	43	191.5	149.6
4	03.2	02.5	64	50.4	39.4	24	97.7	76.3	84	145.0	113.3	44	192.3	150.2
5	03.9	03.1	65	51.2	40.0	25	98.5	77.0	85	145.8	113.9	45	193.1	150.8
6	04.7	03.7	66	52.0	40.6	26	99.3	77.6	86	146.6	114.5	46	193.9	151.5
7	05.5	04.3	67	52.8	41.2	27	100.1	78.2	87	147.4	115.1	47	194.6	152.1
8	06.3	04.9	68	53.6	41.9	28	100.9	78.8	88	148.1	115.7	48	195.4	152.7
9	07.1	05.5	69	54.4	42.5	29	101.7	79.4	89	148.9	116.4	49	196.2	153.3
10	07.9	06.2	70	55.2	43.1	30	102.4	80.0	90	149.7	117.0	50	197.0	153.9
11	08.7	06.8	71	55.9	43.7	131	103.2	80.7	191	150.5	117.6	251	197.8	154.5
12	09.5	07.4	72	56.7	44.3	32	104.0	81.3	92	151.3	118.2	52	198.6	155.1
13	10.2	08.0	73	57.5	44.9	33	104.8	81.9	93	152.1	118.8	53	199.4	155.8
14	11.0	08.6	74	58.3	45.6	34	105.6	82.5	94	152.9	119.4	54	200.2	156.4
15	11.8	09.2	75	59.1	46.2	35	106.4	83.1	95	153.7	120.1	55	200.9	157.0
16	12.6	09.9	76	59.9	46.8	36	107.2	83.7	96	154.5	120.7	56	201.7	157.6
17	13.4	10.5	77	60.7	47.4	37	108.0	84.3	97	155.2	121.3	57	202.5	158.2
18	14.2	11.1	78	61.5	48.0	38	108.7	85.0	98	156.0	121.9	58	203.3	158.8
19	15.0	11.7	79	62.3	48.6	39	109.5	85.6	99	156.8	122.5	59	204.1	159.5
20	15.8	12.3	80	63.0	49.3	40	110.3	86.2	200	157.6	123.1	60	204.9	160.1
21	16.5	12.9	81	63.8	49.9	141	111.1	86.8	201	158.4	123.7	261	205.7	160.7
22	17.3	13.5	82	64.6	50.5	42	111.9	87.4	02	159.2	124.4	62	206.5	161.3
23	18.1	14.2	83	65.4	51.1	43	112.7	88.0	03	160.0	125.0	63	207.2	161.9
24	18.9	14.8	84	66.2	51.7	44	113.5	88.7	04	160.8	125.6	64	208.0	162.5
25	19.7	15.4	85	67.0	52.3	45	114.3	89.3	05	161.5	126.2	65	208.8	163.2
26	20.5	16.0	86	67.8	52.9	46	115.0	89.9	06	162.3	126.8	66	209.6	163.8
27	21.3	16.6	87	68.6	53.6	47	115.8	90.5	07	163.1	127.4	67	210.4	164.4
28	22.1	17.2	88	69.3	54.2	48	116.6	91.1	08	163.9	128.1	68	211.2	165.0
29	22.9	17.9	89	70.1	54.8	49	117.4	91.7	09	164.7	128.7	69	212.0	165.6
30	23.6	18.5	90	70.9	55.4	50	118.2	92.3	10	165.5	129.3	70	212.8	166.2
31	24.4	19.1	91	71.7	56.0	151	119.0	93.0	211	166.3	129.9	271	213.6	166.8
32	25.2	19.7	92	72.5	56.6	52	119.8	93.6	12	167.1	130.5	72	214.3	167.5
33	26.0	20.3	93	73.3	57.3	53	120.6	94.2	13	167.8	131.1	73	215.1	168.1
34	26.8	20.9	94	74.1	57.9	54	121.4	94.8	14	168.6	131.8	74	215.9	168.7
35	27.6	21.5	95	74.9	58.5	55	122.1	95.4	15	169.4	132.4	75	216.7	169.3
36	28.4	22.2	96	75.6	59.1	56	122.9	96.0	16	170.2	133.0	76	217.5	169.9
37	29.2	22.8	97	76.4	59.7	57	123.7	96.7	17	171.0	133.6	77	218.3	170.5
38	29.9	23.4	98	77.2	60.3	58	124.5	97.3	18	171.8	134.2	78	219.1	171.2
39	30.7	24.0	99	78.0	61.0	59	125.3	97.9	19	172.6	134.8	79	219.9	171.8
40	31.5	24.6	100	78.8	61.6	60	126.1	98.5	20	173.4	135.4	80	220.6	172.4
41	32.3	25.2	101	79.6	62.2	161	126.9	99.1	221	174.2	136.1	281	221.4	173.0
42	33.1	25.9	02	80.4	62.8	62	127.7	99.7	22	174.9	136.7	82	222.2	173.6
43	33.9	26.5	03	81.2	63.4	63	128.4	100.4	23	175.7	137.3	83	223.0	174.2
44	34.7	27.1	04	82.0	64.0	64	129.2	101.0	24	176.5	137.9	84	223.8	174.8
45	35.5	27.7	05	82.7	64.6	65	130.0	101.6	25	177.3	138.5	85	224.6	175.5
46	36.2	28.3	06	83.5	65.3	66	130.8	102.2	26	178.1	139.1	86	225.4	176.1
47	37.0	28.9	07	84.3	65.9	67	131.6	102.8	27	178.9	139.8	87	226.2	176.7
48	37.8	29.6	08	85.1	66.5	68	132.4	103.4	28	179.7	140.4	88	226.9	177.3
49	38.6	30.2	09	85.9	67.1	69	133.2	104.0	29	180.5	141.0	89	227.7	177.9
50	39.4	30.8	10	86.7	67.7	70	134.0	104.7	30	181.2	141.6	90	228.5	178.5
51	40.2	31.4	111	87.5	68.3	171	134.7	105.3	231	182.0	142.2	291	229.3	179.2
52	41.0	32.0	12	88.3	69.0	72	135.5	105.9	32	182.8	142.8	92	230.1	179.8
53	41.8	32.6	13	89.0	69.6	73	136.3	106.5	33	183.6	143.4	93	230.9	180.4
54	42.6	33.2	14	89.8	70.2	74	137.1	107.1	34	184.4	144.1	94	231.7	181.0
55	43.3	33.9	15	90.6	70.8	75	137.9	107.7	35	185.2	144.7	95	232.5	181.6
56	44.1	34.5	16	91.4	71.4	76	138.7	108.4	36	186.0	145.3	96	233.3	182.2
57	44.9	35.1	17	92.2	72.0	77	139.5	109.0	37	186.8	145.9	97	234.0	182.9
58	45.7	35.7	18	93.0	72.6	78	140.3	109.6	38	187.5	146.5	98	234.8	183.5
59	46.5	36.3	19	93.8	73.3	79	141.1	110.2	39	188.3	147.1	99	235.6	184.1
60	47.3	36.9	20	94.6	73.9	80	141.8	110.8	40	189.1	147.8	300	236.4	184.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 52 Degrees.

TABLE II. Difference of Latitude and Departure for 39 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	01.6	01.3	62	48.2	39.0	22	94.8	76.8	82	141.4	114.5	42	188.1	152.3
3	02.3	01.9	63	49.0	39.6	23	95.6	77.4	83	142.2	115.2	43	188.8	152.9
4	03.1	02.5	64	49.7	40.3	24	96.4	78.0	84	143.0	115.8	44	189.6	153.6
5	03.9	03.1	65	50.5	40.9	25	97.1	78.7	85	143.8	116.4	45	190.4	154.2
6	04.7	03.8	66	51.3	41.5	26	97.9	79.3	86	144.5	117.1	46	191.2	154.8
7	05.4	04.4	67	52.1	42.2	27	98.7	79.9	87	145.3	117.7	47	192.0	155.4
8	06.2	05.0	68	52.8	42.8	28	99.5	80.6	88	146.1	118.3	48	192.7	156.1
9	07.0	05.7	69	53.6	43.4	29	100.3	81.2	89	146.9	118.9	49	193.5	156.7
10	07.8	06.3	70	54.4	44.1	30	101.0	81.8	90	147.7	119.6	50	194.3	157.3
11	08.5	06.9	71	55.2	44.7	131	101.8	82.4	191	148.4	120.2	251	195.1	158.0
12	09.3	07.6	72	56.0	45.3	32	102.6	83.1	92	149.2	120.8	52	195.8	158.6
13	10.1	08.2	73	56.7	45.9	33	103.4	83.7	93	150.0	121.5	53	196.6	159.2
14	10.9	08.8	74	57.5	46.6	34	104.1	84.3	94	150.8	122.1	54	197.4	159.8
15	11.7	09.4	75	58.3	47.2	35	104.9	85.0	95	151.5	122.7	55	198.2	160.5
16	12.4	10.1	76	59.1	47.8	36	105.7	85.6	96	152.3	123.3	56	198.9	161.1
17	13.2	10.7	77	59.8	48.5	37	106.5	86.2	97	153.1	124.0	57	199.7	161.7
18	14.0	11.3	78	60.6	49.1	38	107.2	86.8	98	153.9	124.6	58	200.5	162.4
19	14.8	12.0	79	61.4	49.7	39	108.0	87.5	99	154.7	125.2	59	201.3	163.0
20	15.5	12.6	80	62.2	50.3	40	108.8	88.1	200	155.4	125.9	60	202.1	163.6
21	16.3	13.2	81	62.9	51.0	141	109.6	88.7	201	156.2	126.5	261	202.8	164.3
22	17.1	13.8	82	63.7	51.6	42	110.4	89.4	02	157.0	127.1	62	203.6	164.9
23	17.9	14.5	83	64.5	52.2	43	111.1	90.0	03	157.8	127.8	63	204.4	165.5
24	18.7	15.1	84	65.3	52.9	44	111.9	90.6	04	158.5	128.4	64	205.2	166.1
25	19.4	15.7	85	66.1	53.5	45	112.7	91.3	05	159.3	129.0	65	205.9	166.8
26	20.2	16.4	86	66.8	54.1	46	113.5	91.9	06	160.1	129.6	66	206.7	167.4
27	21.0	17.0	87	67.6	54.8	47	114.2	92.5	07	160.9	130.3	67	207.5	168.0
28	21.8	17.6	88	68.4	55.4	48	115.0	93.1	08	161.6	130.9	68	208.3	168.7
29	22.5	18.3	89	69.2	56.0	49	115.8	93.8	09	162.4	131.5	69	209.1	169.3
30	23.3	18.9	90	69.9	56.6	50	116.6	94.4	10	163.2	132.2	70	209.8	169.9
31	24.1	19.5	91	70.7	57.3	151	117.3	95.0	211	164.0	132.8	271	210.6	170.5
32	24.9	20.1	92	71.5	57.9	52	118.1	95.7	12	164.8	133.4	72	211.4	171.2
33	25.6	20.8	93	72.3	58.5	53	118.9	96.3	13	165.5	134.0	73	212.2	171.8
34	26.4	21.4	94	73.1	59.2	54	119.7	96.9	14	166.3	134.7	74	212.9	172.4
35	27.2	22.0	95	73.8	59.8	55	120.5	97.5	15	167.1	135.3	75	213.7	173.1
36	28.0	22.7	96	74.6	60.4	56	121.2	98.2	16	167.9	135.9	76	214.5	173.7
37	28.8	23.3	97	75.4	61.0	57	122.0	98.8	17	168.6	136.6	77	215.3	174.3
38	29.5	23.9	98	76.2	61.7	58	122.8	99.4	18	169.4	137.2	78	216.0	175.0
39	30.3	24.5	99	76.9	62.3	59	123.6	100.1	19	170.2	137.8	79	216.8	175.6
40	31.1	25.2	100	77.7	62.9	60	124.3	100.7	20	171.0	138.5	80	217.6	176.2
41	31.9	25.8	101	78.5	63.6	161	125.1	101.3	221	171.7	139.1	281	218.4	176.8
42	32.6	26.4	02	79.3	64.2	62	125.9	101.9	22	172.5	139.7	82	219.2	177.5
43	33.4	27.1	03	80.0	64.8	63	126.7	102.6	23	173.3	140.3	83	219.9	178.1
44	34.2	27.7	04	80.8	65.4	64	127.5	103.2	24	174.1	141.0	84	220.7	178.7
45	35.0	28.3	05	81.6	66.1	65	128.2	103.8	25	174.9	141.6	85	221.5	179.4
46	35.7	28.9	06	82.4	66.7	66	129.0	104.5	26	175.6	142.2	86	222.3	180.0
47	36.5	29.6	07	83.2	67.3	67	129.8	105.1	27	176.4	142.9	87	223.0	180.6
48	37.3	30.2	08	83.9	68.0	68	130.6	105.7	28	177.2	143.5	88	223.8	181.2
49	38.1	30.8	09	84.7	68.6	69	131.3	106.4	29	178.0	144.1	89	224.6	181.9
50	38.9	31.5	10	85.5	69.2	70	132.1	107.0	30	178.7	144.7	90	225.4	182.5
51	39.6	32.1	111	86.3	69.9	171	132.9	107.6	231	179.5	145.4	291	226.1	183.1
52	40.4	32.7	12	87.0	70.5	72	133.7	108.2	32	180.3	146.0	92	226.9	183.8
53	41.2	33.4	13	87.8	71.1	73	134.4	108.9	33	181.1	146.6	93	227.7	184.4
54	42.0	34.0	14	88.6	71.7	74	135.2	109.5	34	181.9	147.3	94	228.5	185.0
55	42.7	34.6	15	89.4	72.4	75	136.0	110.1	35	182.6	147.9	95	229.3	185.6
56	43.5	35.2	16	90.1	73.0	76	136.8	110.8	36	183.4	148.5	96	230.0	186.3
57	44.3	35.9	17	90.9	73.6	77	137.6	111.4	37	184.2	149.1	97	230.8	186.9
58	45.1	36.5	18	91.7	74.3	78	138.3	112.0	38	185.0	149.8	98	231.6	187.5
59	45.9	37.1	19	92.5	74.9	79	139.1	112.6	39	185.7	150.4	99	232.4	188.2
60	46.6	37.8	20	93.3	75.5	80	139.9	113.3	40	186.5	151.0	300	233.1	188.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 51 Degrees.

Table II. Difference of Latitude and Departure for 40 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	46.7	39.2	121	92.7	77.8	181	138.7	116.3	24	184.6	154.9
2	01.5	01.3	62	47.5	39.9	22	93.5	78.4	82	139.4	117.0	42	185.4	155.6
3	02.3	01.9	63	48.3	40.5	23	94.2	79.1	83	140.2	117.6	43	186.1	156.2
4	03.1	02.6	64	49.0	41.1	24	95.0	79.7	84	141.0	118.3	44	186.9	156.8
5	03.8	03.2	65	49.8	41.8	25	95.8	80.3	85	141.7	118.9	45	187.7	157.5
6	04.6	03.9	66	50.6	42.4	26	96.5	81.0	86	142.5	119.6	46	188.4	158.1
7	05.4	04.5	67	51.3	43.1	27	97.3	81.6	87	143.3	120.2	47	189.2	158.8
8	06.1	05.1	68	52.1	43.7	28	98.1	82.3	88	144.0	120.8	48	190.0	159.4
9	06.9	05.8	69	52.9	44.4	29	98.8	82.9	89	144.8	121.5	49	190.7	160.1
10	07.7	06.4	70	53.6	45.0	30	99.6	83.6	90	145.5	122.1	50	191.5	160.7
11	08.4	07.1	71	54.4	45.6	131	100.4	84.2	191	146.3	122.8	251	192.3	161.3
12	09.2	07.7	72	55.2	46.3	32	101.1	84.8	92	147.1	123.4	52	193.0	162.0
13	10.0	08.4	73	55.9	46.9	33	101.9	85.5	93	147.8	124.1	53	193.8	162.6
14	10.7	09.0	74	56.7	47.6	34	102.6	86.1	94	148.6	124.7	54	194.6	163.3
15	11.5	09.6	75	57.5	48.2	35	103.4	86.8	95	149.4	125.3	55	195.3	163.9
16	12.3	10.3	76	58.2	48.9	36	104.2	87.4	96	150.1	126.0	56	196.1	164.6
17	13.0	10.9	77	59.0	49.5	37	104.9	88.1	97	150.9	126.6	57	196.9	165.2
18	13.8	11.6	78	59.8	50.1	38	105.7	88.7	98	151.7	127.3	58	197.6	165.8
19	14.6	12.2	79	60.5	50.8	39	106.5	89.3	99	152.4	127.9	59	198.4	166.5
20	15.3	12.9	80	61.3	51.4	40	107.2	90.0	200	153.2	128.6	60	199.2	167.1
21	16.1	13.5	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.9	167.8
22	16.9	14.1	82	62.8	52.7	42	108.8	91.3	02	154.7	129.8	62	200.7	168.4
23	17.6	14.8	83	63.6	53.4	43	109.5	91.9	03	155.5	130.5	63	201.5	169.1
24	18.4	15.4	84	64.3	54.0	44	110.3	92.6	04	156.3	131.1	64	202.2	169.7
25	19.2	16.1	85	65.1	54.6	45	111.1	93.2	05	157.0	131.8	65	203.0	170.3
26	19.9	16.7	86	65.9	55.3	46	111.8	93.8	06	157.8	132.4	66	203.8	171.0
27	20.7	17.4	87	66.6	55.9	47	112.6	94.5	07	158.6	133.1	67	204.5	171.6
28	21.4	18.0	88	67.4	56.6	48	113.4	95.1	08	159.3	133.7	68	205.3	172.3
29	22.2	18.6	89	68.2	57.2	49	114.1	95.8	09	160.1	134.3	69	206.1	172.9
30	23.0	19.3	90	68.9	57.9	50	114.9	96.4	10	160.9	135.0	70	206.8	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.6	135.6	271	207.6	174.2
32	24.5	20.6	92	70.5	59.1	52	116.4	97.7	12	162.4	136.3	72	208.4	174.8
33	25.3	21.2	93	71.2	59.8	53	117.2	98.3	13	163.2	136.9	73	209.1	175.5
34	26.0	21.9	94	72.0	60.4	54	118.0	99.0	14	163.9	137.6	74	209.9	176.1
35	26.8	22.5	95	72.8	61.1	55	118.7	99.6	15	164.7	138.2	75	210.7	176.8
36	27.6	23.1	96	73.5	61.7	56	119.5	100.3	16	165.5	138.8	76	211.4	177.4
37	28.3	23.8	97	74.3	62.4	57	120.3	100.9	17	166.2	139.5	77	212.2	178.1
38	29.1	24.4	98	75.1	63.0	58	121.0	101.6	18	167.0	140.1	78	213.0	178.7
39	29.9	25.1	99	75.8	63.6	59	121.8	102.2	19	167.8	140.8	79	213.7	179.3
40	30.6	25.7	100	76.6	64.3	60	122.6	102.8	20	168.5	141.4	80	214.5	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.3	142.1	281	215.3	180.6
42	32.2	27.0	02	78.1	65.6	62	124.1	104.1	22	170.1	142.7	82	216.0	181.3
43	32.9	27.6	03	78.9	66.2	63	124.9	104.8	23	170.8	143.3	83	216.8	181.9
44	33.7	28.3	04	79.7	66.8	64	125.6	105.4	24	171.6	144.0	84	217.6	182.6
45	34.5	28.9	05	80.4	67.5	65	126.4	106.1	25	172.4	144.6	85	218.3	183.2
46	35.2	29.6	06	81.2	68.1	66	127.2	106.7	26	173.1	145.3	86	219.1	183.8
47	36.0	30.2	07	82.0	68.8	67	127.9	107.3	27	173.9	145.9	87	219.9	184.5
48	36.8	30.9	08	82.7	69.4	68	128.7	108.0	28	174.7	146.6	88	220.6	185.1
49	37.5	31.5	09	83.5	70.1	69	129.5	108.6	29	175.4	147.2	89	221.4	185.8
50	38.3	32.1	10	84.3	70.7	70	130.2	109.3	30	176.2	147.8	90	222.2	186.4
51	39.1	32.8	111	85.0	71.3	171	131.0	109.9	231	177.0	148.5	291	222.9	187.1
52	39.8	33.4	12	85.8	72.0	72	131.8	110.6	32	177.7	149.1	92	223.7	187.7
53	40.6	34.1	13	86.6	72.6	73	132.5	111.2	33	178.5	149.8	93	224.5	188.3
54	41.4	34.7	14	87.3	73.3	74	133.3	111.8	34	179.3	150.4	94	225.2	189.0
55	42.1	35.4	15	88.1	73.9	75	134.1	112.5	35	180.0	151.1	95	226.0	189.6
56	42.9	36.0	16	88.9	74.6	76	134.8	113.1	36	180.8	151.7	96	226.7	190.3
57	43.7	36.6	17	89.6	75.2	77	135.6	113.8	37	181.6	152.3	97	227.5	190.9
58	44.4	37.3	18	90.4	75.8	78	136.4	114.4	38	182.3	153.0	98	228.3	191.6
59	45.2	37.9	19	91.2	76.5	79	137.1	115.1	39	183.1	153.6	99	229.0	192.2
60	46.0	38.6	20	91.9	77.1	80	137.9	115.7	40	183.9	154.3	300	229.8	192.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 50 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	01.5	01.3	62	46.8	40.7	22	92.1	80.0	82	137.4	119.4	42	182.6	158.8
3	02.3	02.0	63	47.5	41.3	23	92.8	80.7	83	138.1	120.1	43	183.4	159.4
4	03.0	02.6	64	48.3	42.0	24	93.6	81.4	84	138.9	120.7	44	184.1	160.1
5	03.8	03.3	65	49.1	42.6	25	94.3	82.0	85	139.6	121.4	45	184.9	160.7
6	04.5	03.9	66	49.8	43.3	26	95.1	82.7	86	140.4	122.0	46	185.7	161.4
7	05.3	04.6	67	50.6	44.0	27	95.8	83.3	87	141.1	122.7	47	186.4	162.0
8	06.0	05.2	68	51.3	44.6	28	96.6	84.0	88	141.9	123.3	48	187.2	162.7
9	06.8	05.9	69	52.1	45.3	29	97.4	84.6	89	142.6	124.0	49	187.9	163.4
10	07.5	06.6	70	52.8	45.9	30	98.1	85.3	90	143.4	124.7	50	188.7	164.0
11	08.3	07.2	71	53.6	46.6	131	98.9	85.9	191	144.1	125.3	251	189.4	164.7
12	09.1	07.9	72	54.3	47.2	32	99.6	86.6	92	144.9	126.0	52	190.2	165.3
13	09.8	08.5	73	55.1	47.9	33	100.4	87.3	93	145.7	126.6	53	190.9	166.0
14	10.6	09.2	74	55.8	48.5	34	101.1	87.9	94	146.4	127.3	54	191.7	166.6
15	11.3	09.8	75	56.6	49.2	35	101.9	88.6	95	147.2	127.9	55	192.5	167.3
16	12.1	10.5	76	57.4	49.9	36	102.6	89.2	96	147.9	128.6	56	193.2	168.0
17	12.8	11.2	77	58.1	50.5	37	103.4	89.9	97	148.7	129.2	57	194.0	168.6
18	13.6	11.8	78	58.9	51.2	38	104.1	90.5	98	149.4	129.9	58	194.7	169.3
19	14.3	12.5	79	59.6	51.8	39	104.9	91.2	99	150.2	130.6	59	195.5	169.9
20	15.1	13.1	80	60.4	52.5	40	105.7	91.8	200	150.9	131.2	60	196.2	170.6
21	15.8	13.8	81	61.1	53.1	141	106.4	92.5	201	151.7	131.9	261	197.0	171.2
22	16.6	14.4	82	61.9	53.8	42	107.2	93.2	02	152.5	132.5	62	197.7	171.9
23	17.4	15.1	83	62.6	54.5	43	107.9	93.8	03	153.2	133.2	63	198.5	172.5
24	18.1	15.7	84	63.4	55.1	44	108.7	94.5	04	154.0	133.8	64	199.2	173.2
25	18.9	16.4	85	64.2	55.8	45	109.4	95.1	05	154.7	134.5	65	200.0	173.9
26	19.6	17.1	86	64.9	56.4	46	110.2	95.8	06	155.5	135.1	66	200.8	174.5
27	20.4	17.7	87	65.7	57.1	47	110.9	96.4	07	156.2	135.8	67	201.5	175.2
28	21.1	18.4	88	66.4	57.7	48	111.7	97.1	08	157.0	136.5	68	202.3	175.8
29	21.9	19.0	89	67.2	58.4	49	112.5	97.8	09	157.7	137.1	69	203.0	176.5
30	22.6	19.7	90	67.9	59.0	50	113.2	98.4	10	158.5	137.8	70	203.8	177.1
31	23.4	20.3	91	68.7	59.7	151	114.0	99.1	211	159.2	138.4	271	204.5	177.8
32	24.2	21.0	92	69.4	60.4	52	114.7	99.7	12	160.0	139.1	72	205.3	178.4
33	24.9	21.6	93	70.2	61.0	53	115.5	100.4	13	160.8	139.7	73	206.0	179.1
34	25.7	22.3	94	70.9	61.7	54	116.2	101.0	14	161.5	140.4	74	206.8	179.8
35	26.4	23.0	95	71.7	62.3	55	117.0	101.7	15	162.3	141.1	75	207.5	180.4
36	27.2	23.6	96	72.5	63.0	56	117.7	102.3	16	163.0	141.7	76	208.3	181.1
37	27.9	24.3	97	73.2	63.6	57	118.5	103.0	17	163.8	142.4	77	209.1	181.7
38	28.7	24.9	98	74.0	64.3	58	119.2	103.7	18	164.5	143.0	78	209.8	182.4
39	29.4	25.6	99	74.7	64.9	59	120.0	104.3	19	165.3	143.7	79	210.6	183.0
40	30.2	26.2	100	75.5	65.6	60	120.8	105.0	20	166.0	144.3	80	211.3	183.7
41	30.9	26.9	101	76.2	66.3	161	121.5	105.6	221	166.8	145.0	281	212.1	184.4
42	31.7	27.6	02	77.0	66.9	62	122.3	106.3	22	167.5	145.6	82	212.8	185.0
43	32.5	28.2	03	77.7	67.6	63	123.0	106.9	23	168.3	146.3	83	213.6	185.7
44	33.2	28.9	04	78.5	68.2	64	123.8	107.6	24	169.1	147.0	84	214.3	186.3
45	34.0	29.5	05	79.2	68.9	65	124.5	108.2	25	169.8	147.6	85	215.1	187.0
46	34.7	30.2	06	80.0	69.5	66	125.3	108.9	26	170.6	148.3	86	215.8	187.6
47	35.5	30.8	07	80.8	70.2	67	126.0	109.6	27	171.3	148.9	87	216.6	188.3
48	36.2	31.5	08	81.5	70.9	68	126.8	110.2	28	172.1	149.6	88	217.4	188.9
49	37.0	32.1	09	82.3	71.5	69	127.5	110.9	29	172.8	150.2	89	218.1	189.6
50	37.7	32.8	10	83.0	72.2	70	128.3	111.5	30	173.6	150.9	90	218.9	190.3
51	38.5	33.5	111	83.8	72.8	171	129.1	112.2	231	174.3	151.5	291	219.6	190.9
52	39.2	34.1	12	84.5	73.5	72	129.8	112.8	32	175.1	152.2	92	220.4	191.6
53	40.0	34.8	13	85.3	74.1	73	130.6	113.5	33	175.8	152.9	93	221.1	192.2
54	40.8	35.4	14	86.0	74.8	74	131.3	114.2	34	176.6	153.5	94	221.9	192.9
55	41.5	36.1	15	86.8	75.4	75	132.1	114.8	35	177.4	154.2	95	222.6	193.5
56	42.3	36.7	16	87.5	76.1	76	132.8	115.5	36	178.1	154.8	96	223.4	194.2
57	43.0	37.4	17	88.3	76.8	77	133.6	116.1	37	178.9	155.5	97	224.1	194.8
58	43.8	38.1	18	89.1	77.4	78	134.3	116.8	38	179.6	156.1	98	224.9	195.5
59	44.5	38.7	19	89.8	78.1	79	135.1	117.4	39	180.4	156.8	99	225.7	196.2
60	45.3	39.4	20	90.6	78.7	80	135.8	118.1	40	181.1	157.5	300	226.4	196.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 49 Degrees.

Dist.	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	45.3	40.8	121	89.9	81.0	181	134.5	121.1	241	179.1	161.3
2	01.5	01.3	62	46.1	41.5	22	90.7	81.6	82	135.3	121.8	42	179.8	161.9
3	02.2	02.0	63	46.8	42.2	23	91.4	82.3	83	136.0	122.5	43	180.6	162.6
4	03.0	02.7	64	47.6	42.8	24	92.1	83.0	84	136.7	123.1	44	181.3	163.3
5	03.7	03.3	65	48.3	43.5	25	92.9	83.6	85	137.5	123.8	45	182.1	163.9
6	04.5	04.0	66	49.0	44.2	26	93.6	84.3	86	138.2	124.5	46	182.8	164.6
7	05.2	04.7	67	49.8	44.8	27	94.4	85.0	87	139.0	125.1	47	183.6	165.3
8	05.9	05.4	68	50.5	45.5	28	95.1	85.6	88	139.7	125.8	48	184.3	165.9
9	06.7	06.0	69	51.3	46.2	29	95.9	86.3	89	140.5	126.5	49	185.0	166.6
10	07.4	06.7	70	52.0	46.8	30	96.6	87.0	90	141.2	127.1	50	185.8	167.3
11	08.2	07.4	71	52.8	47.5	131	97.4	87.7	191	141.9	127.8	251	186.5	168.0
12	08.9	08.0	72	53.5	48.2	32	98.1	88.3	92	142.7	128.5	52	187.3	168.6
13	09.7	08.7	73	54.2	48.8	33	98.8	89.0	93	143.4	129.1	53	188.0	169.3
14	10.4	09.4	74	55.0	49.5	34	99.6	89.7	94	144.2	129.8	54	188.8	170.0
15	11.1	10.0	75	55.7	50.2	35	100.3	90.3	95	144.9	130.5	55	189.5	170.6
16	11.9	10.7	76	56.5	50.9	36	101.1	91.0	96	145.7	131.1	56	190.2	171.3
17	12.6	11.4	77	57.2	51.5	37	101.8	91.7	97	146.4	131.8	57	191.0	172.0
18	13.4	12.0	78	58.0	52.2	38	102.6	92.3	98	147.1	132.5	58	191.7	172.6
19	14.1	12.7	79	58.7	52.9	39	103.3	93.0	99	147.9	133.2	59	192.5	173.3
20	14.9	13.4	80	59.5	53.5	40	104.0	93.7	200	148.6	133.8	60	193.2	174.0
21	15.6	14.1	81	60.2	54.2	141	104.8	94.3	201	149.4	134.5	261	194.0	174.6
22	16.3	14.7	82	60.9	54.9	42	105.5	95.0	02	150.1	135.2	62	194.7	175.3
23	17.1	15.4	83	61.7	55.5	43	106.3	95.7	03	150.9	135.8	63	195.4	176.0
24	17.8	16.1	84	62.4	56.2	44	107.0	96.4	04	151.6	136.5	64	196.2	176.7
25	18.6	16.7	85	63.2	56.9	45	107.8	97.0	05	152.3	137.2	65	196.9	177.3
26	19.3	17.4	86	63.9	57.5	46	108.5	97.7	06	153.1	137.8	66	197.7	178.0
27	20.1	18.1	87	64.7	58.2	47	109.2	98.4	07	153.8	138.5	67	198.4	178.7
28	20.8	18.7	88	65.4	58.9	48	110.0	99.0	08	154.6	139.2	68	199.2	179.3
29	21.6	19.4	89	66.1	59.6	49	110.7	99.7	09	155.3	139.8	69	199.9	180.0
30	22.3	20.1	90	66.9	60.2	50	111.5	100.4	10	156.1	140.5	70	200.6	180.7
31	23.0	20.7	91	67.6	60.9	151	112.2	101.0	211	156.8	141.2	271	201.4	181.3
32	23.8	21.4	92	68.4	61.6	52	113.0	101.7	12	157.5	141.9	72	202.1	182.0
33	24.5	22.1	93	69.1	62.2	53	113.7	102.4	13	158.3	142.5	73	202.9	182.7
34	25.3	22.8	94	69.9	62.9	54	114.4	103.0	14	159.0	143.2	74	203.6	183.3
35	26.0	23.4	95	70.6	63.6	55	115.2	103.7	15	159.8	143.9	75	204.4	184.0
36	26.8	24.1	96	71.3	64.2	56	115.9	104.4	16	160.5	144.5	76	205.1	184.7
37	27.5	24.8	97	72.1	64.9	57	116.7	105.1	17	161.3	145.2	77	205.9	185.3
38	28.2	25.4	98	72.8	65.6	58	117.4	105.7	18	162.0	145.9	78	206.6	186.0
39	29.0	26.1	99	73.6	66.2	59	118.2	106.4	19	162.7	146.5	79	207.3	186.7
40	29.7	26.8	100	74.3	66.9	60	118.9	107.1	20	163.5	147.2	80	208.1	187.4
41	30.5	27.4	101	75.1	67.6	161	119.6	107.7	221	164.2	147.9	281	208.8	188.0
42	31.2	28.1	02	75.8	68.3	62	120.4	108.4	22	165.0	148.5	82	209.6	188.7
43	32.0	28.8	03	76.5	68.9	63	121.1	109.1	23	165.7	149.2	83	210.3	189.4
44	32.7	29.4	04	77.3	69.6	64	121.9	109.7	24	166.5	149.9	84	211.1	190.0
45	33.4	30.1	05	78.0	70.3	65	122.6	110.4	25	167.2	150.6	85	211.8	190.7
46	34.2	30.8	06	78.8	70.9	66	123.4	111.1	26	168.0	151.2	86	212.5	191.4
47	34.9	31.4	07	79.5	71.6	67	124.1	111.7	27	168.7	151.9	87	213.3	192.0
48	35.7	32.1	08	80.3	72.3	68	124.8	112.4	28	169.4	152.6	88	214.0	192.7
49	36.4	32.8	09	81.0	72.9	69	125.6	113.1	29	170.2	153.2	89	214.8	193.4
50	37.2	33.5	10	81.7	73.6	70	126.3	113.8	30	170.9	153.9	90	215.5	194.0
51	37.9	34.1	111	82.5	74.3	171	127.1	114.4	231	171.7	154.6	291	216.3	194.7
52	38.6	34.8	12	83.2	74.9	72	127.8	115.1	32	172.4	155.2	92	217.0	195.4
53	39.4	35.5	13	84.0	75.6	73	128.6	115.8	33	173.2	155.9	93	217.7	196.1
54	40.1	36.1	14	84.7	76.3	74	129.3	116.4	34	173.9	156.6	94	218.5	196.7
55	40.9	36.8	15	85.5	77.0	75	130.1	117.1	35	174.6	157.2	95	219.2	197.4
56	41.6	37.5	16	86.2	77.6	76	130.8	117.8	36	175.4	157.9	96	220.0	198.1
57	42.4	38.1	17	86.9	78.3	77	131.5	118.4	37	176.1	158.6	97	220.7	198.7
58	43.1	38.8	18	87.7	79.0	78	132.3	119.1	38	176.9	159.3	98	221.5	199.4
59	43.8	39.5	19	88.4	79.6	79	133.0	119.8	39	177.6	159.9	99	222.2	200.1
60	44.6	40.1	20	89.2	80.3	80	133.8	120.4	40	178.4	160.6	300	222.9	200.7
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 48 Degrees.

TABLE II. Difference of Latitude and Departure for 43 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.4
2	01.5	01.4	62	45.3	42.3	22	89.2	83.2	82	133.1	124.1	42	177.0	165.0
3	02.2	02.0	63	46.1	43.0	23	90.0	83.9	83	133.8	124.8	43	177.7	165.7
4	02.9	02.7	64	46.8	43.6	24	90.7	84.6	84	134.6	125.5	44	178.5	166.4
5	03.7	03.4	65	47.5	44.3	25	91.4	85.2	85	135.3	126.2	45	179.2	167.1
6	04.4	04.1	66	48.3	45.0	26	92.2	85.9	86	136.0	126.9	46	179.9	167.8
7	05.1	04.8	67	49.0	45.7	27	92.9	86.6	87	136.8	127.5	47	180.6	168.5
8	05.9	05.5	68	49.7	46.4	28	93.6	87.3	88	137.5	128.2	48	181.4	169.1
9	06.6	06.1	69	50.5	47.1	29	94.3	88.0	89	138.2	128.9	49	182.1	169.8
10	07.3	06.8	70	51.2	47.7	30	95.1	88.7	90	139.0	129.6	50	182.8	170.5
11	08.0	07.5	71	51.9	48.4	131	95.8	89.3	191	139.7	130.3	251	183.6	171.2
12	08.8	08.2	72	52.7	49.1	32	96.5	90.0	92	140.4	130.9	52	184.3	171.9
13	09.5	08.9	73	53.4	49.8	33	97.3	90.7	93	141.2	131.6	53	185.0	172.5
14	10.2	09.5	74	54.1	50.5	34	98.0	91.4	94	141.9	132.3	54	185.8	173.2
15	11.0	10.2	75	54.9	51.1	35	98.7	92.1	95	142.6	133.0	55	186.5	173.9
16	11.7	10.9	76	55.6	51.8	36	99.5	92.8	96	143.3	133.7	56	187.2	174.6
17	12.4	11.6	77	56.3	52.5	37	100.2	93.4	97	144.1	134.4	57	188.0	175.3
18	13.2	12.3	78	57.0	53.2	38	100.9	94.1	98	144.8	135.0	58	188.7	176.0
19	13.9	13.0	79	57.8	53.9	39	101.7	94.8	99	145.5	135.7	59	189.4	176.6
20	14.6	13.6	80	58.5	54.6	40	102.4	95.5	200	146.3	136.4	60	190.2	177.3
21	15.4	14.3	81	59.2	55.2	141	103.1	96.2	201	147.0	137.1	261	190.9	178.0
22	16.1	15.0	82	60.0	55.9	42	103.9	96.8	02	147.7	137.8	62	191.6	178.7
23	16.8	15.7	83	60.7	56.6	43	104.6	97.5	03	148.5	138.4	63	192.3	179.4
24	17.6	16.4	84	61.4	57.3	44	105.3	98.2	04	149.2	139.1	64	193.1	180.0
25	18.3	17.0	85	62.2	58.0	45	106.0	98.9	05	149.9	139.8	65	193.8	180.7
26	19.0	17.7	86	62.9	58.7	46	106.8	99.6	06	150.7	140.5	66	194.5	181.4
27	19.7	18.4	87	63.6	59.3	47	107.5	100.3	07	151.4	141.2	67	195.3	182.1
28	20.5	19.1	88	64.4	60.0	48	108.2	100.9	08	152.1	141.9	68	196.0	182.8
29	21.2	19.8	89	65.1	60.7	49	109.0	101.6	09	152.9	142.5	69	196.7	183.5
30	21.9	20.5	90	65.8	61.4	50	109.7	102.3	10	153.6	143.2	70	197.5	184.1
31	22.7	21.1	91	66.6	62.1	151	110.4	103.0	211	154.3	143.9	271	198.2	184.8
32	23.4	21.8	92	67.3	62.7	52	111.2	103.7	12	155.0	144.6	72	198.9	185.5
33	24.1	22.5	93	68.0	63.4	53	111.9	104.3	13	155.8	145.3	73	199.7	186.2
34	24.9	23.2	94	68.7	64.1	54	112.6	105.0	14	156.5	145.9	74	200.4	186.9
35	25.6	23.9	95	69.5	64.8	55	113.4	105.7	15	157.2	146.6	75	201.1	187.5
36	26.3	24.6	96	70.2	65.5	56	114.1	106.4	16	158.0	147.3	76	201.9	188.2
37	27.1	25.2	97	70.9	66.2	57	114.8	107.1	17	158.7	148.0	77	202.6	188.9
38	27.8	25.9	98	71.7	66.8	58	115.6	107.8	18	159.4	148.7	78	203.3	189.6
39	28.5	26.6	99	72.4	67.5	59	116.3	108.4	19	160.2	149.4	79	204.0	190.3
40	29.3	27.3	100	73.1	68.2	60	117.0	109.1	20	160.9	150.0	80	204.8	191.0
41	30.0	28.0	101	73.9	68.9	161	117.7	109.8	221	161.6	150.7	281	205.5	191.6
42	30.7	28.6	02	74.6	69.6	62	118.5	110.5	22	162.4	151.4	82	206.2	192.3
43	31.4	29.3	03	75.3	70.2	63	119.2	111.2	23	163.1	152.1	83	207.0	193.0
44	32.2	30.0	04	76.1	70.9	64	119.9	111.8	24	163.8	152.8	84	207.7	193.7
45	32.9	30.7	05	76.8	71.6	65	120.7	112.5	25	164.6	153.4	85	208.4	194.4
46	33.6	31.4	06	77.5	72.3	66	121.4	113.2	26	165.3	154.1	86	209.2	195.1
47	34.4	32.1	07	78.3	73.0	67	122.1	113.9	27	166.0	154.8	87	209.9	195.7
48	35.1	32.7	08	79.0	73.7	68	122.9	114.6	28	166.7	155.5	88	210.6	196.4
49	35.8	33.4	09	79.7	74.3	69	123.6	115.3	29	167.5	156.2	89	211.4	197.1
50	36.6	34.1	10	80.4	75.0	70	124.3	115.9	30	168.2	156.9	90	212.1	197.8
51	37.3	34.8	111	81.2	75.7	171	125.1	116.6	231	168.9	157.5	291	212.8	198.5
52	38.0	35.5	12	81.9	76.4	72	125.8	117.3	32	169.7	158.2	92	213.6	199.1
53	38.8	36.1	13	82.6	77.1	73	126.5	118.0	33	170.4	158.9	93	214.3	199.8
54	39.5	36.8	14	83.4	77.7	74	127.3	118.7	34	171.1	159.6	94	215.0	200.5
55	40.2	37.5	15	84.1	78.4	75	128.0	119.3	35	171.9	160.3	95	215.7	201.2
56	41.0	38.2	16	84.8	79.1	76	128.7	120.0	36	172.6	161.0	96	216.5	201.9
57	41.7	38.9	17	85.6	79.8	77	129.4	120.7	37	173.3	161.6	97	217.2	202.6
58	42.4	39.6	18	86.3	80.5	78	130.2	121.4	38	174.1	162.3	98	217.9	203.2
59	43.1	40.2	19	87.0	81.2	79	130.9	122.1	39	174.8	163.0	99	218.7	203.9
60	43.9	40.9	20	87.8	81.8	80	131.6	122.8	40	175.5	163.7	300	219.4	204.6
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

(For 47 Degrees.

TABLE II. Difference of Latitude and Departure for 44 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.9	42.4	121	87.0	84.1	181	130.2	125.7	241	173.4	167.4
2	01.4	01.4	62	44.6	43.1	22	87.8	84.7	82	130.9	126.4	42	174.1	168.1
3	02.2	02.1	63	45.3	43.8	23	88.5	85.4	83	131.6	127.1	43	174.8	168.8
4	02.9	02.8	64	46.0	44.5	24	89.2	86.1	84	132.4	127.8	44	175.5	169.5
5	03.6	03.5	65	46.8	45.2	25	89.9	86.8	85	133.1	128.5	45	176.2	170.2
6	04.3	04.2	66	47.5	45.8	26	90.6	87.5	86	133.8	129.2	46	177.0	170.9
7	05.0	04.9	67	48.2	46.5	27	91.4	88.2	87	134.5	129.9	47	177.7	171.6
8	05.8	05.6	68	48.9	47.2	28	92.1	88.9	88	135.2	130.6	48	178.4	172.3
9	06.5	06.3	69	49.6	47.9	29	92.8	89.6	89	136.0	131.3	49	179.1	173.0
10	07.2	06.9	70	50.4	48.6	30	93.5	90.3	90	136.7	132.0	50	179.8	173.7
11	07.9	07.6	71	51.1	49.3	131	94.2	91.0	191	137.4	132.7	251	180.6	174.4
12	08.6	08.3	72	51.8	50.0	32	95.0	91.7	92	138.1	133.4	52	181.3	175.1
13	09.4	09.0	73	52.5	50.7	33	95.7	92.4	93	138.8	134.1	53	182.0	175.7
14	10.1	09.7	74	53.2	51.4	34	96.4	93.1	94	139.6	134.8	54	182.7	176.4
15	10.8	10.4	75	54.0	52.1	35	97.1	93.8	95	140.3	135.5	55	183.4	177.1
16	11.5	11.1	76	54.7	52.8	36	97.8	94.5	96	141.0	136.2	56	184.2	177.8
17	12.2	11.8	77	55.4	53.5	37	98.5	95.2	97	141.7	136.8	57	184.9	178.5
18	12.9	12.5	78	56.1	54.2	38	99.3	95.9	98	142.4	137.5	58	185.6	179.2
19	13.7	13.2	79	56.8	54.9	39	100.0	96.6	99	143.1	138.2	59	186.3	179.9
20	14.4	13.9	80	57.5	55.6	40	100.7	97.3	200	143.9	138.9	60	187.0	180.6
21	15.1	14.6	81	58.3	56.3	141	101.4	97.9	201	144.6	139.6	261	187.7	181.3
22	15.8	15.3	82	59.0	57.0	42	102.1	98.6	02	145.3	140.3	62	188.5	182.0
23	16.5	16.0	83	59.7	57.7	43	102.9	99.3	03	146.0	141.0	63	189.2	182.7
24	17.3	16.7	84	60.4	58.4	44	103.6	100.0	04	146.7	141.7	64	189.9	183.4
25	18.0	17.4	85	61.1	59.0	45	104.3	100.7	05	147.5	142.4	65	190.6	184.1
26	18.7	18.1	86	61.9	59.7	46	105.0	101.4	06	148.2	143.1	66	191.3	184.8
27	19.4	18.8	87	62.6	60.4	47	105.7	102.1	07	148.9	143.8	67	192.1	185.5
28	20.1	19.5	88	63.3	61.1	48	106.5	102.8	08	149.6	144.5	68	192.8	186.2
29	20.9	20.1	89	64.0	61.8	49	107.2	103.5	09	150.3	145.2	69	193.5	186.9
30	21.6	20.8	90	64.7	62.5	50	107.9	104.2	10	151.1	145.9	70	194.2	187.6
31	22.3	21.5	91	65.5	63.2	151	108.6	104.9	211	151.8	146.6	271	194.9	188.3
32	23.0	22.2	92	66.2	63.9	52	109.3	105.6	12	152.5	147.3	72	195.7	188.9
33	23.7	22.9	93	66.9	64.6	53	110.1	106.3	13	153.2	148.0	73	196.4	189.6
34	24.5	23.6	94	67.6	65.3	54	110.8	107.0	14	153.9	148.7	74	197.1	190.3
35	25.2	24.3	95	68.3	66.0	55	111.5	107.7	15	154.7	149.4	75	197.8	191.0
36	25.9	25.0	96	69.1	66.7	56	112.2	108.4	16	155.4	150.0	76	198.5	191.7
37	26.6	25.7	97	69.8	67.4	57	112.9	109.1	17	156.1	150.7	77	199.3	192.4
38	27.3	26.4	98	70.5	68.1	58	113.7	109.8	18	156.8	151.4	78	200.0	193.1
39	28.1	27.1	99	71.2	68.8	59	114.4	110.5	19	157.5	152.1	79	200.7	193.8
40	28.8	27.8	100	71.9	69.5	60	115.1	111.1	20	158.3	152.8	80	201.4	194.5
41	29.5	28.5	101	72.7	70.2	161	115.8	111.8	221	159.0	153.5	281	202.1	195.2
42	30.2	29.2	02	73.4	70.9	62	116.5	112.5	22	159.7	154.2	82	202.9	195.9
43	30.9	29.9	03	74.1	71.5	63	117.3	113.2	23	160.4	154.9	83	203.6	196.6
44	31.7	30.6	04	74.8	72.2	64	118.0	113.9	24	161.1	155.6	84	204.3	197.3
45	32.4	31.3	05	75.5	72.9	65	118.7	114.6	25	161.9	156.3	85	205.0	198.0
46	33.1	32.0	06	76.3	73.6	66	119.4	115.3	26	162.6	157.0	86	205.7	198.7
47	33.8	32.6	07	77.0	74.3	67	120.1	116.0	27	163.3	157.7	87	206.5	199.4
48	34.5	33.3	08	77.7	75.0	68	120.8	116.7	28	164.0	158.4	88	207.2	200.1
49	35.2	34.0	09	78.4	75.7	69	121.6	117.4	29	164.7	159.1	89	207.9	200.8
50	36.0	34.7	10	79.1	76.4	70	122.3	118.1	30	165.4	159.8	90	208.6	201.5
51	36.7	35.4	111	79.8	77.1	171	123.0	118.8	231	166.2	160.5	291	209.3	202.1
52	37.4	36.1	12	80.6	77.8	72	123.7	119.5	32	166.9	161.2	92	210.0	202.8
53	38.1	36.8	13	81.3	78.5	73	124.4	120.2	33	167.6	161.9	93	210.8	203.5
54	38.8	37.5	14	82.0	79.2	74	125.2	120.9	34	168.3	162.6	94	211.5	204.2
55	39.6	38.2	15	82.7	79.9	75	125.9	121.6	35	169.0	163.2	95	212.2	204.9
56	40.3	38.9	16	83.4	80.6	76	126.6	122.3	36	169.8	163.9	96	212.9	205.6
57	41.0	39.6	17	84.2	81.3	77	127.3	123.0	37	170.5	164.6	97	213.6	206.3
58	41.7	40.3	18	84.9	82.0	78	128.0	123.6	38	171.2	165.3	98	214.4	207.0
59	42.4	41.0	19	85.6	82.7	79	128.8	124.3	39	171.9	166.0	99	215.1	207.7
60	43.2	41.7	20	86.3	83.4	80	129.5	125.0	40	172.6	166.7	300	215.8	208.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

(For 46 Degrees.

TABLE II. Difference of Latitude and Departure for 45 Degrees.

Dist.	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.4	204.4
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

M.	0d.	1d.	2d.	3d.	4d.	5d.	6d.	7d.	8d.	9d.	10d.	11d.	12d.	13d.	M.
0	0	60	120	180	240	300	361	421	482	542	603	664	725	787	0
1	1	61	121	181	241	301	362	422	483	543	604	665	726	788	1
2	2	62	122	182	242	302	363	423	484	544	605	666	727	789	2
3	3	63	123	183	243	303	364	424	485	545	606	667	728	790	3
4	4	64	124	184	244	304	365	425	486	546	607	668	729	791	4
5	5	65	125	185	245	305	366	426	487	547	608	669	730	792	5
6	6	66	126	186	246	306	367	427	488	548	609	670	731	793	6
7	7	67	127	187	247	307	368	428	489	549	610	671	732	794	7
8	8	68	128	188	248	308	369	429	490	550	611	672	734	795	8
9	9	69	129	189	249	309	370	430	491	551	612	673	735	796	9
10	10	70	130	190	250	310	371	431	492	552	613	674	736	797	10
11	11	71	131	191	251	311	372	432	493	553	614	675	737	798	11
12	12	72	132	192	252	312	373	433	494	554	615	676	738	799	12
13	13	73	133	193	253	313	374	434	495	555	616	677	739	800	13
14	14	74	134	194	254	314	375	435	496	556	617	678	740	801	14
15	15	75	135	195	255	315	376	436	497	557	618	679	741	802	15
16	16	76	136	196	256	316	377	437	498	558	619	680	742	803	16
17	17	77	137	197	257	317	378	438	499	559	620	681	743	804	17
18	18	78	138	198	258	318	379	439	500	560	621	682	744	805	18
19	19	79	139	199	259	319	380	440	501	561	622	683	745	806	19
20	20	80	140	200	260	320	381	441	502	562	623	684	746	807	20
21	21	81	141	201	261	321	382	442	503	564	624	685	747	808	21
22	22	82	142	202	262	322	383	443	504	565	625	687	748	809	22
23	23	83	143	203	263	323	384	444	505	566	626	688	749	810	23
24	24	84	144	204	264	324	385	445	506	567	627	689	750	811	24
25	25	85	145	205	265	325	386	446	507	568	628	690	751	812	25
26	26	86	146	206	266	326	387	447	508	569	629	691	752	813	26
27	27	87	147	207	267	327	388	448	509	570	631	692	753	815	27
28	28	88	148	208	268	328	389	449	510	571	632	693	754	816	28
29	29	89	149	209	269	330	390	450	511	572	633	694	755	817	29
30	30	90	150	210	270	331	391	451	512	573	634	695	756	818	30
31	31	91	151	211	271	332	392	452	513	574	635	696	757	819	31
32	32	92	152	212	272	333	393	453	514	575	636	697	758	820	32
33	33	93	153	213	273	334	394	454	515	576	637	698	759	821	33
34	34	94	154	214	274	335	395	455	516	577	638	699	760	822	34
35	35	95	155	215	275	336	396	456	517	578	639	700	761	823	35
36	36	96	156	216	276	337	397	457	518	579	640	701	762	824	36
37	37	97	157	217	277	338	398	458	519	580	641	702	763	825	37
38	38	98	158	218	278	339	399	459	520	581	642	703	764	826	38
39	39	99	159	219	279	340	400	460	521	582	643	704	765	827	39
40	40	100	160	220	280	341	401	461	522	583	644	705	766	828	40
41	41	101	161	221	281	342	402	462	523	584	645	706	767	829	41
42	42	102	162	222	282	343	403	463	524	585	646	707	768	830	42
43	43	103	163	223	283	344	404	464	525	586	647	708	769	831	43
44	44	104	164	224	284	345	405	465	526	587	648	709	770	832	44
45	45	105	165	225	285	346	406	466	527	588	649	710	771	833	45
46	46	106	166	226	286	347	407	467	528	589	650	711	772	834	46
47	47	107	167	227	287	348	408	468	529	590	651	712	773	835	47
48	48	108	168	228	288	349	409	469	530	591	652	713	774	836	48
49	49	109	169	229	289	350	410	470	531	592	653	714	775	837	49
50	50	110	170	230	290	351	411	471	532	593	654	715	777	838	50
51	51	111	171	231	291	352	412	472	533	594	655	716	778	839	51
52	52	112	172	232	292	353	413	473	534	595	656	717	779	840	52
53	53	113	173	233	293	354	414	474	535	596	657	718	780	841	53
54	54	114	174	234	294	355	415	476	536	597	658	719	781	842	54
55	55	115	175	235	295	356	416	477	537	598	659	720	782	843	55
56	56	116	176	236	296	357	417	478	538	599	660	721	783	844	56
57	57	117	177	237	297	358	418	479	539	600	661	722	784	845	57
58	58	118	178	238	298	359	419	480	540	601	662	723	785	846	58
59	59	119	179	239	299	360	420	481	541	602	663	724	786	847	59
M.	0d.	1d.	2d.	3d.	4d.	5d.	6d.	7d.	8d.	9d.	10d.	11d.	12d.	13d.	M.

Table III. Meridional Parts.

M.	14d.	15d.	16d.	17d.	18d.	19d.	20d.	21d.	22d.	23d.	24d.	25d.	26d.	27d.	M.
0	848	910	973	1035	1098	1161	1225	1289	1354	1419	1484	1550	1616	1684	0
1	850	911	974	36	99	63	26	90	55	20	85	51	18	85	1
2	851	913	975	37	1100	64	27	91	56	21	86	52	19	86	2
3	852	914	976	38	01	65	28	92	57	22	87	53	20	87	3
4	853	915	977	39	02	66	29	93	58	23	88	54	21	88	4
5	854	916	978	1041	1103	1167	1230	1295	1359	1424	1490	1556	1622	1689	5
6	855	917	979	42	05	68	32	96	60	25	91	57	23	90	6
7	856	918	980	43	06	69	33	97	61	26	92	58	24	91	7
8	857	919	981	44	07	70	34	98	62	27	93	59	25	93	8
9	858	920	982	45	08	71	35	99	63	28	94	60	26	94	9
10	859	921	983	1046	1109	1172	1236	1300	1364	1430	1495	1561	1628	1095	10
11	860	922	984	47	10	73	37	01	66	31	96	62	29	96	11
12	861	923	985	48	11	74	38	02	67	32	97	63	30	97	12
13	862	924	986	49	12	75	39	03	68	33	98	64	31	98	13
14	863	925	987	50	13	76	40	04	69	34	99	65	32	99	14
15	864	926	988	1051	1114	1177	1241	1305	1370	1435	1500	1567	1633	1700	15
16	865	927	989	52	15	78	42	06	71	36	02	68	34	01	16
17	866	928	990	53	16	79	43	07	72	37	03	69	35	03	17
18	867	929	991	54	17	81	44	08	73	38	04	70	37	04	18
19	868	930	993	55	18	82	45	10	74	39	05	71	38	05	19
20	869	931	994	1056	1119	1183	1246	1311	1375	1440	1506	1572	1639	1700	20
21	870	932	995	57	20	84	48	12	76	41	07	73	40	07	21
22	871	933	996	58	21	85	49	13	77	43	08	74	41	08	22
23	872	934	997	59	22	86	50	14	79	44	09	75	42	09	23
24	873	935	998	60	23	87	51	15	80	45	10	77	43	11	24
25	874	936	999	1061	1125	1188	1252	1316	1381	1446	1511	1578	1644	1712	25
26	875	937	1000	63	26	89	53	17	82	47	13	79	45	13	26
27	876	938	1001	64	27	90	54	18	83	48	14	80	47	14	27
28	877	939	1002	65	28	91	55	19	84	49	15	81	48	15	28
29	878	941	1003	66	29	92	56	20	85	50	16	82	49	16	29
30	879	942	1004	1067	1130	1193	1257	1321	1386	1451	1517	1583	1650	1717	30
31	880	943	05	68	31	94	58	22	87	52	18	84	51	18	31
32	882	944	06	69	32	95	59	24	88	53	19	85	52	20	32
33	883	945	07	70	33	96	60	25	89	55	20	86	53	21	33
34	884	946	08	71	34	98	61	26	90	56	21	88	54	22	34
35	885	947	1009	1072	1135	1199	1262	1327	1392	1457	1522	1589	1656	1723	35
36	886	948	10	73	36	1200	64	28	93	58	24	90	57	24	36
37	887	949	11	74	37	01	65	29	94	59	25	91	58	25	37
38	888	950	12	75	38	02	66	30	95	60	26	92	59	26	38
39	889	951	13	76	39	03	67	31	96	61	27	93	60	27	39
40	890	952	1014	1077	1140	1204	1268	1332	1397	1462	1528	1594	1661	1729	40
41	891	953	15	78	41	05	69	33	98	63	29	95	62	30	41
42	892	954	16	79	42	06	70	34	99	64	30	96	63	31	42
43	893	955	18	80	44	07	71	35	1400	65	31	98	64	32	43
44	894	956	19	81	45	08	72	36	01	67	32	99	66	33	44
45	895	957	1020	1082	1146	1209	1273	1338	1402	1468	1533	1600	1667	1734	45
46	896	958	21	84	47	10	74	39	03	69	35	01	68	35	46
47	897	959	22	85	48	11	75	40	05	70	36	02	69	36	47
48	898	960	23	86	49	12	76	41	06	71	37	03	70	38	48
49	899	961	24	87	50	13	77	42	07	72	38	04	71	39	49
50	900	962	1025	1088	1151	1215	1278	1343	1408	1473	1539	1605	1672	1740	50
51	901	963	26	89	52	16	80	44	09	74	40	06	73	41	51
52	902	964	27	90	53	17	81	45	10	75	41	08	75	42	52
53	903	965	28	91	54	18	82	46	11	76	42	09	76	43	53
54	904	966	29	92	55	19	83	47	12	77	43	10	77	44	54
55	905	968	1030	1093	1156	1220	1284	1348	1413	1479	1544	1611	1678	1746	55
56	906	969	31	94	57	21	85	49	14	80	46	12	79	47	56
57	907	970	32	95	58	22	86	50	15	81	47	13	80	48	57
58	908	971	33	96	59	23	87	52	16	82	48	14	81	49	58
59	909	972	34	97	60	24	88	53	18	83	49	15	82	50	59
M.	14d.	15d.	16d.	17d.	18d.	19d.	20d.	21d.	22d.	23d.	24d.	25d.	26d.	27d.	M.

Table III. Meridional Parts.

M.	28d.	29d.	30d.	31d.	32d.	33d.	34d.	35d.	36d.	37d.	38d.	39d.	40d.	41d.	M.
0	1751	1819	1888	1958	2028	2100	2171	2244	2318	2393	2468	2545	2623	2702	0
1	52	21	90	59	30	01	73	46	19	94	70	46	24	03	1
2	53	22	91	60	31	02	74	47	20	95	71	48	25	04	2
3	55	23	92	62	32	03	75	48	22	96	72	49	27	06	3
4	56	24	93	63	33	04	76	49	23	98	73	50	28	07	4
5	1757	1825	1894	1964	2034	2105	2178	2250	2324	2399	2475	2551	2629	2708	5
6	58	26	95	65	35	07	79	52	25	2400	76	53	31	10	6
7	59	27	96	66	37	08	80	53	27	01	77	54	32	11	7
8	60	29	98	67	38	09	81	54	28	03	78	55	33	12	8
9	61	30	99	69	39	10	82	55	29	04	80	57	34	14	9
10	1762	1831	1900	1970	2040	2111	2184	2257	2330	2405	2481	2558	2636	2715	10
11	64	32	01	71	41	13	85	58	32	06	82	59	37	16	11
12	65	33	02	72	43	14	86	59	33	08	84	60	38	18	12
13	66	34	03	73	44	15	87	60	34	09	85	62	40	19	13
14	67	35	05	74	45	16	88	61	35	10	86	63	41	20	14
15	1768	1837	1906	1976	2046	2117	2190	2263	2337	2411	2487	2564	2642	2722	15
16	69	38	07	77	47	19	91	64	38	13	89	66	44	23	16
17	70	39	08	78	48	20	92	65	39	14	90	67	45	24	17
18	72	40	09	79	50	21	93	66	40	15	91	68	46	26	18
19	73	41	10	80	51	22	94	68	42	16	92	69	48	27	19
20	1774	1842	1912	1981	2052	2123	2196	2269	2343	2418	2494	2571	2649	2728	20
21	75	43	13	83	53	25	97	70	44	19	95	72	50	29	21
22	76	45	14	84	54	26	98	71	45	20	96	73	51	31	22
23	77	46	15	85	56	27	99	72	46	22	98	75	53	32	23
24	78	47	16	86	57	28	2200	74	48	23	99	76	54	33	24
25	1780	1848	1917	1987	2058	2129	2202	2275	2349	2424	2500	2577	2655	2735	25
26	81	49	18	88	59	31	03	76	50	25	01	78	57	36	26
27	82	50	20	90	60	32	04	77	51	27	03	80	58	37	27
28	83	52	21	91	61	33	05	79	53	28	04	81	59	39	28
29	84	53	22	92	63	34	07	80	54	29	05	82	61	40	29
30	1785	1854	1923	1993	2064	2135	2208	2281	2355	2430	2506	2584	2662	2742	30
31	86	55	24	94	65	37	09	82	56	32	08	85	63	43	31
32	87	56	25	95	66	38	10	83	58	33	09	86	65	44	32
33	89	57	27	97	67	39	11	85	59	34	10	88	66	46	33
34	90	58	28	98	69	40	13	86	60	35	12	89	67	47	34
35	1791	1860	1929	1999	2070	2141	2214	2287	2361	2437	2513	2590	2669	2748	35
36	92	61	30	2000	71	43	15	88	63	38	14	91	70	50	36
37	93	62	31	01	72	44	16	90	64	39	15	93	71	51	37
38	94	63	32	02	73	45	17	91	65	40	17	94	73	52	38
39	95	64	34	04	75	46	19	92	66	42	18	95	74	54	39
40	1797	1865	1935	2005	2076	2147	2220	2293	2368	2443	2519	2597	2675	2755	40
41	98	66	36	06	77	49	21	95	69	44	21	98	76	56	41
42	99	68	37	07	78	50	22	96	70	45	22	99	78	58	42
43	1800	69	38	08	79	51	24	97	71	47	23	2601	79	59	43
44	01	70	39	10	80	52	25	98	73	48	24	02	80	60	44
45	1802	1871	1941	2011	2082	2153	2226	2299	2374	2449	2526	2603	2682	2762	45
46	03	72	42	12	83	55	27	2301	75	51	27	04	83	63	46
47	05	73	43	13	84	56	28	02	76	52	28	06	84	64	47
48	06	75	44	14	85	57	30	03	78	53	30	07	86	66	48
49	07	76	45	15	86	58	31	04	79	54	31	08	87	67	49
50	1808	1877	1946	2017	2088	2159	2232	2306	2380	2456	2532	2610	2688	2768	50
51	09	78	48	18	89	61	33	07	81	57	33	11	90	70	51
52	10	79	49	19	90	62	35	08	83	58	35	12	91	71	52
53	11	80	50	20	91	63	36	09	84	59	36	14	92	72	53
54	13	81	51	21	92	64	37	11	85	61	37	15	94	74	54
55	1814	1883	1952	2022	2094	2165	2238	2312	2386	2462	2538	2616	2695	2775	55
56	15	84	53	24	95	67	39	13	88	63	40	17	96	76	56
57	16	85	55	25	96	68	41	14	89	64	41	19	98	78	57
58	17	86	56	26	97	69	42	16	90	66	42	20	99	79	58
59	18	87	57	27	98	70	43	17	91	67	44	21	2700	80	59
M.	28d.	29d.	30d.	31d.	32d.	33d.	34d.	35d.	36d.	37d.	38d.	39d.	40d.	41d.	M.

M.	42d.	43d.	44d.	45d.	46d.	47d.	48d.	49d.	50d.	51d.	52d.	53d.	54d.	55d.	M.
0	2782	2863	2946	3030	3116	3203	3292	3382	3474	3569	3665	3764	3865	3968	0
1	83	64	47	31	17	04	93	84	76	70	67	65	66	70	1
2	84	66	49	33	18	06	95	85	78	72	68	67	68	71	2
3	86	67	50	34	20	07	96	87	79	74	70	69	70	73	3
4	87	69	51	36	21	09	98	88	81	75	72	70	71	75	4
5	2788	2870	2953	3037	3123	3210	3299	3390	3482	3577	3673	3772	3873	3977	5
6	90	71	54	38	24	12	3301	91	84	78	75	74	75	78	6
7	91	73	56	40	26	13	02	93	85	80	77	75	77	80	7
8	92	74	57	41	27	14	03	94	87	82	78	77	78	82	8
9	94	75	58	43	29	16	05	96	88	83	80	79	80	84	9
10	2795	2877	2960	3044	3130	3217	3306	3397	3490	3585	3681	3780	3882	3985	10
11	97	78	61	46	31	19	08	99	92	86	83	82	83	87	11
12	98	80	63	47	33	20	09	3400	93	88	85	84	85	89	12
13	99	81	64	48	34	22	11	02	95	90	86	85	87	91	13
14	2801	82	65	50	36	23	12	03	96	91	88	87	89	92	14
15	2802	2884	2967	3051	3137	3225	3314	3405	3498	3593	3690	3789	3890	3994	15
16	03	85	68	53	39	26	16	07	99	94	91	90	92	96	16
17	05	86	70	54	40	28	17	08	3501	96	93	92	94	98	17
18	06	88	71	55	42	29	19	10	03	98	95	94	95	99	18
19	07	89	72	57	43	31	20	11	04	99	96	95	97	4001	19
20	2809	2891	2974	3058	3144	3232	3322	3413	3506	3601	3698	3797	3899	4003	20
21	10	92	75	60	46	34	23	14	07	02	99	99	3901	05	21
22	11	93	76	61	47	35	25	16	09	04	3701	3800	02	06	22
23	13	95	78	63	49	37	26	17	10	06	03	02	04	08	23
24	14	96	79	64	50	38	28	19	12	07	04	04	06	10	24
25	2815	2897	2981	3065	3152	3240	3329	3420	3514	3609	3706	3806	3907	4012	25
26	17	99	82	67	53	41	31	22	15	10	08	07	09	14	26
27	18	2900	83	68	55	42	32	23	17	12	09	09	11	15	27
28	20	02	85	70	56	44	34	25	18	14	11	11	13	17	28
29	21	03	86	71	57	45	35	27	20	15	13	12	14	19	29
30	2822	2904	2988	3073	3159	3247	3337	3428	3521	3617	3714	3814	3916	4021	30
31	24	06	89	74	60	48	38	30	23	18	16	16	18	22	31
32	25	07	91	75	62	50	40	31	25	20	17	17	19	24	32
33	26	08	92	77	63	51	41	33	26	22	19	19	21	26	33
34	28	10	93	78	65	53	43	34	28	23	21	21	23	28	34
35	2829	2911	2995	3080	3166	3254	3344	3436	3529	3625	3722	3822	3925	4029	35
36	30	13	96	81	68	56	46	37	31	26	24	24	26	31	36
37	32	14	98	83	69	57	47	39	32	28	26	26	28	33	37
38	33	15	99	84	71	59	49	40	34	30	27	27	30	35	38
39	34	17	3000	85	72	60	50	42	36	31	29	29	32	37	39
40	2836	2918	3002	3087	3173	3262	3352	3443	3537	3633	3731	3831	3933	4038	40
41	37	19	03	88	75	63	53	45	39	34	32	32	35	40	41
42	39	21	05	90	76	65	55	47	40	36	34	34	37	42	42
43	40	22	06	91	78	66	56	48	42	38	36	36	38	44	43
44	41	24	07	93	79	68	58	50	43	39	37	38	40	45	44
45	2843	2925	3009	3094	3181	3269	3359	3451	3545	3641	3739	3839	3942	4047	45
46	44	26	10	95	82	71	61	53	47	43	41	41	44	49	46
47	45	28	12	97	84	72	62	54	48	44	42	43	45	51	47
48	47	29	13	98	85	74	64	56	50	46	44	44	47	52	48
49	48	31	14	3100	87	75	65	57	51	47	46	46	49	54	49
50	2849	2932	3016	3101	3188	3277	3367	3459	3553	3649	3747	3848	3951	4056	50
51	51	33	17	03	90	78	68	60	55	51	49	49	52	58	51
52	52	35	19	04	91	80	70	62	56	52	50	51	54	60	52
53	54	36	20	05	92	81	71	64	58	54	52	53	56	61	53
54	55	37	21	07	94	83	73	65	59	55	54	54	58	63	54
55	2856	2939	3023	3108	3195	3284	3374	3467	3561	3657	3755	3856	3959	4065	55
56	58	40	24	10	97	86	76	68	62	59	57	58	61	67	56
57	59	42	26	11	98	87	78	70	64	60	59	60	63	69	57
58	60	43	27	13	3200	89	79	71	66	62	60	61	64	70	58
59	62	44	29	14	01	90	81	73	67	64	62	63	66	72	59
M.	42d.	43d.	44d.	45d.	46d.	47d.	48d.	49d.	50d.	51d.	52d.	53d.	54d.	55d.	M.

M.	56d.	57d.	58d.	59d.	60d.	61d.	62d.	63d.	64d.	65d.	66d.	67d.	68d.	69d.	M.
0	4074	4183	4294	4409	4527	4649	4775	4905	5039	5179	5324	5474	5631	5795	0
1	76	84	96	11	29	51	77	07	42	81	26	77	33	97	1
2	77	86	98	13	31	53	79	09	44	84	28	79	36	5800	2
3	79	88	4300	15	33	55	81	12	46	86	31	82	39	03	3
4	81	90	02	17	35	57	84	14	49	88	33	84	42	06	4
5	4083	4192	4304	4419	4537	4660	4786	4916	5051	5191	5336	5487	5644	5809	5
6	85	94	06	21	39	62	88	18	53	93	38	89	47	11	6
7	86	95	08	23	41	64	90	20	55	95	41	92	50	14	7
8	88	97	09	25	43	66	92	23	58	98	43	95	52	17	8
9	90	99	11	27	45	68	94	25	60	5200	46	97	55	20	9
10	4092	4201	4313	4429	4547	4670	4796	4927	5062	5203	5348	5500	5658	5823	10
11	94	03	15	31	49	72	98	29	65	05	51	02	60	25	11
12	95	05	17	33	51	74	4801	31	67	07	53	05	63	28	12
13	97	07	19	34	53	76	03	34	69	10	56	07	66	31	13
14	99	08	21	36	55	78	05	36	71	12	58	10	68	34	14
15	4101	4210	4323	4438	4557	4680	4807	4938	5074	5214	5361	5513	5671	5837	15
16	03	12	25	40	59	82	09	40	76	17	63	15	74	39	16
17	04	14	27	42	62	84	11	43	78	19	66	18	76	42	17
18	06	16	28	44	64	87	14	45	81	22	68	20	79	45	18
19	08	18	30	46	66	89	16	47	83	24	71	23	82	48	19
20	4110	4220	4332	4448	4568	4691	4818	4949	5085	5226	5373	5526	5685	5851	20
21	12	21	34	50	70	93	20	51	88	29	76	28	87	54	21
22	13	23	36	52	72	95	22	54	90	31	78	31	90	56	22
23	15	25	38	54	74	97	24	56	92	34	80	33	93	59	23
24	17	27	40	56	76	99	26	58	95	36	83	36	95	62	24
25	4119	4229	4342	4458	4578	4701	4829	4960	5097	5238	5385	5539	5698	5865	25
26	21	31	44	60	80	03	31	63	99	41	88	41	5701	68	26
27	22	32	46	62	82	05	33	65	5102	43	90	44	04	71	27
28	24	34	47	64	84	07	35	67	04	46	93	46	06	74	28
29	26	36	49	66	86	10	37	69	06	48	95	49	09	76	29
30	4128	4238	4351	4468	4588	4712	4839	4972	5108	5250	5398	5552	5712	5879	30
31	30	40	53	70	90	14	42	74	11	53	5401	54	15	82	31
32	32	42	55	72	92	16	44	76	13	55	03	57	17	85	32
33	33	44	57	74	94	18	46	78	15	58	06	59	20	88	33
34	35	46	59	76	96	20	48	81	18	60	08	62	23	91	34
35	4137	4247	4361	4478	4598	4722	4850	4983	5120	5263	5411	5565	5725	5894	35
36	39	49	63	80	4600	24	52	85	22	65	13	67	28	96	36
37	41	51	65	82	02	26	55	87	25	67	16	70	31	99	37
38	42	53	67	84	04	28	57	90	27	70	18	73	34	5902	38
39	44	55	69	86	06	31	59	92	29	72	21	75	36	05	39
40	4146	4257	4370	4488	4608	4733	4861	4994	5132	5275	5423	5578	5739	5908	40
41	48	59	72	90	10	35	63	96	34	77	26	80	42	11	41
42	50	60	74	92	12	37	65	99	36	80	28	83	45	14	42
43	52	62	76	94	14	39	68	5001	39	82	31	86	47	17	43
44	53	64	78	95	16	41	70	03	41	84	33	88	50	19	44
45	4155	4266	4380	4497	4618	4743	4872	5005	5143	5287	5436	5591	5753	5922	45
46	57	68	82	99	20	45	74	08	46	89	38	94	56	25	46
47	59	70	84	4501	23	47	76	10	48	92	41	96	58	28	47
48	61	72	86	03	25	50	79	12	51	94	43	99	61	31	48
49	62	74	88	05	27	52	81	14	53	97	46	5602	64	34	49
50	4164	4275	4390	4507	4629	4754	4883	5017	5155	5299	5448	5604	5767	5937	50
51	66	77	92	09	31	56	85	19	58	5301	51	07	70	40	51
52	68	79	94	11	33	58	87	21	60	04	54	10	72	43	52
53	70	81	96	13	35	60	90	23	62	06	56	12	75	46	53
54	72	83	98	15	37	62	92	26	65	09	59	15	78	48	54
55	4173	4285	4399	4517	4639	4764	4894	5028	5167	5311	5461	5617	5781	5951	55
56	75	87	4401	19	41	66	96	30	69	14	64	20	83	54	56
57	77	89	03	21	43	69	98	33	72	16	66	23	86	57	57
58	79	91	05	23	45	71	4901	35	74	19	69	25	89	60	58
59	81	92	07	25	47	73	03	37	76	21	71	28	92	63	59
M.	56d.	57d.	58d.	59d.	60d.	61d.	62d.	63d.	64d.	65d.	66d.	67d.	68d.	69d.	M.

M.	70d.	71d.	72d.	73d.	74d.	75d.	76d.	77d.	78d.	79d.	80d.	81d.	82d.	83d.	M.
0	5966	6146	6335	6534	6746	6970	7210	7467	7745	8046	8375	8739	9145	9606	0
1	69	49	38	38	49	74	14	72	49	51	81	45	53	14	1
2	72	52	41	41	53	78	18	76	54	56	87	52	60	22	2
3	75	55	45	45	57	82	22	81	59	61	93	58	67	31	3
4	78	58	48	48	60	86	27	85	64	67	98	65	74	39	4
5	5981	6161	6351	6552	6764	6990	7231	7490	7769	8072	8404	8771	9182	9647	5
6	84	64	54	55	68	94	35	94	74	77	10	78	89	55	6
7	86	67	58	58	71	97	39	98	78	83	16	84	96	64	7
8	89	70	61	62	75	7001	43	7503	83	88	22	91	9203	72	8
9	92	73	64	65	79	05	47	07	88	93	27	97	11	80	9
10	5995	6177	6367	6569	6782	7009	7252	7512	7793	8099	8433	8804	9218	9689	10
11	98	80	71	72	86	13	56	16	98	8104	39	10	25	97	11
12	6001	83	74	76	90	17	60	21	7803	09	45	17	33	9706	12
13	04	86	77	79	93	21	64	25	08	15	51	23	40	14	13
14	07	89	80	83	97	25	68	30	13	20	57	30	48	23	14
15	6010	6192	6384	6580	6801	7029	7273	7535	7817	8125	8463	8836	9255	9731	15
16	13	95	87	90	04	33	77	39	22	31	69	43	62	40	16
17	16	98	90	93	08	37	81	44	27	36	74	49	70	48	17
18	19	6201	94	97	12	41	85	48	32	41	80	56	77	57	18
19	22	05	97	6600	15	45	89	53	37	47	86	63	85	65	19
20	6025	6208	6400	6603	6819	7048	7294	7557	7842	8152	8492	8869	9292	9774	20
21	28	11	03	07	23	52	98	62	47	58	98	76	9300	83	21
22	31	14	07	10	26	56	7302	66	52	63	8504	83	07	91	22
23	34	17	10	14	30	60	06	71	57	68	10	89	15	9800	23
24	37	20	13	17	34	64	11	76	62	74	16	96	22	09	24
25	6040	6223	6417	6621	6838	7068	7315	7580	7867	8179	8522	8903	9330	9817	25
26	43	26	20	24	41	72	19	85	72	85	28	09	37	26	26
27	46	30	23	28	45	76	23	89	77	90	34	16	45	35	27
28	49	33	27	31	49	80	28	94	82	96	40	23	53	44	28
29	52	36	30	35	53	84	32	99	87	8201	46	30	60	52	29
30	6055	6239	6433	6639	6856	7088	7336	7603	7892	8207	8552	8936	9368	9861	30
31	58	42	37	42	60	92	41	08	97	12	58	43	76	70	31
32	61	45	40	46	64	96	45	12	7902	18	65	50	83	79	32
33	64	49	43	49	68	7100	49	17	07	23	71	57	91	88	33
34	67	52	47	53	71	04	53	22	12	29	77	63	99	97	34
35	6070	6255	6450	6656	6875	7108	7358	7626	7917	8234	8583	8970	9407	9906	35
36	73	58	53	60	79	12	62	31	22	40	89	77	14	15	36
37	76	61	57	63	83	16	66	36	27	45	95	84	22	24	37
38	79	64	60	67	86	20	71	40	32	51	8601	91	30	33	38
39	82	68	63	70	90	24	75	45	37	56	07	98	38	42	39
40	6085	6271	6407	6674	6694	7128	7379	7650	7942	8262	8614	9005	9445	9951	40
41	88	74	70	77	98	32	84	54	48	67	20	12	53	60	41
42	91	77	73	81	6901	36	88	59	53	73	26	18	61	69	42
43	94	80	77	85	05	40	92	64	58	79	32	25	69	78	43
44	97	83	80	88	09	45	97	68	63	84	38	32	77	87	44
45	6100	6287	6483	6692	6913	7149	7401	7673	7968	8290	8644	9039	9485	9996	45
46	03	90	87	95	17	53	06	78	73	95	51	46	93	10005	46
47	06	93	90	99	20	57	10	83	78	8301	57	53	9501	10015	47
48	09	96	94	6702	24	61	14	87	83	07	63	60	09	10024	48
49	12	99	97	06	28	65	19	92	89	12	69	67	17	10033	49
50	6115	6303	6500	6710	6932	7169	7423	7697	7994	8318	8676	9074	9525	10043	50
51	18	06	04	13	36	73	27	7702	99	24	82	81	33	10052	51
52	21	09	07	17	40	77	32	06	8004	29	88	88	41	10061	52
53	24	12	11	20	43	81	36	11	09	35	95	96	49	10071	53
54	27	15	14	24	47	85	41	16	14	41	8701	9103	57	10080	54
55	6130	6319	6517	6728	6951	7189	7445	7721	8020	47	8707	9110	9565	10089	55
56	33	22	21	31	55	94	49	25	25	8352	14	17	73	10099	56
57	36	25	24	35	59	98	54	30	30	58	20	24	81	10108	57
58	40	28	28	38	63	7202	58	35	35	64	26	31	89	10118	58
59	43	32	31	42	66	06	63	40	40	69	33	38	98	10127	59
M.	70d.	71d.	72d.	73d.	74d.	75d.	76d.	77d.	78d.	79d.	80d.	81d.	82d.	83d.	M.

N. B. In the following Tables, all Places marked thus * are determined by Celestial Observations; Places not so marked, are from the best Charts, compared and corrected by these.

N. B. H. W. stands for High Water; R. for River; I. for Island; P. for Point; and C. for Cape.—The Longitude is reckoned from the Meridian of London.

Coast of the UNITED STATES *of* AMERICA.

	Lat. D. M.	Long. D. M.
* ENTRANCE of St. Croix River	45 00 N.	67 00 W.
Island of Campo-Bello, (middle or West passage of Passamaquoddy Bay) —	44 50	67 4
Wolves'-Islands	44 48	66 50
E. end of Grand-Manan	44 40	66 50
Grand-Manan N. head	44 43	66 55
do. West end —	44 30	67 4
do. S. W. Ledge of Seal-Rock —	44 25	67 6
Quady-Head (N.E.P.)	44 43	67 5
Entrance of Machias River —	44 35	66 56
Cross-Island off Machias Bay —	44 31	67 23
Machias Seal-Islands—	44 27	66 52
Beal's Island (S. point)	44 24	67 37
Little-Manan-Island	44 19	67 52
Gouldsboro'-Harbour	44 20	67 56
*Mount-Desert-Rock	43 52	68 05
Cranberry Island (near Mount-Desert)	44 14	68 12
Long-Island, (South of Mount-Desert or entrance of Blue-Hill-Bay) -	44 06	68 22
Isle of Holt -	44 00	68 5
Castine (formerly Penobscot) -	44 24	68 46
Matinicus-Island -	43 50	68 56
Wooden Bald Rock	43 45	68 55
Island of Manheigin	43 44	69 15
Penmaquid-Point	43 48	69 27
Townsend, or Booth-Bay entrance -	43 49	69 04
do. South point Rock	43 26	69 07
Bantum Ledges -	43 42	69 03
*Kennebeck-River entrance - -	43 43	69 42
*Seguine Island -	43 41	69 41
Cape-Small point -	43 40	69 47
Cashe's-Ledge, (shoalest part) - -	43 04	69 06
Alden's-Ledge, (off Cape-Elizabeth)	43 28	70 00
Brunswick - -	43 52	
*Fort-Hill (Portland)	43 43	
*Portland Light-House	43 39	70 08
*Cape-Elizabeth -	43 33	70 06
Saco River entrance	43 28	70 17
Wood-Island off do.	43 27	70 15
Biddeford Town	43 30	70 21
Agamenticus-Hill	43 16	70 36
Cape-Porpoise -	43 21	70 20
Wells harbour -	43 19	70 28
Bald-head - -	43 13	70 30
Cape-Neddock Nubble	43 10 N.	70 31 W
York-River -	43 07	70 33
Boon-Island - -	43 06	70 26
Boon-Island-Ledge	43 04	70 22
*Portsmouth Light-House - -	43 04	70 39
*Portsmouth - -	43 05	70 41
*Isles of Shoals -	42 57	70 33
*Newburyport Lights on Plumb-Island	42 48	70 46
*Ipswich entrance	42 43	70 44
*Squam (Pigeon Hill)	42 42	70 36
Sandy Cove (or Bay)	42 41	70 34
*Cape-Ann lighthouses on Thatcher's island	42 40	70 33
*East Point of Cape Ann Harbour - -	42 38	70 39
*Light house on Baker's Island	42 35	70 45
*Beverly - -	42 35	70 50
*Salem - -	42 34	70 50
*Marblehead -	42 32	70 49
*Nahant Point (N. E. Point of Boston harbour) - -	42 27	70 52
*Boston Light-House	42 21	70 53
*Boston - -	42 23	70 58
*Cambridge (Mass.)	42 23	71 3
*Cape-Cod - -	42 05	70 14
*Cape-Cod light-house	42 05	70 14
Sandy Point or Malabar	41 34	70 00
Shoal of George's, E end	41 45	68 22
do. of do. W. end	41 35	68 54
Nantucket Great round Shoal - -	41 25	69 55
*Nantucket light house	41 22	69 58
*Sancoty head on Nantucket-Island -	41 16	69 56
*Tom-Nevers-head	41 14	69 57
*Nantucket south-shoal	40 44	69 55
Cape Poge - -	41 25	70 27
Squibnocket-head (southwesterly part of Martha's Vineyard)	41 19	70 48
* Gay Head Light House	41 22	70 53
Noman's Land-Island	41 16	70 52
New-Bedford -	41 41	70 57
Buzzard's Bay entrance	41 28	70 58
*New-Port entrance	41 29	71 23
*Rhode-Island Light-House - -	41 28	71 30
*Point Judith	41 24	71 33
*Block-Island (Middle)	41 10	71 40
Montock-Point, East end of Long-Island	41 04	72 01
*New London, (or entrance of Thames-River) -	41 22	72 16
Norwich on do. -	41 34	72 29
*New-Haven entrance-	41 18	72 57

	Lat. D. M.	Long. D. M.
*New York light house on Sandy Point	40 28N.	74 07W
Perth-Amboy -	40 35	
Little Egg Harbour	39 30	74 23
Great Egg Harbour	39 18	74 33
Cape May -	38 57	74 55
Philadelphia -	39 57	75 14
Cape James -	38 47	75 08
Light-house on Cape Henlopen -	38 47	75 10
False-Cape -	38 27	75 08
Cape Charles -	37 11	76 10
Cape Henry -	36 58	76 17
Norfolk (Vir.)	36 55	76 37
Peterſburgh (Vir.)	37 14	77 54
York-Town (Vir.)	37 12	76 52
Richmond (Vir.)	37 30	77 50
Annapolis (Mar.)	39 00	
Alexandria (Vir.)	38 49	77 18
Waſhington (City)	38 53	77 14
Chincoteague ſhoals, (on Maryland ſhore)	38 00	75 05
Baltimore -	39 20	76 50
Roanoke Inlet -	35 47	76 08
Cape Hatteras ſhoals (South Weſt point)	34 48	76 00
Cape Hatteras -	35 08	76 7
Occacocke Inlet -	34 54	76 28
Newbern (N. C.)	35 14	
Beaufort (N. C.)	34 42	
Cape Lookout -	34 22	77 06
Shoals off do. (S. part)	34 12	77 01
Gore Sound (or entrance to Beaufort)	34 28	77 18
Bouge Inlet -	34 33	77 38
Bear do. -	34 32	77 42
New River do.	34 27	77 52
Topſail do. -	34 18	78 04
Wilmington (N. C.)	34 11	78 21
Peterſburgh (Geor.)	33 46	81 32
Cape Fear -	33 50	78 25
S. end of do. Shoals	33 40	78 23
Fryingpan-Shoals off ditto -	33 30	78 17
George Town (Geor.)	33 14	79 07
Shoals off do.	33 10	79 03
Cape Roman	33 03	79 24
Charleſton light-houſe	32 44	80 02
North Eddiſto Inlet -	32 33	80 16
South Eddiſto do.	32 30	80 24
Beaufort (S. C.)	32 28	
Port Royal -	32 05	80 52
Tybee-Light -	32 00	80 57
St. Catherine-Sound	31 37	81 18
St. Simon's Sound	31 01	81 48
Brunſwick (Geor.)	31 10	
Amelia Sound (or entrance of St. Mary's river)	30 35	82 00
Talbert's Iſland (Geo.)	30 20	82 00

Iſlands in the Weſt-Indies.

	Lat. D. M.	Long. D. M.
Trinidada, (N. E. P.)	10 45N.	60 36W
Tobago, N. E. ditto	11 29	59 57
S. W. ditto	11 5	60 49
Grenada, (N. E. Pt.)	12 14	61 49
S. W. ditto	11 57	62 19
Grenada Bank, Middle	11 55	62 45
Barbadoes, (S. Point)	13 4	59 45
E. ditto	13 12	59 37
Bridge Town	13 9	59 51
N. W. Point	13 22	59 52
St. Vincent, (N. Point)	13 12	61 16
S. ditto	13 4	61 15
St. Lucia, (S. Point)	13 30	61 0
N. ditto	13 56	60 46
Martinico, (S.E. Point)	14 24	60 57
Dimond ditto	14 24	61 1
Port Royal	14 36	61 4
W. Point	14 25	61 14
N. E. ditto	14 58	61 0
Dominica, (S. Point)	15 15	61 20
N. ditto	15 29	61 25
Marigalante, (N. E. P.)	16 4	61 0
S. E. ditto	15 53	60 59
Guadaloupe, (S. Point)	15 54	61 43
N. ditto	16 30	61 42
Grandeterre, (S.E. P.)	16 15	61 4
N. ditto	16 41	61 25
Deſeada, (N. E. Point)	16 24	60 56
S. W. ditto	16 18	61 3
Antigua, (E. Point)	17 3	61 45
Montſerrat, (N. E. P.)	16 47	62 12
S. W. ditto	16 40	62 15
Redondo Iſland -	17 3	62 20
Nevis - -	17 17	62 28
St. Chriſtophers, or St. Kitts, (S. E. Point)	17 16	62 31
N. W. ditto	17 26	62 42
St. Euſtatia, (the Town)	17 29	63 4
Saba - -	17 39	63 8
Aves Iſland	15 33	63 35
Barbuda, (S. E. Point)	17 50	61 45
St. Bartholomew, E.P.	17 56	62 34
W. ditto	17 54	62 51
St. Martin's (E. Point)	18 3	62 50
W. ditto	18 40	63 7
Anguilla, (N.E. Point)	18 22	62 46
S. W. ditto	18 9	63 5
Prickly Pear	18 20	63 10
Sombrero -	18 26	63 21
Anegado, (E. Point)	18 36	63 50
W. ditto	18 41	64 1
St. Croix, or Santa Cruz, (E. Point)	17 36	63 40
W. ditto	17 44	64 25
Virgin Gorda, E. Point	18 18	63 40
The Fort	18 18	63 54
Tortola, (E. Point)	18 21	64 27

	Lat. D. M.	Long. D. M.
Tortola, (W. Point)	18 18N.	64 39W
St. John's, (S. Point)	18 5	64 40
St. Thomas, (S. ditto)	18 25	64 41
The Town	18 22	64 46
Porto Rico, N.E. Point	18 39	65 39
S. E. ditto	18 10	65 38
N. W. ditto	18 41	67 46
S. W. ditto	18 11	67 45
La Mona Island	18 10	68 24
Hispaniola, or St. Domingo -		
Cape Enganno	18 27	68 47
Saona I. (E. Point)	17 55	68 48
* Altavela Rock, off ditto	17 23	71 35
Abacou Point	17 52	73 30
*Port au Prince	18 40	72 10
Cape Tiberon	18 15	74 26
*Fort St. Louis	18 19	73 15
Navaza Island	18 18	74 55
Cape Dona Maria	18 38	74 22
*Petit Grove	18 27	72 45
Cape Nicolas	19 46	73 25
*The Mole	19 49	73 25
Tortudas, E. Point	20 2	73 32
W. ditto	20 5	72 54
Monte Christo	19 56	71 39
*Old C. Francois	19 40	69 57
*Cape Samana	19 15	69 10
Cape Raphael	18 56	69 00
Island of Jamaica		
Morant, S.E. end	17 58	75 37
*Port Royal	18 0	76 40
Portland Point	17 44	77 2
Carlisle Bay	17 50	77 15
Pedro Bluffs	17 52	77 35
Black River	18 5	77 40
Savannah la Mar	18 15	78 6
Negril Point	18 17	78 31
Montego Bay	18 40	77 52
St. Ann's Harbour	18 39	76 56
Portia Maria	18 32	76 35
Port Anthony	18 25	76 5
Islands and Shoals lying off Jamaica		
Morant Keys, E.P.	17 35	75 25
W. ditto	17 27	75 48
Pedro Shoals, E.P.	17 20	77 1
Little Cayman, S. W. ditto	19 32	80 10
Great Cayman, S. W. ditto	19 11	81 8
N. ditto	19 18	
Swan I. S. W. do.	17 12	83 30
Mesteriosa Shoal	18 0	83 50
A dry Bank	18 36	73 15
Pracel Shoal	18 50	84 20
Island of Cuba		
C. Mayze	20 16	74 4
St. Jago	19 55	75 35
Cabo de Cruz	19 42	77 52
I. of Pines, (S. W. Point)	21 20N.	83 12W
Cape Corientes	21 46	84 57
Middle Cape	21 44	84 34
Cape Antonio	21 49	85 15
Colorados Rocks, (N. W. P.)	22 30	85 14
Havannah	23 12	82 12
Matanzas	23 12	81 15
Islands and Shoals North of Cuba and Jamaica		
East Reef -	20 12	68 43
North Reef, (E. Point)	20 18	69 10
W. ditto -	20 31	69 32
The Triangle -	20 40	69 48
Square Handkerchief, (N. E. Point)	21 35	70 14
S. W. ditto	21 5	70 43
Grand Turks I. (N. E. ditto) -	21 42	70 49
The Great Caycos, S.P.	21 20	71 30
S. E. ditto	21 43	71 17
W. ditto -	21 40	72 24
Inagua or Heneaga, (N. E. Point)	21 35	72 59
W. ditto	22 4	73 40
Little Inagua or Heneaga, (S. W. Point)	21 42	72 56
N. ditto -	21 56	72 50
Hogstyes, (the Middle)	21 44	73 50
Mayaguana, (E. Point)	22 44	72 33
N. Point	22 51	72 53
S. W. ditto	22 45	72 55
French Keys	22 51	73 27
Miraperoos Keys, S. P.	22 14	74 18
Castle I. or South Key	22 20	74 0
North Key Crooked I.	23 14	74 2
Atwood's Key, N.E.P.	23 29	73 25
Key Verde, S. W. do.	22 12	75 10
The Brothers -	22 38	75 0
Long Island (S. part)	22 48	74 34
N. ditto -	23 38	74 45
Rum Key -	23 54	74 15
Whatland I. (S. part)	24 0	73 55
Little I. (its Centre)	24 4	74 30
Cat Island (S. part)	24 4	74 44
N. ditto -	24 39	75 12
Exuma, (E. ditto)	23 54	75 10
Eleuthera, (Powel's Pt. or S. part) -	24 45	76 10
Egg. I. or (W. part)	25 35	77 10
New Providence, W.P.	24 56	78 5
*Nassau Town in ditto	25 4	77 45
W. P. of ditto	24 57	78 3
Andros I. (S. Point)	24 5	78 0
N. ditto -	25 15	78 30
Frozen Key -	25 22	78 0
The Hole in the Wall	26 10	77 40
Little Bank of Bahama (N. W. Point)	27 45	79 44
Sandy Key	26 33	79 34

	Lat. D. M.	Long. D. M.
Great Iſaac	26 0N.	79 47W
Little ditto	26 5	79 11
Cat Keys Harbour	25 10	79 36
Orange Key	24 43	79 36
Double-Headed Shot Keys, (W. Point)	24 0	80 10
Key Sal	23 31	80 3
Anguilla, E. part	23 22	78 43
Iſl. of Bermudas, Saint George's Town	32 20	64 48
N. W. Point	32 25	64 46
S. W. Point	32 11	65 0

NOTE. This Iſland is ſurrounded with dangerous Rocks at ſix or ſeven Miles diſtance, eſpecially on the North Side.

Coaſt of Florida towards the Mouth of the River Miſſiſippi.

	Lat. D. M.	Long. D. M.
River St. John (Ent.)	30 09N.	81 55W
St. Auguſtine	29 40	81 45
Auguſtine-Bay	29 41	81 49
Cape Caneverel	28 12	80 52
Shoals off do.	28 15	80 47
Cooper's Hill (eaſternmoſt part of Eaſt Florida)	26 42	80 23
Cape Florida	25 44	80 34
Dry-Tortuga-Shoals	24 22	83 10
Cape Sable	25 00	81 37
Charlotte Harbour	26 43	82 55
Spiritu Santo Bay	27 46	83 22
Bay of Apalache	29 40	83 35
Cape St. Blaze	29 35	85 00
Penſacola Bar	30 20	86 42
Mobille Point	30 15	87 21
Mouth of the Miſſiſippi River	29 00	88 37

Coaſt of America from the mouth of the River Miſſiſippi to Cape Horn, with the adjacent Iſlands.

	Lat. D. M.	Long. D. M.
Mouth of R. Miſſiſippi	29 0N.	88 37W
Mouth of Rio Brava	26 7	90 49
New St. Ander	23 46	90 27
Cape Roxo	21 57	99 42
*Vera Cruz	19 12	97 24
Campeche	19 41	92 54
Praceles Shoals, N. P.	23 59	88 54
*Cape Catoche	21 33	87 26
*Loggerhead Key	21 38	87 14
Falſe Cape	21 28	87 14
Cozumel I. S. Point	20 3	87 34
North Triangles, S. P.	18 25	87 26
N. Point	19 5	87 27
Key Bokel	16 27N.	88 14W
Glover's Reef, (N. part)	16 52	87 47
S. ditto	16 33	88 17
Utila, (E. Point)	16 11	87 27
Rattan I. (E. Point)	16 25	86 30
Bonacca I. N. E. ditto.	16 29	85 55
Cape Honduras	16 1	86 9
Cape Cameron	16 0	85 4
Black River	15 56	85 4
Cape Dias Gracias	15 1	82 50
Triangles, (S. part)	16 30	79 55
N. ditto	17 0	80 53
Sand Key, (N. part)	16 30	78 20
St. Andrew's Iſland	12 32	80 50
Corn Iſlands, (N. part)	12 10	82 2
St. John's Point	10 33	82 50
*Porto Bello	9 33	79 44
Gulf of Darien	8 40	76 40
*Carthagena	10 27	75 21
*St. Martha	11 27	73 59
Cape de la Vala	12 10	71 53
Monjes Iſlands	12 23	71 21
Cape Coquibacoa	12 5	71 21
Aruba I. (E. Point)	12 9	69 25
Curacoa I. (N. Point)	12 25	69 7
Cape St. Roman	11 30	69 30
*Point Cabello	10 31	67 26
*Aves Iſland (S. part)	11 54	67 13
Roca Iſland	11 45	66 17
Orchilla Iſland (S. part)	11 44	66 3
Salt Tortuga, E. ditto	11 0	64 44
Blanca Iſland N. ditto	11 40	63 56
Margarita I. N. E. P.	11 10	63 13
N. W. ditto	11 3	63 46
Cape Three Points	10 19	62 25
Oroonoco River	8 25	59 26
Eſſequebo River	6 30	58 30
Surinam River	5 52	55 2
*Cayenne	4 56	52 10
Cape North	1 48	49 57
Mouth of R. Amazon	0 18	51 30
St. Louis de Maranhan	2 15 S.	46 34
Cape Baxas	3 0	42 26
Cape St. Roque	5 1	36 17
Pernambuca or Plende	8 0	35 0
Cape St. Auguſtine	8 32	35 0
St. Franciſco River	11 0	36 15
St. Salvadore	12 46	38 38
Porto Seguro	16 36	39 30
Abrolhos Banks	18 0	38 30
Eſpirituo Santo	20 0	39 45
Cape St. Thome	21 51	40 20
Cape Frio	22 35	41 15
*Rio Janeiro	22 54	42 38
Grande Iſland	23 15	43 30
Santos	24 4	45 30
St. Catherine's Iſland	27 15	49 0
Porto St. Pedro	31 44	51 17
*Cape St. Mary, (N. entrance to R. Plate)	34 45	54 10
Cape St. Anthony, (S. entrance to ditto)	36 31	58 27

	Lat. D. M.	Long. D. M.
Buenos Ayres in ditto River	34 35 S.	58 25 W
Cape La Matas	45 0	65 45
Cape Blanco	47 20	64 36
Bay of St. Julian	49 10	68 38
Straits of Magellan	52 35	67 45
Cape Succefs	55 1	65 21
Staten Ifland	54 40	64 30
* Cape Horn	55 58	67 20

The Weft Coaft of America, from Cape Horn to Behring's Straits.

	Lat. D. M.	Long. D. M.
Cape Horn	55 58 S.	67 20 W
Barnwell's Ifland	55 49	66 52
Cape Diego	54 33	64 6
Juan Fernandez Ifland	29 54	71 22
Arica	18 29	71 5
Conception Bay	36 43	72 34
Lima	12 1	76 43
Gallapagos Ifles	23 30 N.	85 0
Panama	8 48	80 15
Aquapulco	17 10	101 40
Cape Corientes	22 20	107 0
California, (S. point)	23 30	109 30
Nootka, or Saint George's Sound	49 36	126 42
Pr. William's Sound	61 5	147 15
Cook's River	59 0	152 0
Cape Grevill	57 30	153 0
Alafka, S. point	54 45	163 10
Shallow Water point	63 0	162 45
Cape Stephens	64 21	162 15
Norton Sound	64 15	162 0
Cape Rodney	64 35	164 24
Cape Prince of Wales	65 45	168 13

From the River St. Croix to Cape Canfor.

	Lat. D. M.	Long. D. M.
* Entrance of St. Croix River	45 00 N.	67 00 W
Morgone's I. (Entrance of St. John's River)	45 18	65 59
Cape Spencer	45 17	65 50
C. Chignecto, (Entrance Bafon of Mines)	45 24	64 44
Hauto Ifland	45 19	64 47
Annapolis Royal	44 47	65 50
Breyer's I. Var. 11° 15′ Weft	44 19	66 20
St. Mary's Cape, Var. 11° 45′ Weft	44 10	66 7
Cape Forchu	43 52	66 4
Seal Ifles	43 27	65 55
Cape Sable, Var. 11° 15′ Weft	43 27	65 30
Sable I. (Eaft point)	44 8 N.	59 55 W
Weft ditto	44 4	60 30
Port Rofeway	43 40	65 12
Ifle of Hope	43 53	64 39
Port Jackfon	44 13	64 22
Charlotte Bay, Var. 14° Weft	44 34	63 50
C. Sambro Light-houfe	44 30	63 27
Halifax Harbour	44 36	63 23
Port Stephens	45 0	61 53
Sandwich Bay	45 8	61 31
Torbay	45 12	61 11
Port Howe	45 13	61 0
C. Canfor, Var. 15° W.	45 16	60 50

The Gulf of St. Lawrence.

	Lat. D. M.	Long. D. M.
Chedabucto Bay	46 23 N.	60 46 W
Gut of Canfor, (South Entrance)	46 28	60 46
I. Madam	45 29	60 44
Cape Hinchinbroke	45 34	60 24
Louifburg	45 54	59 49
Cape Breton	45 57	59 39
Scatari Ifland	46 2	59 27
Flint Ifland	46 11	59 33
Spanifh Bay, (off Cape Breton)	46 18	59 57
Port Dauphin, ditto	46 23	60 13
C. North Ifland, ditto	47 1	60 10
Port Hood	45 57	61 20
Juftan Corp Ifland	45 56	61 22
Gut of Canfor, (North Entrance)	45 42	61 22
Cape St. George or St. Lewis	45 51	61 44
St. John's I. N. Cape	47 2	63 49
Weft point	46 34	64 11
Eaft ditto	46 27	61 48
Bear Cape	46 0	62 13
Hilfborough Bay	46 6	62 55
P. Efcuminac	47 1	64 37
Mifcou I. (Entrance of Chaleur Bay)	48 0	64 16
Cape Defpair	48 24	64 1
Ifland Bonaventure	48 28	63 53
Flat Point	45 34	63 53
Cape Gafpe and Bay	48 41	63 53
Cape Rozire	48 47	63 56
Magdalen R.	49 13	65 18
Cape St. Ann	49 3	66 0
Mount Camille	48 37	67 15
I. de Bik, in the R. St. Lawrence	48 32	67 50
I. of Anticofta, (E. P.)	49 8	61 34
S. W. ditto	49 22	63 18
Weft ditto	49 48	64 18
North ditto	49 53	63 58
Deadman's Ifland	47 15	61 48

	Lat. D. M.	Long. D. M.
Entry Iſland	47 15N.	61 15W
Magdalen I. S. W. P.	47 12	61 36
N. E. P.	47 41	60 55
Brion Iſland	47 52	60 55
Bird Iſlands	47 55	60 36
St. Paul's Iſland	47 11	59 55

Newfoundland.

	Lat. D. M.	Long. D. M.
Limits of the Great Bank of Newfoundland, North point	50 15N.	49 45W
South point	41 0	52 0
Outer Bank	47 0	45 0
Cape Norman	51 40	55 57
Bay St. Barbe	51 15	56 48
Point Ferolle	57 3	57 6
St. John's Iſland	50 50	57 18
Ingornachoix bay	50 38	57 22
Bay St. Paul	49 50	57 50
Cape St. Gregory	49 22	58 12
South Head	49 7	58 21
C. St. George	48 30	59 8
God Roy Iſland	47 52	59 18
C. Ray,	47 37	59 10
*Burges Iſland	47 32	57 37
Great Barriſuay	47 37	57 40
Runney Iſland	47 32	57 25
Penguin's iſlands	47 24	57 0
Fortune bay	47 16	55 30
Burnet	47 15	55 56
Great Miquelon	46 55	56 16
Langley Iſland	46 42	56 15
St. Peter's Iſland	46 36	56 6
Chapeau Rouge	46 52	55 17
Bay of Placentia	47 0	54 30
Cape St. Mary's	46 52	54 2
St. Mary's bay	46 50	53 30
Cape Pine	46 40	53 15
Cape Race	46 42	52 44
Cape Ballard	46 49	52 37
Cape Broyle	47 7	52 30
Bay of Bull	47 21	52 24
Cape Spear	47 30	52 15
*St. John's harbour	47 32	52 20
Cape St. Francis	47 54	52 25
P. of Grates	48 22	52 30
Trinity bay	48 30	53 0
Cape Bonaviſta	48 52	52 35
Barrow harbour	48 50	53 0
Funk Iſland	50 1	52 12

	Lat. D. M.	Long. D. M.
Cape Freels	49 34 N	52 55W
Wadham iſlands	49 54	53 25
Gander Bay	49 40	54 10
Fogo Iſland *	50 0	53 49
Twillingate iſlands	50 3	54 35
Bay of Notre Dame	50 0	55 30
Cape St. John	56 10N.	55 33W
Horſe iſlands	56 21	56 46
White bay	50 15	56 20
Hooping harbour	50 46	56 13
Green Iſland	50 47	55 30
Groais Iſland	50 55	55 40
Hare bay	51 15	55 56
St. Anthony's Cape	51 17	55 39
Quirpon harbour	51 40	55 34
Bell Iſle	51 55	55 25

From Quebec to Hudſon's Bay.

	Lat. D. M.	Long. D. M.
Quebec	46 55N.	69 46W
St. Paul's bay	47 30	69 10
Bay of Rocks	48 5	68 38
Laval bay	48 55	68 0
St. Nicholas's bay	49 28	67 0
Trinity bay	49 37	66 27
The Seven iſland bay	50 7	65 45
Grand Bay, St. John's	50 22	64 0
Mingan Iſland	50 16	63 15
Eſkimaux iſlands	50 12	63 0
Mount Joli	50 5	61 30
Little Mecatina iſlands	50 28	59 27
Great Mecatina point	50 42	59 8
Haha bay	50 52	59 2
Eſkimaux bay	51 28	57 45
Grand point	51 24	57 12
Forteau bay	51 30	56 55
Red Cliffs	51 33	56 45
Black bay	51 40	56 42
Red bay	51 44	61 25
York point	51 57	55 52
Cape Charles	52 13	55 25
Great Bay of Eſkimaux	54 20	57 30
Cape Harriſon	54 54	56 45
St. Peter's harbour	56 28	60 45
Inchanted Cape	56 40	60 50
Sadel Iſlands	57 13	60 45
Eaſt Iſland	57 45	61 15
Steel point	58 7	61 45
Cardinals Iſland	58 50	62 55
Falſe Black Head	59 20	69 14
Black Head	59 50	63 32
Button's Iſlands	60 47	65 16

Hudson's Bay.

	Lat. D. M.	Long. D. M.
Button's Iſles	60 47N.	65 16W
Lowe's Savage Iſland	61 48	56 20
Terra Nieva	62 4	68 0
Saddle Back Iſland	62 10	68 10
Great Bear Iſland	54 4	79 56
Ice Cove	62 0	69 0
Baker's Dozen	57 0	
Great Savage Iſland	62 25	70 0
North Bluff	62 26	71 10
God's Mercies	62 28	70 48
Saliſbury Iſland	63 30	76 50
Nottingham (E. End)	63 35	76 45
Cape Charles (Eaſt End)	62 50	74 15
Weſt End	62 40	76 0
Cape Walſingham	62 40	78 0
Cape Diggs	62 45	78 48
Mansfield (North end)	62 40	78 0
South end	61 35	81 30
Sleeper's Iſland	60 10	81 30
Great ditto	58 35	81 30
Cape Pembroke	62 57	82 10
Large Swan's Neſt	62 20	83 30
Cape Southampton	62 10	86 10
Churchill River	58 47	94 7
Charlton Iſland	52 3	79 5
Port Nelſon's Shoals	57 35	92 30
Hay River	77 10	93 0

Davis's Straits.

	Lat. D. M.	Long. D. M.
Cape Reſolution	62 40N.	46 38W
Cape Comfort	62 45	47 30
Hope Harbour	63 55	47 50
Gilbert's Sound	64 15	47 53
Cooken Sound	64 50	47 58
K. Chriſtian's River	66 7	47 8
Muſketto Cove	64 55	52 51
Romel Fort	67 22	45 53
Diſco. I. (S.W. Point)	69 6	44 38
Waygate Iſland	70 40	44 8
James I. C. *Bedford*	68 30	50 8
Cumberland Iſland S. P	66 0	60 30
Bay of Good Fortune	64 20	61 29
Reſolution *Iſland*, Cape	62 5	64 30
Warwick	61 4	64 30

The Coaſt of Greenland.

	Lat. D. M.	Long. D. M.
*John or Manen's I.	71 10N.	9 44W
Gael Hamkes *Bay*	75 0	6 45
Bontokoe Iſland	73 27	9 30
Charn point	70 5	22 17
Dangy Iſland	67 23	27 19
Herjoiſs Neſs	65 3	30 19
Whales Iſland	62 30	39 3
Cape Diſcord	60 50	39 55
Cape Prince Chriſtian	59 55	41 30
*Cape Farewel	59 38	42 38
Cape Deſolation	62 0	46 7

The Coaſt of Iceland.

	Lat. D. M.	Long. D. M.
Reikianeſs Cape	63 55N.	22 40W
Weſtman's Iſland	63 2	21 4
Palrixfiord	65 36	24 4
*Straumneſs	65 40	24 26
North Cape	66 34	23 5
Grims Iſland	67 0	21 41
*Rikefiord	67 0	17 30
Long Noſe	66 45	12 14
Balaneſs	66 2	12 16
Enchuiſon Iſland	65 0	10 0
Engelhoaſt	64 32	12 14
Wreeland Iſland	64 5	13 14
Cape Hekla	63 22	16 49

Engliſh Coaſt from London to St. Mary's Light, Scilly.

*London —	51 32N.	0 0E	
*Greenwich Obſ.	51 29	0 5	
Woolwich —	51 30	0 9	
Purfleet —	51 30	0 19	
Graveſend —	51 27	0 28	
Rocheſter —	51 23	0 38	
Nore —	51 28	0 51	
N. Foreland light	51 25	1 32	11 45
S. Foreland lights	51 12	1 30	
*Dover - —	51 8	1 24	11 15
Dungeneſs —	50 52	1 5	10 30
Haſtings —	50 53	0 47	10 45
Beachy Head —	50 44	0 26	10 15
Shoreham —	50 47	0 11W	9 15

	Lat. D. M.	Long. D. M.	H.W. H.M.
Arundel —	50 46 N	0 26W	9 30
Selſey Bill —	50 43	0 41	9 30
Owers (S.E. Part)	50 36	0 36	9 30
*Portſmouth Town —	50 47	1 0	11 15
Iſle of Wight			
*Bembridge Ledge or Point	50 40	0 59	11 45
*Dunnoſe —	50 33	1 10	9
*Saint Catherine's Point —	50 30	1 14	9
*Needles Lights	50 41	1 24	9 30
Pool Harbour —	50 42	2 5	9
St. Alban's Head	50 37	2 8	7 30
*Weymouth —	50 37	2 30	6 15
Portland Lights	50 31	2 31	7 15
Exmouth Bar —	50 37	3 18	6 15
Torbay, Berry Head —	50 22	3 22	6 30
Dartmouth	50 18	3 33	6 15
*Start Point —	50 9	3 40	6 45
Praul ditto	50 8	3 47	6
*Eddyſtone Light	50 8	4 18	5 30
Hand Deeps	50 11	4 22	5 30
Ram Head —	50 18	4 15	5 45
*Plymouth	50 22	4 10	6 15
Fowey —	50 17	4 47	5 30
*Deadman's Pt.	50 12	4 54	5 15
*Falmouth —	50 8	5 5	5 15
Manacles Rocks	50 2	5 6	5
Black Head —	50 5	5 10	5
*Lizard Point	49 57	5 14	5
Mount's Bay —	50 8	5 37	5
Runnel's Stone	50 2	5 48	5
Wolf Rock —	49 56	6 30	4 45
Land's End	50 6	5 55	4 30
*St. Agnes Light (Scilly) —	49 55	6 42	4 45
*St. Mary's ditto	49 57	6 36	4 45

French Coaſt from Calais to Uſhant.

	Lat. D. M.	Long. D. M.	H.W. H.M.
*Calais —	50 58N.	1 57E.	
Cape Griz Nez —	50 58	1 40	3 15
Bologne —	50 44	1 44	3 15
Etaples	50 31	1 47	3 15
St. Vallery —	49 52	0 47	3 15
*Dieppe	49 55	0 10	11
Fecamp —	49 50	0 30	11
*Havre de Grace	49 29	0 12	9
*Paris —	48 50	2 15	
Mouth of Seine	49 27	0 10W	9
*Caen —	49 11N.	0 16W	11
Cape Barfleur Ls.	49 44	1 7	10 30
Cherbourgh —	49 38	1 32	7 15
Cape St. Germains	49 46	1 52	9 .
Alderney I. (W. Point) —	49 48	2 12	9
Caſkets Lights	49 48	2 25	10
Guernſey I. (W. Point) —	49 32	2 36	
Sark I. (N. Point)	48 28	2 16	
Jerſey I. (N.W.P.)	49 16	2 17	6 30
*Coutance —	49 3	1 21	6
*Granville	48 50	1 31	6
*Avranches —	48 41	1 17	6 30
*St. Maloe	48 39	1 56	6 30
Cape Frehel —	48 48	2 22	
St. Brieux	48 32	2 48	
De Brahat Iſland	48 52	2 52	7 30
Roche Blanche	48 59	3 52	7 30
*St. Anthony's Lights —	48 40	4 24	6
*Uſhant, W. Pt.	48 29	4 58	4 30

The Current in the Mid. Channel is N. E. about 1 H. 30 M. after High Water; and it runs off Dungeneſs 4 H. to 4 and an half hours; in the Downs 4 Hours; and Eaſt, in the King's Channel, 3 Hours after High Water.

In the firſt column of the following table is given the time of high water at the principal headlands, &c. in the channel, on full and change days: In the ſecond column is given the time the current runs after high water: And in the third the time the current has done running.

High Water.	H.M.	H.M.	H.M.
At the Lizard, at	5 0	3 0	8 0
Off the Eddiſtone	5 30	3 0	8 30
Off the Start	6 10	2 30	8 40
Off Portland —	7 15	3 0	10 15
Off I. of Wight	8 14	3 15	11 29
Off Arundel and Shoreham —	9 15	1 15	10 30
Off Beachy	9 45	1 15	11
Off Dungeneſs	10 30	4 0	2 30

NOTE. The Variation in the Engliſh and St. George's Channels, is 25° 30', and on the Eaſt Coaſt of England 23° Weſt, and about the Orkneys and Shetland Iſlands about two and a half Points, on the Weſtern Coaſt of Ireland two and a quarter Points Weſt, and is found to vary between 11 and 12 Minutes Weſterly every Year, or a Degree in five and a half Years; therefore, by adding a Degree for every five and a half Years to the Variation here given for 1793, you will have the Variation nearly for any ſucceeding Year.

From the North Foreland to Duncan's Bay Head.

	Lat. D. M.	Long. D. M.	H.W. H.M.
*North Foreland	51 25N.	1 32E.	11 45
Kentish Knock	51 43	1 45	11 30
Long Sand Head	51 48	1 45	11 30
Galloper (N. P.)	51 58	2 0	12
Ditto (South P.)	51 48	1 59	12
Shipwash (N. P.)	52 9	1 43	12
Ditto (South P.)	52 2	1 39	12
Gabbard —	52 5	1 45	12
Orfordness	52 13	1 40	10 30
Aldboro' knaps, (South Point)	52 15	1 49	9 45
Southwold	52 28	1 37	9
Leostaff Lights	52 38	1 49	9
*Yarmouth	52 45	1 45	8 15
Winterton Ness Lights —	52 54	1 40	8 15
Smiths Knowl	52 57	2 20	
Hailborough Sand, (S. P.)	52 54	1 48	7 30
Ditto, (North P.)	53 06	1 32	7 30
Cromer Lights—	53 3	1 16	9
Lemon and Ower, North Point —	53 23	1 43	
Ditto, South P.	53 13	1 45	
Cromer Bank —	53 21	1 30	
Dudgeon Lights	53 26	1 0	7 30
Outer Dowsings	53 40	1 0	
Inner Dowsings	53 22	0 50	5 30
Lynn Deeps —	53 0	0 27	6
Spurn Lights	53 41	0 22	5 15
* Flamborough Head —	54 10	0 7	4 30
Filey Brig	54 17	0 5W	4 30
Scarborough —	54 21	0 13	4 30
Robin Hood's Bay —	54 30	0 22	3 45
Whitby —	54 34	0 27	3 15
River Tee's Mouth, Stockton —	54 41	0 59	3 30
River Tee's Mouth, Newcastle—	55 2	1 9	3 30
Cuquet Island	55 22	1 21	2 30
Staples Islands—	55 39	1 40	2 30
Holy Island	55 42	1 48	2 30
Berwick —	55 47	2 1	2 45
St. Abb's Head	55 57	2 6	4 30
Dunbar—	55 59	2 29	1 30
May Island Lights	56 11	2 32	4 30
* Edinburgh —	55 58	3 9	4 30
Fife Ness	56 15	2 33	4 30
Mouth of Tay—	56 26	2 38	3 30
C. Rock, off ditto	56 29	2 22	3 30
Red Head —	56 38	2 24	12
Montrose —	56 44	2 28	12
New Aberdeen	57 7	1 51	12 45
Peter Head —	57 34N.	1 42W	12
Buchan Ness	57 31	1 42	12
Kinnaird's Head	57 39	1 56	12
Bamff —	57 38	2 27	11 30
Fort St. George	57 33	4 1	11 15
Inver Ness —	57 28	3 45	11 15
Cromartie	57 42	3 56	11 15
Tarbet Ness —	57 52	3 44	11 15
Caithness	58 17	3 3	11
Nose Head —	58 28	3 4	11
Duncansbay Head	58 43	3 5	8 15

The Orkney Islands.

	Lat. D. M.	Long. D. M.	H.W. H.M.
Pentland Skerries —	58 41N.	2 55W	11 30
Stromo —	58 45	3 10	11 30
South Ronaldsha, South Point	58 47	3 0	11 30
Copinsha —	58 54	2 45	11 30
Lambs Head, on Stronsal Island	59 4	2 40	11
North Ronaldsha, North Point	59 23	2 38	10 30
Mould Head, on Patra Westra Island —	59 21	3 10	9
Noup Head, on Westra Island	59 18	3 15	9
Marwick Head, on Pomona I.	59 6	3 26	10
Hoy Head, on Hoy Wells I.	58 55	3 28	10
Slue Skerry —	59 3	3 34	10
Fair Island —	59 30	1 48	4

The Shetland Islands.

	Lat. D. M.	Long. D. M.	H.W. H.M.
Sunbro Head, South Point —	59 47N.	1 19W	4
Rose or Hangcliff	60 13	0 38	4
Brassa Sound, Larwick —	60 12	0 56	4
Out Skerries	60 42	0 8	4
Whalsey Isle —	60 35	0 32	4
Ulst I. N. E. P.	61 7	0 15	4
Foul Island —	60 18	2 16	3

Ferro Islands.

	Lat. D. M.	Long. D. M.	H.W. H.M.
The Munk Rock appears like a Ship under sail	61 18N.	6 47W	3
Fulae I, N. E. part of Ferro	62 12	6 7	4
East Point of Mygenes Isl. N. W, part of Ferro —	62 3	7 32	4

From Duncan's Bay to the Head of the Land's End.

	Lat. D. M.	Long. D. M.	H.W. H.M.
Duncansbay Head	58 43N.	3 3W	11 30
Dunnet Head —	58 44	3 18	11 30
Farout Head	58 36	5 0	11 30
Cape Wrath, or Barre Head —	58 36	5 20	7

	Lat. D. M.	Long. D. M.	H.W. H. M.
A Rock ſeen at ¾ Ebb —	58 45N.	5 21W	7
Rona Iſland	58 55	6 15	7
Rockal —	57 28	10 32	
St. Kilda	57 51	8 56	
Butt of the Lewis	58 29	6 34	5 30
Gallan Head —	58 10	7 24	4 15
Flannan Iſland	58 13	7 50	4 15
Hiſkere Iſland —	57 23	7 58	5
Na Monich I.	57 22	7 56	5 45
Bara Head —	56 56	7 44	5 30
Rocks very dangerous	56 55	7 7	5 30
Cana Iſlands —	57 3	6 58	5 30
Hyſker Iſlands	56 56	6 58	5 30
Rum I. Weſt P.	56 59	6 46	5 30
Tircey I. S. P. —	56 30	7 12	5
Colt I. North P.	56 42	6 45	5
Bomſhly Rocks	56 9	7 5	5 30
Skerryvore —	56 17	7 22	5 30
Ila I. S. W. P.	55 47	6 44	10 30
Ditto, South P.	55 39	6 30	10 30
Rachland Iſl. E. Part —	55 17	6 17	9 45
Mull of Cantire Light Houſe	55 21	6 0	11
I. of Arran, S. E. Part —	55 32	5 20	11
Cumray I. Entrance of Clyde	55 47	5 17	11
Elſa Iſland —	55 16	5 24	11
Irvin —	55 36	5 0	11 45
Air —	55 26	4 57	11 45
Loch Ryan —	55 3	5 21	11 30
Port Patrick Lts.	54 48	5 20	11
Mull of Galloway	54 37	5 8	11
Great Scar Iſland	54 40	4 57	11
Burrow Head	54 41	4 39	11
Solway Firth	54 47	4 30	11 30
St. Bee's Head Light ——	54 30	3 50	11 15
White Haven	54 32	3 47	11 30
Selker Rock	54 16	3 39	11
Lancaſter ——	54 3	3 3	11 15
Liverpool	53 27	3 12	11 15
Great Orms Head	53 20	4 3	10 30
Skerries Light --	53 25	4 50	9 45
Holyhead --	53 19	4 52	9 45
Brachy Pool Head	52 47	4 57	7 30
Bardſey Iſland --	52 45	5 0	7 30
Barmouth --	52 48	4 12	8
Cardigan Harbour --	52 12	4 47	7 15
Strumble Head	52 0	5 10	7
St. David's Head	51 55	5 20	6
Ramſey Iſland --	51 48	5 22	6
Small's Light Houſe ---	51 48	5 36	9
St. Ann's ditto, Milford Haven	51 44	5 10	5 30
Worms Head —	51 35	4 22	5 30
Caldy Iſland ---	51 43	4 42	5 15

	Lat. D. M.	Long. D. M.	H.W. H. M.
Lundy Iſland Entrance of *Briſtol* Channel	51 15N.	4 44W	5 5
Mort P. S. Entrance of *Briſtol* Channel	51 15	4 15	5 30
Hartland Point	51 4	4 38	5 45
Padſtow	50 42	4 55	5 45
Towan *Head*	50 30	5 7	5 45
St. Ives *Bay*	50 17	5 34	4 30
Cape Cornwall	50 10	5 55	4 30
The Seven Stones	50 6	6 23	4 30
The Wolf Rock	49 57	6 2	4 30
The Land's End	50 6	5 55	4 30

Ireland.

	Lat. D. M.	Long. D. M.	H.W. H. M.
Cape Clear	51 15N.	9 50W	3
Faſnet Rock	51 13	9 55	3
Crookhaven	51 19	10 5	3
Mizen Head	51 18	10 13	3 45
Sheep's Head	51 24	10 15	3 45
Bantry Bay	51 26	10 10	3 45
Grelagh Rocks	51 22	10 41	3
Durſey I. W. P.	51 26	10 45	3
Bull Rock	51 27	10 45	3
Cow Ditto	51 27	10 48	3
Cod's *Head*	51 32	10 32	3
Kenmare *Bay*	51 35	10 50	3 30
Lamb's *Head*	51 38	10 37	3 30
Hog Iſland	51 37	10 49	3 30
Hog's *Head*	51 41	10 48	3 45
Bolus Head	51 41	10 55	3 45
Skelling's Rocks	51 40	11 10	3 45
Lemon Rock	51 42	11 2	3 45
Bray Head	51 47	10 49	3 30
Dingle *Bay*	51 55	11 0	3 30
Foze Rock	51 54	11 14	3 30
Fretter's Iſland	51 56	11 22	3 30
Tiraght Rocks	51 57	11 24	3 45
Great *Blaſket*	51 57	11 9	3 45
Ennis Tuſcan	52 0	11 23	3 45
Dunmore *Head*	51 59	10 55	3 45
Dunorling *Head*	52 5	10 57	3 45
Brandon Head	52 9	10 46	3 45
The Seven *Hogs* Rocks	52 11	10 37	3 45
Kerry *Head*, S. Entrance of Shannon River	52 15	10 32	3 45
Loop *Head*, N. Entrance ditto	52 23	10 33	3 45
North Arran, or Killaney	53 6	10 17	4
Galway *Bay*	53 9	9 59	4
Slime *Head*	53 23	10 49	4
Ennis Shark I.	53 34	10 52	4
Ennis Turk I.	53 40	10 42	4
Clare Iſland	53 45	10 36	4 30
Achill *Head*	53 56	10 49	4 30
Black Rock	54 2	10 53	5
Urris *Head*	54 18	10 37	5

	Lat. D. M.	Long. D. M.	H.W. H. M.
Broad Haven	54 15 N	10 29 W	5
Stag Rocks, (off Broad Haven)	54 21	10 24	5
Down Patrick Head	54 18	9 58	5
Sligo Bay	54 15	9 18	5 15
Ennis Murray I.	54 24	9 18	5
Donegal Bay	54 30	9 6	5 30
Tillen Head	54 38	9 25	5 30
Arranmore	54 58	9 8	5 30
Tory Iſland	55 15	8 48	4 30
Loch Swilly	55 17	8 0	5
Malin Head	55 24	7 48	4
Enniſtrahul Rocks	55 29	7 35	4
Iniſhoan Head, (Entrance of Londonderry)	55 16	7 16	4
Bengore Head	55 18	6 44	4
Rachlin I. (Weſt Point)	55 21	6 32	8
Fair Head	55 15	6 22	10 30
The Maid's Rocks	54 55	5 46	10 30
Belfaſt Loch	54 43	5 45	10 30
Copeland Lights	54 41	5 33	10 30
St. John's Point	54 12	5 49	11
Dundrum	54 13	6 0	11
Carlingford Loch	54 0	6 12	10 30
Dundalk	53 57	6 27	10 30
Drogheda Bar	53 45	6 22	11
St. Patrick's I.	53 36	6 10	11
Lambay Iſland	53 31	6 7	11
Dublin	53 22	6 22	11 45
Wicklow Lights	52 59	6 7	10
Wexford	52 22	6 30	8 30
Tuſker Rock	52 12	6 14	8 30
Carnſore Point	52 11	6 23	8 30
The Saltee Rocks	52 5	6 36	5 30
Hook Lights, (Waterford Harbour)	52 3	7 3	4 30
Dungarvon	51 59	7 36	5
Helwick Head	51 57	7 36	5
Youghall	51 50	7 53	5
Cork Harbour	51 41	8 23	4
Kinſale Harbour	51 34	8 42	4
Old Head of Kinſale	51 30	8 42	4
Seven Heads	51 27	8 52	4
Dundedy Head	51 25	9 8	4
The Stags, (off Toe Head)	51 19	9 23	4
Baltimore Harbour	51 20	9 40	4

The Iſle of Man.

	Lat.	Long.	H.W.
Calf of Man	54 1 N.	5 3 W	10 30
Douglas	54 7	4 42	
Ramſay Bay	54 17	4 38	10 30
Point of Air	54 25	4 34	10 30
Peel Hill	54 12	4 57	10 30

From Calais to the Scaw.

	Lat. D. M.	Long. D. M.
*Calais	50 57 N	1 57 E.
Gravelines	51 0	2 15
*Dunkirk	51 2	2 28
*Newport	51 8	2 51
Oſtend	51 14	3 2
Walcheren I. (Weſt P.)	51 32	3 26
Goree Iſland	51 53	3 58
Schowen Iſland	51 47	3 43
*North Gatt	52 1	4 9
*Rotterdam	51 56	4 34
*Amſterdam	52 23	4 51
Texel	53 10	4 52
Bremen	53 23	8 28
Elbe River, Entrance of	54 4	8 1
Holmen	57 1	8 38
Robſnout	57 30	9 49
Scaw	57 42	10 43

From the Naze to Peterſburg.

	Lat.	Long.
*Naze of Norway	57 59 N	7 13 E.
Fer Light	59 20	10 8
Chriſtiana	59 50	10 20
Frederickſtad	59 10	10 35
Paternoſters	57 54	11 32
Marſtrand Light	57 54	11 40
Wingo Beacon	57 38	11 42
Gothernburgh	57 42	11 45
Leſſou I. (Eaſt Point)	57 20	11 9
Weſt Point	57 17	10 51
Trindelen Rock	57 28	11 15
Kummel Bank	57 27	11 21
Nidigen Light	57 18	12 1
Warberg	57 7	12 19
Falkenburgh	56 54	12 34
Halmſtad	56 40	12 56
Halland's I. (Wadero)	56 26	12 36
Koll Light	56 19	12 33
Anholt Light	56 44	11 36
Haſelo Iſland	56 12	11 48
Hielm Iſland	56 10	10 54
Cronenburgh Light	56 3	12 42
*Elſeneur	56 1	12 41
Huen I. (North Point)	55 55	12 44
*Lendscrone	56 8	12 5
*Copenhagen	55 41	12 41
Saltholm (North Point)	55 41	12 51
Falſtrebo Light	55 21	12 53
Lubek	53 51	10 50
Dars Head	54 28	12 40
Barnholm I. (N. E. Pt.)	55 19	14 54
S. W. Pt.	54 57	15 17
*Dantzick	54 22	18 40

	Lat.		Long.	
	D.	M.	D.	M.
Oland (North Point)	56	11N.	16	29E.
South Point	57	24	17	9
Gotland (North Point)	56	55	18	16
South Point	57	55	19	37
Goltſke Iſland	58	16	19	27
Memel	55	24	21	6
Swaferott Lights	57	55	22	1
Domes Neſs Lights	57	48	22	30
Runoe Light	57	49	23	12
Riga	57	2	23	45
Dagerort Light	58	56	22	3
Hengo Light	59	49	23	2
*Stockholm	59	21	18	9
*St. Peterſburgh	59	56	30	25

From the Naze to Archangel.

	Lat.		Long.	
	D.	M.	D.	M.
*The Naze	57	59N.	7	13E.
Liſter Land	58	9	6	45
Judder, or Walbert's Hd	58	34	5	55
Rutt's Iſland	58	42	5	58
Great Wylingſoe Light Houſe	58	56	5	50
Stavanger	58	56	6	5
Ulſter's Iſland	59	24	5	20
Bergen	60	12	5	50
Mus Sound	60	18	5	30
Sillewoog Iſland	60	36	5	21
Kate Noſe	61	25	5	42
*Drontheim,	63	26	11	10
*Werro Iſland	67	43	9	7
*North Cape	71	10	26	10
*Archangel	64	30	39	0
Weigate's Straits	69	30	62	2
Nova Zembla	78	0	70	0

From Uſhant to Cape Spartel.

	Lat.		Long.		H.W.	
	D.	M.	D.	M.	H.	M.
*Uſhant	48	29 N	5	0W	4	30
**Breſt*	48	23	4	25	3	15
Point Raz	48	2	4	40		
Point L'Abbe	47	48N.	4	11W		
Iſles de Glenan	47	44	4	0		
L'Orient	47	44	3	21		
Iſle de Groa	47	36	3	28		
Quiberon	47	34	3	5		
**Belle Iſle*	47	17	3	1	2	30
Houat Iſle	47	20	2	57		
Dumet Iſle	47	15	2	52		
*Nantes	47	13	1	25		
Nourmouſter Iſl.	47	2	2	10		
Dieu Iſle	46	42	2	16		
*Roche *Bon*	46	14	2	21	4	30
Ree Iſle	46	15	1	28	3	30
*Rochelle	46	9	1	4	3	45
*Rochefort	46	3	0	53		
Oleron Iſle	46	3	1	19		
Cordovan Light-Houſe	45	36	1	6	4	30
**Bordeaux*	44	50	0	30	3	
Cape Feret	44	43	1	10		
**Bayonne*	43	29	1	24	3	30
Cape Machicaco	43	31	3	15		
Bilboa	43	15	3	1	3	
Cape de Lata	43	34	3	53		
Cape Penas	43	48	5	48	3	
*Cape Ortegal	43	46	7	36	3	
Cape Prior	43	31	8	8	3	
Ferrol	43	30	8	0	3	
Corrunna	43	17	8	12	3	
Cape *Belem*	43	10	9	13	3	
Cape Turiana	43	4	9	21	3	
*Cape Finiſterre	42	52	9	14	3	
Vigo *Bay*	42	14	8	34	3	30
Cape Faſilis	42	5	8	50	3	
*Oporto	41	20	8	21	3	
Cape Mondego	40	5	8	46	3	
Cape Fiſeraon	39	24	9	10	3	
The *Burlings*	39	20	9	31	3	
*The Rock of Liſbon	38	45	9	31	3	
*Liſbon	38	42	9	7	3	30
Cape Epichel	38	21	9	15	3	
St. Ubes	38	29	9	0	3	
*Cape St. Vincent	37	2	8	56	3	
Cape St. Mary	37	0	7	55	3	
Point Arenilla	37	6	6	53	3	
*Cadiz	36	31	6	6	3	30
Cape Trafalgar	36	10	5	56	3	
*Gibraltar	36	5	5	16	3	
Ceuta	35	50	5	12	3	30
*Cape Spartel	35	48	5	48	3	

The North Coast of the Mediterranean Sea, from Gibraltar to Constantinople.

	Lat. D.	Lat. M.	Long. D.	Long. M.
*Gibraltar	36	5 N	5	16W
Malaga	36	42	4	15
*Cape de Gatt	36	46	2	24
*Carthagena	37	37	1	2
*Cape Pallos	37	34	0	58
*Alicant	38	18	0	9
Cape St. Martin	38	47	0	5E.
Valentia	39	30	0	32W
Cape Oropeso	40	0	0	7
River Ebro	40	44	0	30E.
*Barcelona	41	26	2	18
Cape Sebastian	41	48	3	15
Cape de Creux	42	18	3	23
Perpignan	42	30	2	57
Cette	43	24	3	46
Narbonne Road	43	0	2	55
Montpelier	43	37	3	49
Mountfort	43	39	5	0
*Marseilles	43	18	5	28
*Toulon	43	7	6	3
Cape Taillar	43	4	6	56
Cape de Oropes	43	29	7	21
Villa Franca	43	42	7	25
Cape de Mille	43	54	7	56
*Genoa	44	25	8	41
Point de Fino	44	16	9	0
*Leghorn	43	27	10	27
Cape M. Nero	43	18	10	0
Vada	43	15	10	35
Piombino	43	0	10	33
Point Ercore	42	29	11	1
*Civita Vecchia	42	5	11	52
*Rome	41	54	12	35
Cape Dazzia	41	38	12	35
*Naples	40	51	14	20
Cape de Polonado	40	3	15	28
Policastro	41	17	15	53
Cape Batican	38	47	16	35
Cape Grose	38	17	16	16
Cape Spartevento	38	0	16	57
Cape Collonia	39	0	18	8
Tarento	40	14	18	2
Galipoli	39	56	18	36
Cape St. Mary, the Entrance to the Gulf of Venice.	39	40	19	14
Brindici	40	38	18	45
Barry	41	4	17	18
Manfredonia	41	40	16	10
Cape Vestio	41	43	16	34
Pescara	43	12	14	30
*Ancona	43	38	13	37
Comacchio	44	25	12	0
*Venice	45	26	12	10
Trieste	46	0	13	34
Rovigno	45	11	13	48
St. Maria	45	23 N	14	25E.
Pescera	44	42	15	40
Cape Sesto	43	45	16	25
Rosaro	42	48	17	40
Patero	42	23	19	15
Dorazo	41	40	18	45
La Vallona	40	55	20	8
Cape Liqueta	40	42	19	50
Pageni	39	19	21	28
Larta	38	55	22	3
Cape de Larta	38	40	21	44
Lepanto	38	15	22	54
Cape Gallo	36	40	21	49
Cape Mantapan	36	35	22	37
Cape St. Angelo	36	37	23	44
Cape Mala	37	34	24	13
Corinth	38	10	23	35
*Athens	38	4	23	58
Negropont	38	28	24	10
Cape Doro	38	0	25	0
Cape St. George	39	10	23	44
*Salonica or Salonique	40	41	23	14
Cape Ballouri	39	43	23	55
Cape Pellice	39	57	24	25
Cape Monte Santo	40	10	24	57
Adrianople	40	44	27	5
Galipoli	40	25	27	11
*Constantinople	41	1	29	0

The South Coast of the Mediterranean Sea.

	Lat. D.	Lat. M.	Long. D.	Long. M.
Ceuta	35	50N	5	12W
Cape Tetuan	35	28	5	14
Cape Negril	35	25	4	24
*Cape Three Forcas	35	38	2	45
Cape Fegalle	36	46	1	2
Cape Falcon	36	6	0	44
Cape Ferrat	36	4	0	3E.
Cape Teanis	36	35	1	12
*Algiers	36	49	2	19
Cape Matisfor	36	52	3	3
*Cape Carbon	36	53	4	15
Cape Tenes	37	4	5	44
Cape Fyel	36	58	6	37
Cape Ferro	37	4	7	33
Bona	36	45	7	53
Tabarca	37	8	8	55
Cape Serra	37	25	9	35
Cape Blanc	37	30	9	35
Tunis	36	45	10	10
Cape Bon	37	9	11	8
Susa	35	44	10	50
Cape Paul	35	5	11	15
Cape de Zoara	33	30	11	24
*Tripoli	32	54	13	11
Magra	32	29	15	0
Cape Mensurato	32	24	15	39
Cape Lorat	31	0	16	30
Cape Studico	31	43	17	37
Stantores	30	17	18	40

	Lat. D. M.	Long. D. M.
Cape Linconta	30 57N.	18 10E.
Cape Sarabion	31 28	19 1
Zoara	31 12	19 0
Cape Bengaza	32 28	20 2
Cape Razat	33 7	22 26
Derne	32 59	22 21
Cape Razatin	32 45	22 57
Cape Luco	32 15	25 25
Cape Soliman	31 40	25 45
Point Ramitan	31 25	26 27
Cape Lagnfego	31 13	27 19
Cape Capopero	31 3	28 49
Cape Rofe	31 0	29 40
*Alexandria	31 11	30 22
Cape Brule	31 44	31 34
Domiata	31 36	32 1
Berella	31 20	32 47
Cape Gallo	31 34	33 55
Jaffa	32 5	35 10
M. Carmel	32 50	35 16
Cape Vardo	34 18	35 57
Tripoly	36 46	36 24
Tortofa	35 20	36 25
Cape Saudin	36 0	36 0
Cape Canzin	36 24	35 47
*Alexandretta, or Scanderoon	36 35	36 26
Aleppo	35 45	37 26
Cape Urico	36 35	34 20
Porto Cavelero	36 33	33 17
Cape Dranmont	36 23	32 7
Satalia	36 58	30 35
Cape Seven Capes	36 31	28 54
Cape Biabe	36 44	28 10
Cape Crio	36 45	27 34
Cape Petrera	37 10	27 30
Cape St. Mary	37 45	27 20
Cape Blanc	38 16	26 32
*Smyrna	38 28	27 26
Cape Baba	39 24	26 20
G. Janefari	39 53	26 32
Cape Capitani	40 13	28 0
Pruffias	40 35	29 4

Iſlands within the Straits.

	Lat. D. M.	Long. D. M.
*Alboran	36 1N.	2 48W
Zaffarine Iſlands	35 23	2 8
Formentera, W. Point	38 41	0 49E.
Ditto, (E. ditto)	38 39	1 10
Ivica, (S. ditto)	38 48	0 51
Ditto, (N. E. ditto)	39 10	1 11
Salina	38 50	0 40
Carbera, (S. Point)	39 10	2 23
Majorca, (S. Point)	39 18	2 30
Ditto, (N. ditto)	40 45	2 40
Ditto, (W. ditto)	39 40	1 51
Ditto, (E. ditto)	39 42	3 2
Minorca, (S. ditto)	39 43	3 50
*Minorca, (St. Phillip's Fort)	39 51N.	3 54E.
Ditto, (N. ditto point)	40 16	3 21
Corfica, (W. Point)	42 30	7 45
Sardinia, (S. W. point)	39 4	8 18
Ditto, (S. E. ditto)	39 0	9 54
Ditto, (N. ditto)	41 15	8 55
Ditto, (N. W. ditto)	40 57	8 2
Senera, (N. point)	41 13	8 6
St. Pelem	39 0	8 5
Tovo	38 40	8 20
Galite	37 50	8 55
Elba	42 48	9 50
Planofo	42 34	9 45
Capraia	43 10	9 35
Gorgona	43 24	9 21
Ponza	42 32	9 55
Lufterca	38 53	13 35
Strombolo	38 57	15 52
Leuaze	38 12	12 20
Marelimo	38 0	12 11
Faugnana	37 56	12 26
Sicily, (W. point)	38 11	12 40
Ditto, (S. ditto)	36 45	15 36
Meffina, in ditto	38 15	15 59
Pantelaria	36 54	12 0
Linofa	35 55	12 38
Piduffa	35 40	12 40
Malta, (N. point)	36 0	14 22
Ditto, (S. ditto)	35 39	14 35
*The harbour in Malta	36 0	14 34
Gozo, (N. point)	36 12	14 50
Corfu, (S. E. point)	39 31	20 50
Fano, entrance of the Gulph of Venice	40 8	21 6
Pelegofa	42 14	16 30
Piani	42 9	16 13
Tremilli	42 10	15 50
Liffa	42 47	16 27
Pomo	43 2	15 55
Longa, (S. E. part)	43 53	15 52
Scio, (S. point)	38 14	26 32
Cerigo, (S. point)	36 22	23 21
Cerigotte	35 55	24 43
Milo	36 41	25 6
Mitelene, (W. point)	39 15	27 12
Goze	35 2	24 5
Candia: S. W. point	35 17	23 56
Candia: Cape Spada	35 45	24 18
Candia: S. E. point	35 21	23 55
Candia: N. E. point	35 35	27 6
Rhodes, (S. E. point)	35 27	28 45
Cyprus, W. point	35 0	31 55
E. point	35 40	35 0
S. point	34 30	33 16

The Coaſt of Africa from Cape Spartel to Cape Verd.

	Lat. D. M.	Long. D. M.
*Cape Spartel	35 48N.	5 47W.
*Larafh	35 11	6 8
*New Sale	32 35	6 38
*Mazagan	33 13	8 11

	Lat. D. M.	Long. D. M.
*Cape Blanco	33 5N.	8 20W
*Cape Cantin	32 35	9 0
*Saffia Bay	32 20	8 40
*Mogadore Iſland	31 27	9 25
*Cape Geer	30 28	9 47
Santa Cruz	30 29	9 34
Cape Nun	28 40	11 10
*Cape Bajadore	26 29	14 20
*Cape das Barbas	22 15	16 34
*Cape Blanco	20 41	16 52
Arguin	20 22	16 22
Cape Miric	19 15	16 16
Portendic	18 6	16 58
Senegal Bar	15 51	16 9
*Cape Verd	14 46	17 47

The Weſtern Iſles.

*Corvo	39 42N.	31 0W
*Flores	39 34	29 54
*Fayal, the Town	38 32	28 37
*Pico	38 29	28 20
Tercera	38 54	28 15
St. George	38 39	27 55
Gracioſa	39 2	28 4
*St. Michael, E. Point	37 47	25 48
ditto W. Point	37 50	26 48
*St. Mary	37 0	25 6

The Madeiras.

*Porto Santo —	32 58N.	16 20W
Rock (E. of ditto under water) —	33 30	16 2
Madeira, (Eaſt Point)	32 50	16 46
Ditto, (Weſt Point)	32 30	17 26
*Funchal —	32 38	17 5
The Salvages Iſland	30 8½	16 4

The Canaries.

*Lanzarote, (North P.)	29 25N	13 26W
*Ditto, (South P.)	28 51	13 41
Forteventura, (Weſt P.)	28 4	14 26
Ditto, (Eaſt Point)	28 40	13 40
*Canaria, (N. E. P.)	28 13	15 33
*Ditto, (South P.)	27 42	15 54
*The Peak of Teneriffe	28 13	16 26
*Ditto, (North P.)	28 39	16 0
*Orotavia in ditto	28 23	16 30
Santa Cruz in ditto	28 27	16 18
Palma, (North Point)	28 36	17 32
Tazicote in ditto	28 6	17 3
Ditto, (South Point)	28 18	17 37
Gomera, at the Port	28 6	17 4
*Ferro, (the Town)	27 47	17 40
*Ditto, (Eaſt Point)	27 50	17 37
Ditto, (Weſt Point)	27 46	17 52

Cape Verd Iſlands.

	Lat. D.M.	Long. D.M.
St. Anthony —	17 9N.	24 48W
St. Vincent —	16 50	24 36
St. Lucia —	16 44	24 31
St. Nicholas —	16 32	24 16
*Sal — —	16 38	22 50
*Bonaviſta —	16 6	22 41
*Mayo — —	15 10	23 0
St. Jago, (North Point)	14 54	23 27
Ditto, (South Point)	14 17	23 25
Brava — —	14 50	24 39
*Fogo — —	14 57	24 22

From Cape Verd to the Cape of Good Hope.

	Lat.	Long.
*Cape de Verd	14 46N.	17 47W.
*Goree Iſle —	14 36	17 37
Cape Naze - -	14 24	17 18
Cape St. Mary, (Ent. to the river Gambia)	13 17	16 56
Cape Roxo —	12 23	17 10
Cape Vergue —	9 52	14 56
Delos Iſles —	9 29	14 7
*Cape Sierra Leon	8 29	13 48
*Cape Ann —	7 7	13 27
*Cape Mount —	6 46	11 42
*Cape Mezurado	6 16	11 17
Cape Baxos —	5 28	10 7
Seſtos River --	5 27	9 47
Cape Formoſa ---	5 8	9 39
*Cape Palmas	4 26	8 15
St. Andrew's River	4 58	6 20
Cape Laho ---	5 12	5 12
*Cape Appollonia	4 59	3 11
*Axim - -	4 52	2 36
*Cape Three Points	4 40	2 38
*Dix Cove --	4 48	2 22
*Sakondee --	5 0	1 51
*Elmina ---	5 10	1 40
*Cape Corſe Caſtle	5 12	1 20
*Devil's Hill --	5 24	0 50E.
*Anamaboe Fort	5 10	1 7
*Acra - --	5 30	0 16
*Tibberacoe ---	5 53	1 23
River Volta ---	5 53	1 25
Cape St. Paul ---	5 52	2 0
Whidah ---	6 25	3 13
Formoſa River ---	5 33	6 10
Cape Formoſa	4 30	6 40
New Callabar River	4 23	8 0
Cameron River	3 20	10 0
Cape St. John ---	1 15	9 23
Gabon River ---	0 0	9 23
C. de Lopas Gonſalvez	0 47S.	9 12
Seſto River ---	2 16	9 45
Alvary Bay ---	3 27	10 40

	Lat. D. M.	Long. D. M.
Congo River	4 35S.	11 5E.
Ambris River	8 55	13 13
Cape Ledo	9 50	12 3
St. Philip de Benguela	12 18	12 35
*Cape Negro (appears like black hommocks)	16 5	12 44
*Tiger's Island	16 30	12 0
Cape Frio	18 40	13 42
*Elizabeth's Bay	26 12	15 30
Cape Roftro de Pedro	23 0	14 0
*Angra Pequena	26 35	15 40
Cape das Voltas	29 0	16 45
*Walwick Bay (N. W. Point)	23 0	14 0
Cape Defeada	32 20	15 24
*St. Helen's Bay (C. St. Martin's)	32 45	17 45
*Saldanah Bay	33 8	18 0
*Cape of Good Hope	34 29	18 29

Iflands between Cape Verd, the Cape of Good Hope, and Cape Horn.

	Lat. D. M.	Long. D. M.
St. Paul's	0 55N.	27 40W.
*Ferdinand Noronha	3 53S.	32 32
St. Matthew	1 33	7 30
Fernand de Po (N. P.)	3 23N.	8 50E.
Prince's Ifland	1 44	7 35
*St. Thomas (Man of War's Bay)	0 27	7 0
*Ditto (S. P.)	0 5	6 50
*Annabona	1 33S.	5 42
*Trinidad (†)	20 28	28 35W.
*Martin Vas (largeft)	20 31	28 8
*Afcenfion	7 56	14 16
*St. Helena (James Town)	15 55	5 46
Saxemburgh	30 41	19 15
*Triftan d'Acunha (N. P.) (‡)	37 6	11 38
*Inacceffible Ifland	37 19	11 45
*Nightingale Ifland	37 29	11 43
Diego Alvarez	39 20	11 2
*Gough's Ifland	40 15	2 30
Falkland's I. (N. E. P.)	51 50	57 30
Ditto (S. W. point)	52 0	61 45
*Ifland Georgia		
*Cape Buller	53 58	37 35
*C. Difappointment	54 58	36 10
*Willis's Ifles	54 0	38 21
*Sandwich Land (Cape Montagu)	58 33	26 41
*Candlemas Ifles	57 10	27 8
*Southern Thule	59 34	27 40

From the Cape of Good Hope to Canton.

	Lat. D. M.	Long. D. M.
*Cape of Good Hope	34 26S.	18 29E.
Falfe Cape	34 16	18 50
*Falfe Bay	34 10	18 39
Cape Agullias	34 44	20 15
Bay St. Braze	34 28	21 59
Cape Talhado	34 12	23 17
*Algoa Bay	33 30	26 35
Cape Delgado (Mufcle Bay)	33 38	24 10
*Firft Point of Natal	32 11	28 51
*Middle Point of Natal	30 45	30 20
Port Natal	29 50	30 57
Smoky Cape	27 7	33 15
Cape St. Mary (entrance of Delagoa Bay)	25 51	33 16
Cape Corientes	23 37	36 35
Cape St. Sebaftian	21 35	36 25
Sofala	20 15	35 32
Angoxa	16 11	39 27
*Mozenbique	14 56	40 29
Cape Delgado	10 6	41 15
Quiloa	8 41	39 40
Mombas	3 34	41 30
Melinda	2 45	41 47
*Magadofha	2 20N.	46 25
Cape Baffas	4 50	49 2
*Cape Orful	10 27	51 38
*Cape Guardafui	11 47	51 35
*Cape Babelmandel (entrance of the Red Sea)	12 38	43 47
*Cape Aden	12 45	45 17
*Cape Fartafh	15 29	52 5
Cape Morebet	17 0	54 19
*Socotra Ifland (E. P.)	12 13	54 23
Ditto (W. Point)	12 45	53 2
*Cape Pedro	17 54	55 27
*Moka (in the Red Sea)	13 1[illegible]	43 17
Judda	21 29	39 26
Cape Ifolete	19 4	57 18
Great Mazeira Ifland	20 15	58 51
Cape Rofelgate	22 36	60 54
Mufcat	23 30	59 26
Cape Jafk	25 57	57 55
C. Mufeldon (entrance to the Gulf of Perfia)	26 17	56 57
Cape Birdiftan	28 0	51 8
Gambaroon	27 18	56 6
*Bafforà	30 31	47 32
Cape Monze	25 0	66 18
*Point Gigat	23 30	68 35
Diu Point	20 44	69 50
Cambaye	22 36	72 17
Surat	21 10	72 26

† The longitude of Trinidad given above is 2 degrees lefs than in many charts and books. Peroufe, in his voyage round the world, touched at this place, and made it longitude [illegible] from Paris, or [illegible] W. of London; which agrees nearly with fome lunar obfervation. I had near this ifland in the year 1796, which made the longitude [illegible] W. of London.

‡ The longitude of Triftan d'Acunha was given in Staunton's Embaffy to China, page 100, vol. 1, Amer. edit. 1799, be[illegible] 2 degrees lefs than in moft books and charts.

	Lat. D. M.	Long. D. M.
Cape de St. John	20 6N.	72 34E.
*Bombay	18 57	72 43
Dabul	17 48	73 9
*Goa	15 31	73 55
Barcelore	13 53	75 2
Mangalore	13 0	75 35
Mount Dilly	12 5	75 35
*Cochin	9 53	76 27
*Cape Comorin	7 57	77 32
Dondra Head (ſouth P. of Ceylon)	5 47	81 2
*Trincomaley	8 35	81 27
Point Pedro	9 57	80 39
Point Calymere	10 13	79 54
*Negapatnam	10 32	79 53
*Pondicherry	11 42	79 59
*Fort St. David's	11 29	79 54
*Madras	13 5	80 35
Point Divy	16 2	81 29
*Maſulipatnam	16 16	81 24
*Coringa Bay	16 58	82 30
*Point Gordeware	16 45	82 37
*Viſagapatam	17 46	83 35
*Gamjam	19 25	85 7
*Jagernaut Pagoda	19 48	85 57
*Black Pagoda	19 51	86 10
Falſe Point	20 17	86 51
*Point Palmyras	20 44	87 10
*Kadgiree	21 52	88 16
*Balaſore	21 21	87 21
*Ingellee	21 48	88 11
*Calcutta	22 34	88 53
*Chandernagor	22 51	88 35
*Iſlamabad	22 20	91 52
Aracan River	20 17	93 0
Cheduba Iſle	18 45	93 37
*Cape Negrais.	16 8	94 9
*Gulf of Martaban	15 37	96 30
*Tavay Point	13 37	97 44
*Junkſeylon	8 15	98 2
*Malacca	2 12	102 11
*Cape Romania	1 15	104 5
*Siam (in Gulf of Siam)	14 18	100 55
*Cambaja Point	8 45	103 45
Avarella Point	12 54	107 50
Cape Nord or Turon	16 4	106 30
*Macao	22 12	113 52
*Canton	23 8	113 8

Iſlands & Shoals lying between the Cape of Good Hope & Cape Cameron.

	Lat. D. M.	Long. D. M.
Shoal diſcovered by Capt. Fortune of the ſhip Commerce	33 8S.	43 10E.
A ſhoal with breakers diſcovered by the Dutch	31 44	44 0
Iſland of Madagaſcar.		
*South Point (Cape St. Mary's)	25 33	44 55
North Point (C. Ambro or Natal)	12 2S.	50 19E.
*St. Auguſtine's Bay	23 35	43 30
Cape St. Vincent	21 48	43 37
Cape St. Andrews	16 6	45 32
Cape St. Sebaſtian	12 30	49 44
Bay Antongil	16 0	50 38
Iſland St. Mary	16 54	50 36
*Foul Point	17 41	49 59
*Fort Dauphin	25 0	47 5
Baſſas de India	22 20	41 30
Europa Rocks	21 30	40 17
Juan de Nova	17 15	43 7
Suſſex Rocks	21 29	42 26
Bazaruto Iſlands	21 16	36 30
Engliſh Bank	17 30	39 27
Cheſterfield Shoal	16 17	44 0
*Mayotto Iſland	12 47	45 30
*Mohilla Iſland	12 30	43 55
*Johanna Iſland	12 15	44 35
*Comoro	11 32	43 30
Portugueſe Shoals	12 33	46 55
John Martin's Iſland	10 9	43 15
Aldabra Iſlands	9 40	46 55
Aſſumption Iſland	9 46	
Coſmoledo Iſland	9 46	48 38
St. Peter's Iſland	9 34	50 47
Natal Iſland	8 30	47 15
Sandy Iſland	9 16	48 12
Zanzibar Iſland	6 10	40 45
Amirante Iſland (N. W. Point)	5 10	53 45
Ditto (S. E. P.)	6 10	55 0
Mahe Iſland (N. W. Point)	3 40	54 5
Ditto (S. E. P.)	5 20	56 30
*Iſle Bourbon	20 52	55 36
*Mauritius, or Iſle of France	20 10	57 35
*Diego Rais, or Rodrigue	19 40	63 10
*St. Brandon	16 34	62 50
Nazareth Bank (S. W. Point)	16 45	60 0
Ditto (N. E. P.)	13 35	61 44
Sandy Iſland	15 10	55 5
South Roquepiz (doubtful)	10 30	64 32
Suppoſed to be the ſame as Galega	10 30	56 50
John de Nova	10 15	53 30
Providence Iſland	9 7	53 32
St. Francis Iſles	7 10	56 30
Peros Banhos	5 30	72 20
*Diego Garcia	7 30	72 35
Candu Iſles	6 0	76 35
Adu Iſles	5 30	76 20
Maldive Iſles (S. E. P.)	0 40S.	74 55
Ditto (N. W. P.)	7 15N.	73 40
Malique Iſl.	8 17	72 59
Laccadive Iſles (S. E. Point)	9 50	71 55
Ditto (N. W. Point)	13 36	70 35

Islands and shoals to the southward and eastward of the Cape of Good Hope.

	Lat. D. M.	Long. D. M.
Denia Isl. } existence Marseveen } doubtful.	41 0S.	21 30E.
Telemaque shoal	38 50	22 2
Dutch Bank	37 20	38 30
Ditto	38 24	
Prince Edward's Islands		
*Southernmost	46 53	37 51
*Northernmost	46 40	38 13
Marion Islands	47 15	46 0
Kerguellen's Land, or Isle of Desolation		
*Bligh's Cap(NP)	48 29	68 49
*Christmas Harb.	48 41	69 9
*Port Pallifer	49 3	69 42
* Cape Digby	49 23	70 39
*Cape George	49 54	70 15
I. Solitaire	49 49	68 11
Cape Louis	49 3	68 23
St. Paul's Island	37 52	77 11
*Amsterdam, (E.P.)†	38 42	77 11

Islands and shoals west of New Holland.

	Lat. D. M.	Long. D. M.
Danish Rock	28 17 S.	98 30E
Cloate's Island, Longitude uncertain	21 45	93 27
Tryal Rocks	20 40	104 30
Rosemary Islands	20 30	110 45
Abrolhos Shoals	28 30	110 45
Christmas Island	10 30	104 27
*Coco I's(Northernm.)	11 50	97 13
Southernmost	12 23	97 24

Islands and shoals between Cape Cameron and Sumatra.

	Lat. D. M.	Long. D. M.
*Ceylon, (South Point)	5 47N.	81 2E.
*North Point	9 57	80 39
*Trincomaley	8 35	81 27
Bale of Cotton Rock (doubtful)	5 28	86 15
Preparis Island	14 50	93 35
Cocos Island (N.Point)	14 6	93 10
*Great Andaman Isl.		
North Point.	13 30	92 40
South Point.	11 21	92 35
Little Andaman I. S. P.	10 31	92 30
Nicobar Isles, N. P.	9 25	93 12
South Point.	6 51	94 22

Sumatra.

	Lat. D. M.	Long. D. M.
West-Point	5 25N.	95 32E
*Acheen	5 22	95 40
Cape Felix	3 58	96 3
Point Labou	2 55	96 48
Cape Sitoe	2 3	97 34
Point Batang	0 5	98 55
*Bencoolen	3 49 S.	102 6
*South Point	5 53	104 7
Hog's Point	5 48	105 12
Lucepera Point	3 5	106 5
Tanjong Bou	1 0	104 24
Sangoa	2 8N.	100 22
Diamond Point	5 0	97 38

Islands on the Western Coast of Sumatra, and in the Straits of Malacca.

	Lat. D. M.	Long. D. M.
*Pulo Ronda	5 59N.	95 21E
*Pulo Way, N. Point	5 49	95 33
*Pulo Brasse N. Point	5 38	95 12
Hog Island	2 30	95 45
Pulo Nyas	0 57	97 2
Pulo Mintaon Island	0 25 S.	98 0
Good Fortune Isl. S. P.	1 57	99 49
Poggy or Nassau S. P.	3 15	100 25
Engano or Deceit Isl.	5 33	102 25
*Fortune Island	6 47	104 0
Pulo Sever	8 30N.	98 00
*Pulo Buton	6 30	99 24
*Prince of Wales Island (Fort Cornwallis)	5 27	100 30
Bintang (S. entrance of the Straits of Sincapore;	1 0	104 30

Island of Java, and Islands in the Straits of Sunda.

	Lat. D. M.	Long. D. M.
*Java Head or W. P.	6 45 S.	104 45E
*Anjer Point	6 2	105 53
*St. Nichols' Point	5 51	106 0
*Bantam Point	5 54	106 1
*Batavia	6 10	106 56
Indermay Point	6 15	109 2
C. Sandano	7 39	114 32
E. Point	8 40	114 37
Winerow Point	7 25	106 7
*Peak on Prince's Isl. ‡	6 24	104 50
*Peak on Crocatoa Isl.	6 8	105 24
*Peak on Tamarind Isl.	5 54	105 28
Pulo Somboricoo	5 44	105 28
*Pulo Salier	5 50	106 1
*Cap	5 59	105 54
*Button	5 50	105 54
*Thwart-the-way	5 55	105 48

† The latitude of the island of Amsterdam was observed by Capt. Bligh, in the Bounty; it is also given in Staunton's Embassy to China, vol 1, page 110, American edit. Its longitude, according to Capt. Bligh, is 7?° 22' E. and in Staunton's work it is 76° 59', the mean being 77° 11' E. The Island of Amsterdam is about four miles long, from north to south, and two and a half miles from east to west. The Island of St. Paul lies in the same meridian as Amsterdam, its latitude being about 37° 52' S. as appears by the observations of several navigators, who made the island three or four hours after having had a good meridian observation. This note was added as a caution to navigators in running for this island, as it is marked 20 or 30 miles more northerly in most books and charts.

‡ Bearings of a rock on which the Indostan struck in the Straits of Sunda:—Zeelip, W 5° N.—Peak on Crocatoa, S. 15°W.—Peak on Tamarind Island, N. 6° W. Capt. M'Intosh rowed round the rock in a circle of ten fathoms, and the boat was never in less than ten fathoms water.

A sunken rock, on which the sea was seen to break, was discovered at the entrance of the Straits of Sunda, by Capt Moses Barnard, of Boston, and published in the Boston papers. The bearings taken from it were these:—Fortune Island, N. W. by W. distant 7 leagues.—South point of Sumatra, E. N. E. two and a half leagues.—Nearest part of the Sumatra shore, N. 1 league. Soundings 7 fathoms, within 20 yards of the eastern side of the rock. To keep clear of this rock, a vessel in the night should not shoalen her water to less than 13 fathoms. In many charts, this part of the coast is marked rocky; but in none (that I have seen) at so great a distance from the shore.

Iſlands and Shoals from the Straits of Sunda to the north entrance of the Straits of Banca.

	Lat. D. M.	Long. D. M.
*Three Siſters	5 42 S.	105 47 E
*North Iſland	5 38	105 48
*Two Brothers	5 8	106 9
* Lucepera S. entrance of the Straits of Banca	3 11	106 20
*Nanku Iſlands in the Straits of Banca	2 22	105 46
Banca Iſland S. E P.	3 4	107 0
*Monopin Hill N. W. P.	2 3	105 23
North Point	1 33	106 0
Eaſt Point	2 38	107 0

Straits of Gaſpar and Billiton.

Gaſpar Iſland	2 24 S.	107 20 E
Billiton Iſland S. E. P.	3 16	108 20
S. W. P.	3 9	107 46
N. P.	2 33	107 58
Point Sambar S. W. Point Borneo	2 45	109 50
Carimata †	1 26	108 54

Iſlands in the weſtern part of the China Sea and Gulf of Siam.

Bintang	1 0 N.	104 30 E
Spirit Iſlands	0 39	106 57
St. Julian Iſlands	0 52	106 33
Timelans Iſlands	1 0	107 15
Small Iſland	1 36	106 17
Wood Iſland	1 41	106 15
Saddle Iſland	2 22	106 0
Great Anambas Iſland	2 56	106 15
Great Natunas Iſland	4 2	108 0
*Pulo Tingy	2 23	104 25
*Pulo Aore	2 30	104 55
*Pulo Timon Iſland	2 46	104 35
*Pulo Brata	4 45	103 56
Pulo Lazen	7 11	101 40
Ridang Iſland	6 0	102 37
*Pulo Uby	8 30	104 30
*Pulo Way	10 0	102 44
Two Brothers	8 30	105 55
*Pulo Condore	8 40	106 24
*Pulo Sapata	10 2	108 42
Hainan (North Point)	20 2	110 35
South Point	18 12	109 20
*Great Ladron	21 52	113 41
*Chook-choo	21 55	113 41
*Aſſes ears	21 55	114 12
*Typa Road	22 9	113 54
*Pedra Branca	22 19	115 2

Dalrymple's account of Shoals in the China Sea.	*Authorities.*	*Lat.*	*Long.*
The ſituation of *Pratas' Shoal* was determined by Capt. King and Mr. Bayley; it is of conſiderable extent, being 6 leagues from N. to S. and ſtretching three or four leagues to the eaſtward of Prata Iſland.			
N. E. Extremity - -	Mr. Bayley,	20 54 N.	116 55 E.
	Capt. King.	20 58	117 5
S. W. Extremity - -	Mr. Bayley,	20 39	116 40
	Capt. King.	20 45	116 49
St. *Eſprit Bank*, nearly round 18 or 20 leagues in circuit, on the north part rocks even with the water's edge, on the ſouth part 9, 10, 15 fathoms, ſand, rocks and gravel - - -	Ship Aſſeviedo, 1755	19 33	113 6
Suppoſed *part of the ſame*, 8 fathoms, red coral rocks - - - -	La Paix, 1763.	19 9	
Ditto 12, 10¼, 6¾, 8, 9, 12 fathoms (none at 20 and 40) ſand, with ſmall ſtones and coral rock; ſteered on it N. N. W. ½ mile and N. ½ W. 1½ miles; appearance of ſhoal water to the weſtward - - - - -	Groſvenor, 1765.	19 7	112 22
Breakers and ſome rocks above water, extending N. E. and S. W. 3 or 4 leagues, ſuppoſed north-eaſt ſhoal of Amphitrite, or Triangles - -	E. Sandwich, 1784.	17 4	
Low Black Iſland, with white ſand, round and long bank of white ſand to the north and breakers - - - - -	E. Lincoln, 1764.	16 35	112 57
High black rock ſeen from the maſt head, bearing W. 8 or 9 miles, when the above iſland bore N. W. ¾ N. 8 or 9 miles diſtant - -			
Pyramid Rock, to the northward of it a low ſandy iſland, and another to the N. E. - -	Em. Elizabeth, 1720.	16 30	

† The American Indiamen Ontario was loſt on a reef in the Straits of Billiton in January, 1799; the bearings taken from the N. W. part of the reef were theſe:—N. W. part of Quoine Iſland bore north—Eaſtern end of Soorooto Iſland bore N. N. E. 7 or 8 leagues diſtant—Carimata was open with the eaſtern part of Soorooto about one quarter of a point—Eaſtern part of Quoine Iſland juſt joining the weſtern part of Soorooto

Dalrymple's account of Shoals in the China Sea.	*Authorities.*	*Lat.*	*Long.*
Soundings 13 fathoms, rocky	E. Lincoln, 1764.	16 14	113 1E.
Scarborough ſhoal	Scarborough, 1748.	15 6	
Ditto	Aſſeviedo, 1755.	15 0	
Ditto, extending 12 miles from S. by E. to N. by W. and 4 miles broad, breakers, and two ſmall rocks juſt on the ſurface about the middle of the ſhoal	RoyalCaptain, 1773	15 11 15 5	117 46
Shoal of Sand extending from N. E. to S. W. 45 fathoms at 2 leagues diſtance	Sou.SeaCaſtle, 1762	11 48N.	112 36
Ditto by Nichelſon's account *two low ſandy iſlands*	Ditto	11 40 11 34	112 21 112 16
Probably the ſame	Ship Luconia, 1764.	11 39	
Ditto, *two ſhoals, breakers and dry ſand* with one or two ſmall rocks	Capt. Gaſpar.	11 36	113 56
Bank of Soundings	Saubut Jung, 1763.	11 34	113 56
Low Iſland, about 1 mile extent, covered with ſhrubs and ſea-wreck, at the eaſt ſide a dry ſand bank, about a mile extent, Iſland N. N. W. 4 miles, no ground at 85 fathoms.	Ditto, 1763.	11 32	113 34
Bank of ſoundings	Falmouth, 1762.	11 25	114 20
Ditto 9 fathoms, rocky	SieurGoſſard, 1741.	11 24	114 17
Breakers	Capt. Eaton, 1685.	11 20	
Iſland	Capt. Bacon, 1768.	11 11	113 19
Breakers	Dolphin, 1767.	11 10	112 59
Low Iſland, ſeen in company by the Eſſex and Falmouth	Eſſex, 1762.	11 2	111 45
Low Iſland with ſand to the ſouthward and breakers 2 miles N. W. from the iſland	Falmouth, 1762.	10 58	112 17
Low Black Iſland ſurrounded with breakers, and has a bank of white and reddiſh ſand at the ſouth point, and at the north a long ledge of breakers and green water; lies N. E. and S. W.	CavalloMarino, 1752	11 1	115 22
Bank of ſoundings 8, 9, 10, 11, fine white ſand and coral rocks, about a mile long eaſt and weſt, and ¼ mile broad	Sea Horſe, 1776.	10 57	117 58
Very white ſand above water, with a ledge of breakers at each end ſtretching about ½ mile; it lies N. E. and S. W. about 2¼ miles	CavalloMarino, 1752	10 48	115 18
Northmoſt of two ſands juſt above water	RoyalCharlotte 1773	10 47	114 34
Ledge of Breakers	Dolphin, 1767.	10 46	112 52
Small Iſland with two reefs of breakers	Sieur Goſſard, 1741	10 42	113 31
Ledge of Breakers	Dolphin, 1767.	10 41 10 39	112 52
Firſt Iſland by Dolphin	Ditto, 1767.	10 35	112 43
Breakers lying eaſt and weſt, 1 mile long, and very narrow	Ganges, 1759.	10 31	
Breakers	Dolphin, 1767.	10 22	112 36
Small low Iſland	Ganges, 1759.	10 20	
Sand bank with high breakers, lies N. N. E. and S. S. W.	CavalloMarino 1752	10 18	115 12
Andrade, ſoundings on it	Bridgewater, 1771.	10 16	110 39
Long Iſland	Dolphin, 1767.	10 17	112 40
Sand like a handkerchief, about 1 mile long, dry and breakers	Capt. Eaton, 1685.	10 10	
Breakers	Dolphin, 1767.	10 8	112 20
North end of *Great Reef*	Ditto.	10 7	112 14
Sand	Capt. Eaton, 1685.	10 5	
Breakers	Hardwicke, 1744.	10 2	112 1
Sand	Capt. Eaton, 1685.	10 0	
Reef	Dolphin, 1767.	9 59	112 1
Reef great length, all feather white, nothing above water	Hardwicke, 1744.	9 54	112 6

Dalrymple's account of Shoals in the China Sea.	*Authorities.*	*Lat.*	*Long.*
Breakers, ſuppoſed Andrade, 25 fathoms, rocky and no ground - -	Falmouth, 1762.	9 50N.	108 46E.
Shoal, three black rocks in the middle; at the ſouth point many breakers, and at the north point green water, but ſcarce any breaking; lies N. E. and S. W. 6 miles in length	CavalloMarino, 1752	9 39	115 3
Breakers two thirds of a mile extent -	Ganges, 1759.	9 22	
Breakers in three places, a reef under water, ſtretching N. N. W. and S. S. E. about half a mile, 8 or 9 leagues from Palawan -	Sea Horſe, 1776.	9 15	
Small reef, one quarter of a league long from eaſt to weſt, on which the ſea broke; 7 fathoms at the weſt point - - -	Sieur Goſſard, 1741.	8 58	110 45
Breakers, extending W. by N. and E. by S. ſix miles long and very narrow; eaſt end appeared to be rocky, as the ſea broke very high on it; weſt point ſuppoſed to be ſand, on which the ſea did not break ſo high, and only ſeemed to roll over it - - -	Sea Horſe, 1776.	8 57	116 59
Breakers, lying N. E. and S. W. about ten or eleven miles long, and three broad, in form of a half moon, with the curve to the weſtward, and is all ſine white ſand juſt above the ſurface of the water - - -	Ditto.	8 47	116 49
Shoal 25 fathoms, black rocks and breakers, lies N. by E. and S. by W. nine miles long and three broad - - -	CavalloMarino, 1752	8 31	114 26
Bank of fourteen fathoms, failed weſt four or five miles on it - - -	Pr. of Wales, 1755.	8 4	110 35
High breakers - -	Viper, 1769.	8 0	115 30
Rocks and *high breakers* - -	Walpole, 1783.	7 50	114 35
Bank with *high breakers* - -	Viper, 1769.	7 30	115 12
Bank ſeems to be P. Wale's-bank -	Viper, 1769.	7 24	110 55
Rocks and *breakers* - -	Royal Charlotte.	6 57	113 46
Northernmoſt of two *ſhoals*, two and a half fathoms, about four leagues aſunder, Borneo in ſight	Mr. Barton.	6 55	116 5
Breakers, N. E. and S. W. one and a quarter mile long, probably the ſouthern part of the Royal Charlotte's ſhoal - -	Louiſa, 1774.	6 14	113 22
Forty four black ſtones, the breakers N. by E. four or five miles - -	Ditto.	6 9	
Shoal about 4 miles long, north and ſouth, had ſix fathoms, rock; believe as little as three fathoms; had 55 and 60 ſhells, at two cables length diſtant - - -	CavalloMarino, 1752	5 54	114 23
Shoal of four fathoms (doubtful) -	Capt. Kirton.	5 49	113 7
Shoal of five fathoms, rocks, (doubtful)	Ditto.	5 39	113 20
Two *Shoals*, rocks ſeen on the northernmoſt }	Euphrates.	5 39 5 37	113 29
Shoal three fathoms, rocks, then 10, 17 fathoms, (doubtful) - - -	Capt. Kirton.	5 37	113 16
Reef of ſand and rocks, with high breakers, lying N. N. W. and S. S. E. half a mile long, and very narrow - - -	Sea Horſe, 1776.	5 35	112 33
Bank of five fathoms, ſand and rocks -			
Shoals ſometimes broke N. W. and S. E. Theſe appear in four different parts, extending about N. W. and S. E. ſeven or eight miles in length	Ditto.		
Three or four *ſhoals* near together -	CavalloMarino.	5 28	114 44
Shoal one and a half fathoms, hard rocks N.N.E. and S. S. W. - - -	Luconia, 1776.	5 24	112 35
Shoal of two fathoms - -	Ditto.	5 5	112 29
Dry ſand S. 37° E. from the laſt ſhoal, about eight miles diſtant.	Ditto.	4 57	112 35

Islands in the Java Sea, and straits east of Java.

	Lat. D. M.	Long. D. M.
Pulo Babee	5 42S.	106 16E
Carimon Java	5 43	110 30
Isle Lubeck	5 40	112 15
Isle Madura (N. W. P.)	6 48	112 52
Ditto E. P.	6 54	114 17
Bally Isle (south Point)	8 56	115 22
Bally Straits (south ent.)	8 45	114 47
Lombock Isl. (S. W. P.)	9 2	116 12
Peak of ditto	8 14	116 31
Lombock Straits (S. ent.)	9 0	115 55
Cumbava Isl. (S. W. P.)	8 54	116 57
Straits of Alass (S. ent.)	9 0	116 50
Straits of Salee	8 10	117 35
Sraits of Sapy	8 30	119 20
Sandlewood Island	9 45	120 0
*Savu Island	10 35	122 25
Rotto Island	11 17	123 7
Timor Island S.	10 15	123 43

Borneo, Celebes, Luconia, and the adjacent islands.

	Lat. D. M.	Long. D. M.
Borneo		
Point Sambar (S. W. P.)	2 45S.	109 50E
Tanjong Mora (W. P.)	0 45N	108 45
Tanjong Dato	3 2	110 15
North Point	7 0	116 45
East Point	5 15	119 20
Monsieur Island	4 24S.	116 0
Three little islands near the S. E. point of G. Pulo Laut. *Two northernmost	4 3	
*Southernmost	4 7	
Great Pulo Laut, N. P.	3 8	
*The three alike islands (straits of Macassar)	3 36	
Celebes (south point)	5 46	120 0
Macassar	5 9	119 49
North point	2 0N	124 0
Sooloo (E. P.)	5 57	121 21
*Basilan	6 25	
Straits, between Basilan and Mindanao	6 40	
Cagayan Islands, (northernmost)	9 40	
*Negros (south point)	9 8	
Panay (S. P. or P. Nasog)	10 18	121 50
*Quiniluban Island, lying between the north parts of Panay and Palawan, the northernmost of the group	11 25	
Cuyo Isle, to the south of the above	11 0	
Dangerous shoal marked eight fathoms on some charts, at 7 or 8 leagues distant from the N. W part of Panay, its latitude being nearly	11 20	
Palawan (south point)	8 18N	117 30E
North point	11 20	119 40
*Balambangan (entrance to the Sooloo Sea)	7 17	117 15
Banguey	7 17	117 30
*Islands lying near the south point of Mindoro		
*Westernmost	12 14	
*Easternmost	12 12	
*Mindoro (P. Ylilim)	12 29	
*Apo Bank, large rock above water	12 39	
*Smaller ditto	12 42	
*Entrance of Manilla B.	14 28	
*Manilla in Luconia	14 36	120 59
*Goat Island	13 55	
Luconia (N. W. P.)	18 45	120 45
*Bashee I. (northernmost)	21 9	122 7
*Formosa (south point)	21 54	121 5
North point	25 15	122 13
Tayoan in Formosa	22 30	120 35
*Tobaco Sima	22 0	121 43
*Little Tobol	21 57	121 43
*Vela-rete	21 40	120 53
Marianne or Ladrone Islands	20 30 11 30	144 0
Tinian, W. P.	14 59	145 47
St. Bartholemi	14 20	167 30
Pescadores	10 3	165 0

New-Holland and the adjacent Islands.

	Lat. D. M.	Long. D. M.
*S. W. Cape	43 37S.	146 12E
*S. Cape	43 42	147 1
*Swilly Island	43 55	147 11
*Mew Stone	43 48	146 32
*Tasman's Head	43 33	147 33
*Adventure Bay	43 21	147 34
*St. Maria's Isles	43 20	148 10
*St. Patrick's Head	41 44	148 20
*Cape Howe	37 24	149 14
*Cape Dromedary	36 21	150 4
*Botany Bay	34 0	151 20
*Port Jackson	33 47	151 21
*Cape Hawke	32 13	152 28
*Smoky Cape	30 49	153 7
*Cape Danger	28 7	153 28
*Cape Morton	26 57	153 22
*Sandy Cape	24 45	153 2
*Kepple Bay	23 30	150 40
*Cumberland Island	20 30	148 45
*Cape Cleveland	19 10	147 5
*Cape Flattery	14 52	145 10
*Cape York	10 44	141 37
Well's Shoal	12 20	158 3
Murray's Isles	9 57	143 22
Wreck Reef	11 22	143 43
Van Diemen's Bay	11 30	131 15

New-Guinea and adjacent Islands.

	Lat. D. M.	Long. D. M.
New-Guinea (C. False)	8 40S.	136 30E
East Point	6 20	148 0
Louisiade Isles, E. point	11 35	154 0
W. point	8 30	148 30

	Lat. D. M.	Long. D. M.
New-Britain, E. point	4 53S	151 9E
W. point	6 0	148 20
New-Ireland, E. point	5 0	152 30
W. point	2 20	148 20

N. Zealand & adjacent islands.

	Lat. D. M.	Long. D. M.
*Cape South	47 20S	167 30E
Cape Saunders	47 0	170 35
Banks' Island	43 45	172 46
*Cape Pallifer	41 38	175 23
*Cape Turnagain	40 26	177 5
Cape East	37 33	178 25
*North Cape	34 10	172 10
*Ship Cove	41 6	174 30
*Q. Charlotte's Sound	41 6	174 30
*Cape Farewel	40 37	
*Dusky Bay	45 47	166 23
*Norfolk Island	29 2	168 22

New Caledonia and adjacent Islands & Shoals.

	Lat. D. M.	Long. D. M.
P. Prince of Wale's Foreland	22 40S	166 50E
*Isle of Pines	22 38	167 43
*Botany Island	22 27	167 22
*Q.Charlotte's Foreland	22 15	167 18
*Cape Coronation	22 5	167 13
*Cape Colonet	20 30	165 1
*Ballabea Island	20 7	164 27
*Pudyona	20 18	164 46
N. W. Point	20 6	164 12

Islands & shoals lately discovered in the tract from New Holland to Canton.

	Lat. D. M.	Long. D. M.
*N. W. extremity of a reef running off from the N. W. point of New Caledonia, observed by Capt. Bond in 1792	18 45S	162 48E
*Walpole's Island, discovered by Capt Butler in 1794	22 40	169 20
*Durand's Reef extending 4 or 5 miles, discovered by Capt Butler	22 6	169 7
Baring's Islands	5 35N	168 18
Muskillo Group, low and dangerous }	7 20 / 7 47	168 28
Brown's Range		
Arthur's I. (northern)	11 43	162 47
Parry's I. (southern)	11 19	162 57

N. Hebrides, & adjacent islands.

	Lat. D. M.	Long. D. M.
*Annatom Island	20 10S	170 9E
*Erronan	19 31	170 21
*Tanna, Port Resolution	19 32	169 46
*Immer Island	19 16	169 51
*Erromanga (Traitor's H.	18 43	169 25
*Sandwich Island	17 41	168 38
*Hinchingbroke Island	17 25	168 43
*Montague Island	17 26	168 37
*The Monument	17 14	168 43
*Shepherd's Islands	16 58	168 47
*Apee Isle	16 46	168 27
Three Hills	16 59	168 2-
*Paoom Island	16 30	168 34
*Ambrym Island	16 9	168 18
*Mallicollo's Isles	16 3:	168 4
*Mallicollo (Sandwich	16 28	168 4
*Sandwich Harbour	16 25	167 58
*Whitsuntide Isle	15 44	168 25
*Aurora Isle	15 8	168 22
*Leper's Island	15 23	168 3
*Espiritu Santo C.Quiros	14 56	167 25
*Cape Cumberland	14 39	166 52
Cape Lisburne	15 41	167 2
*St. Bartholomew's Isle	15 42	167 22
*[illegible] Island	15 38	167 14
*Pitt's Island	11 50	166 51
*Cherry Island	11 37	170 0
*Mitre Island	11 49	170 0
Pandora's reef	12 11	171 57
*Rotumah or Grenville I.	12 29	1[illegible] 2

Friendly and other Islands in the Pacific Ocean.

	Lat. D.M.	Long. D. M.
*Wallis's Island	13 22S	176 11W
*Proby's Island	15 53	175 46
*Pilstart	22 22	175 36
*Gardner's Island	17 57	175 12
*Hoonga-hapee	20 36	175 12
*Toofoa	19 46	175 1
*Tongatabou, Van Diemen's Road	21 6	175 0
*Bickerton's Island	18 48	174 43
*Annamoka	20 14	174 45
*Eoa (E. P.)	21 24	174 40
*Bouhee	19 34	174 24
*Haanho	19 41	174 10
*Howe's Island	18 32	173 48
*Pola (W. P.)	13 32	172 30
*Duke of York's Island	8 33	171 59
*Calinaffe (N. P.)	13 45	171 46
*Ilot Plat	13 51	171 43
*Duke of Clarence's I.	9 9	171 26
*Oyolava (E. P.)	14 3	171 2
*Oyutuelah	14 30	170 36
Muouna (E. P.)	14 17	169 58
*Savage Island	19 2	169 25
*Fanfoue (E. P.)	14 5	169 13
*Leone (S. P.)	14 8	169 11
*Opoun (E. P.)	14 9	168 57
*Palmerston's Island	18 0	162 54
*Whytootakee	18 52	159 36
*Hervey's Island	19 17	158 43
*Wateeoo Island	20 1	158 10
*Mangeea Island	21 57	158 2
*Howe's Island	16 46	154 1
*Bolabola Island	16 32	151 47
*Ulietea	16 45	151 26
*Ohameneno Harbour	16 45	151 30
*Eimeo (TalooHarbour)	17 30	149 55
*Toobouai	23 25	149 18
*Huaheine (Owharre Bay)	16 43	151 3
*Maurura	16 26	152 28
*Otaheite, OaitipehaBay)	17 46	149 9
*Venus' Point	17 29	149 31
*Oznaburgh or Miatea I.	17 52	148 1
*Pallifer's Island	15 8	146 25
*Adventure Island	17 5	144 13
*Furneaux Island	17 11	143 2
*Resolution Island	17 23	141 40
*Taoukae Island	14 30	145 4
*Ohitahoo(ResolutionB.)	9 55	139 4
*Ohevahoa Island	9 41	138 57
*Onateavo Island	9 58	138 46
*Magdalene Island	10 25	138 44
*Hood's Island	9 26	138 47
*Carysfort Island	20 49	138 28
*Lord Hood's Island	21 31	135 27
*Ducie's Island	24 40	124 35
*Easter I. (Cook's Bay)	27 9	109 30
Juan Fernandez Island †	33 45	78 37
Gallapagos Isles † }	2 0 / 2 0N	89 0
I. Gallego	1 40	104 0
*Christmas Island	1 58	157 27
St. Peter's Isle	11 0	1[illegible]8 45

Sandwich Islands.

	Lat. D.M.	Long. D. M.
*Owyhee, N. point	20 17N	155 53
*East point	19 34	154 49
*South point	18 51	155 40
*Mowee, East point	20 50	155 51
*South point	20 34	156 7
*West point	20 54	156 31
*Marokinee	20 39	156 22
*Tahoorowa	20 38	156 28
*Ranai, S. point	20 46	156 47
*Morotoi, W. point	21 10	157 9
*Woahoo	21 43	157 46
*Atooi (Wymoa Bay)	21 57	159 35
*Oneeheow	21 50	160 10
*Oreehoua	22 2	160 3
*Tahoora	21 43	160 19
*Necker Island	23 34	164 27
*French Frigate's shoal	23 45	165 45

From Canton to Kamtskatka, with the adjacent islands, from the observations of Captains Cook and La Perouse.

	Lat. D. M.	Long. D. M.
*Island Kumi, E. point	24 39N	123 21E
*Hoapinsu Island	25 44	123 39
*Tiaoyu-su Island	25 55	123 52
*Sulpher Isles { Southernmost	24 22	141 25
Middle	24 48	141 17
Northernmost	25 14	141 15
Great Lieukieu, N. P	28 0	129 0
S. P.	25 40	129 0
*A Rock	30 45	123 51
*Quelpaert I. S. P.	33 8	126 24
*Island Dagelet, N.E. P	37 25	131 27
*Niphon Island, N. point	40 34	141 40
*Cape Noto	37 36	137 59
S. point	33 5	136 0
*Jootsi Sima	37 51	137 45
*A rock west of C. Noto	37 36	137 39
*Bay de Ternai	45 13	137 34
*Bay de Suffren	47 51	139 50
Island Tchoka		
*South P. (C. Crillon)	45 57	142 59
*Bay de Langle	47 49	142 23
*Bay d'Estaing	48 59	142 57
*Bay de Castries	51 29	142 4
C. Lopatka Kamtscatka	51 0	156 50
B. d'Avatscha, in Kamts.	54 52	158 55
*Cape Tschukotskoi	64 13	171 19W
*East Cape	66 6	169 32
*Cape Serdze Kamen	67 3	171 44
*Cape North	68 56	179 4

North West coast of America, from the observations of Captains Cook and La Perouse.

	Lat. D. M.	Long. D. M.
Port of St. Blas	21 30N	104 50W
*Port St. Diego	32 39	116 54
*Port of Monterey	36 38	121 38
*Port St. Francisco	37 50	122 29
Cape Mendocino	40 6	124 18
Port of Trinidad	41 24	123 12
Cape Blanco	42 53	124 26
*Cape Gregory	43 30	123 58
*Cape Foulweather	44 55	124 1
Cape Rond	45 43	123 48
Bay of Martyrs	47 32	124 23
I. des Dolores	48 1	124 50
*Cape Flattery	48 15	124 52
*Breakers Point	49 15	126 35
*Nootka	49 36	126 37
*Woody Point	50 0	127 55
*Bay St. Louis	50 34	128 47
*Isles de Sartine	50 56	128 53
*Cape Fleurieu	51 45	128 50
*Cape Hector	51 57	131 12
*Bay de la Touche	52 42	132 15
Bay de Clouard	53 52	133 30
*Cape St. Augustin	55 2	133 43
*Cape Tschirikow	56 12	134 50
Port Guibert	56 38	135 9
Port Neckar	56 43	135 13
Cape Engano	57 2	136 3
Port of Guadaloupe	57 10	135 56
Port de los Remedios	57 24	135 56
*Cape Cross	57 59	136 24
*Port des Francais	58 37	137 25
*Cape Fairweather	58 55	138 7
Behrings River (entr.)	59 8	138 33
Baye de Monti	59 40	140 10
*Point de la Boussole	59 50	141 0
*Mount St. Elias	60 27	140 58
Cape Hinchinghroke	60 15	
*Cape Elizabeth	59 10	152 13
*Barren Isles	59 0	152 15
Point Banks	58 41	152 44
*Cape Douglass	58 56	153 45
*Cape Whitsunday	58 15	152 31
*Cape Greville	57 33	152 40
*Trinity Island	56 36	154 55
*Foggy Island	56 10	157 10
*Halibut Head Island	54 27	162 55
Oonalashka Island, N. P.	53 55	166 25

† The latitudes and longitudes of Juan Fernandes and the Gallapago Islands were incorrectly printed, in the fifth page of this table; a few errors were also discovered in the same sheet, which the reader is desired to correct, viz.—

Page 4, col. 2. The longitude of Cape St. Anthony should be 56° W. nearly.
5, col. 1. The latitude of Cape Blanco — — — 46° 20' S.
— The longitude of Bay St. Julian — — 66 38 W.
— Barnwell's Island should be Barnevelt's Island.
— Longitude of Cape Diego — — — 65 0 W.
— Latitude of Cape Corientes — — — 20 18 N.
Page 8, col. 1. Longitude of Paris — — — — 2 25 E.
Page 1[illegible], col. 1. The latitude of Rockal, by a late observation of Capt. William Story, of the ship Friendship, is 57° 39' N. and its longitude, found from his run from Fair Island, is 14° 18' W.

The longitude of Bermudas, given in the fourth page of this table, is about one degree more than in most books and charts, and it agrees nearly with the late observations of Captains Hurd and Dixon, viz.—"St. George's, the easternmost part of the island, is in the latitude of 32° 22' 20" N. longitude 64° 28' W. of London. Wreck Hill (westernmost land) latitude 32° 15' 20" N. longitude 64° 45' W. The best latitude to run for Bermudas is 32° 8' N. When vessels bound there make the north side of the island, they should keep a good look out, as the ledge of rocks extends 10 or 12 miles from the land, and in a parallel line from east to west about 40 miles."

TABLE

OF THE

SUN's DECLINATION

For the Year 1800.

Days.	Jan.	Feb.	March.	April	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	South	South	South.	North	North	North	North	North	North.	South	South	South	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 1	17. 5	7.33	4.34	15. 5	22. 4	23. 8	18. 3	8.18	3.12	14.28	21.51	1
2	22.56	16.47	7.10	4.57	15.23	22.12	23. 4	17.48	7.56	3.35	14.47	22.00	2
3	22.50	16.30	6.47	5.20	15.41	22.20	23. 0	17.32	7.34	3.58	15. 6	22. 8	3
4	22.44	16.12	6.24	5.43	15.59	22.27	22.55	17.17	7.12	4.21	15.25	22.17	4
5	22.37	15.54	6. 1	6. 6	16.16	22.34	22.49	17. 0	6.50	4.45	15.43	22.24	5
6	22.30	15.35	5.38	6.28	16.33	22.40	22.43	16.44	6.28	5. 8	16. 1	22.32	6
7	22.23	15.17	5.15	6.51	16.50	22.46	22.37	16.27	6. 5	5.31	16.19	22.39	7
8	22.15	14.58	4.51	7.13	17. 6	22.52	22.31	16.11	5.43	5.54	16.37	22.45	8
9	22. 6	14.39	4.28	7.36	17.22	22.57	22.24	15.53	5.20	6.17	16.54	22.51	9
10	21.57	14.19	4. 4	7.58	17.38	23. 2	22.16	15.36	4.57	6.39	17.11	22.57	10
11	21.48	14. 0	3.41	8.20	17.54	23. 6	22. 8	15.18	4.34	7. 2	17.28	23. 2	11
12	21.39	13.40	3.17	8.42	18. 9	23.10	22. 0	15. 0	4.11	7.25	17.44	23. 7	12
13	21.28	13.20	2.54	9. 4	18.24	23.14	21.52	14.42	3.48	7.47	18. 0	23.11	13
14	21.18	12.59	2.30	9.25	18.38	23.17	21.43	14.24	3.25	8.10	18.16	23.15	14
15	21. 7	12.39	2. 6	9.47	18.53	23.20	21.34	14. 5	3. 2	8.32	18.32	23.18	15
16	20.56	12.18	1.43	10. 8	19. 7	23.22	21.24	13.46	2.39	8.54	18.47	23.21	16
17	20.44	11.57	1.19	10.29	19.20	23.24	21.14	13.27	2.16	9.16	19. 2	23.23	17
18	20.32	11.36	0.55	10.50	19.34	23.26	21. 4	13. 8	1.53	9.38	19.16	23.25	18
19	20.19	11.15	0.32	11.11	19.47	23.27	20.53	12.48	1.29	10. 0	19.30	23.26	19
20	20. 7	10.53	0. 8	11.32	19.59	23.28	20.42	12.29	1. 6	10.22	19.44	23.27	20
21	19.53	10.31	0.16N.	11.52	20.12	23.28	20.31	12. 9	0.42	10.43	19.57	23.28	21
22	19.40	10.10	0.39	12.13	20.24	23.28	20.19	11.49	0.19	11. 5	20.10	23.28	22
23	19.26	9.48	1. 3	12.33	20.36	23.27	20. 7	11.28	0. 4S.	11.26	20.23	23.27	23
24	19.11	9.26	1.27	12.53	20.47	23.26	19.54	11. 8	0.28	11.47	20.35	23.27	24
25	18.57	9. 3	1.50	13.12	20.58	23.25	19.41	10.47	0.51	12. 8	20.47	23.25	25
26	18.42	8.41	2.14	13.32	21. 8	23.23	19.28	10.26	1.15	12.28	20.59	23.23	26
27	18.26	8.18	2.37	13.51	21.19	23.21	19.15	10. 5	1.38	12.49	21.10	23.21	27
28	18.11	7.56	3. 1	14.10	21.29	23.19	19. 1	9.44	2. 2	13. 9	21.21	23.18	28
29	17.55		3.24	14.29	21.38	23.16	18.47	9.23	2.25	13.29	21.31	23.15	29
30	17.38		3.47	14.47	21.47	23.12	18.33	9. 1	2.48	13.49	21.41	23.11	30
31	17.21		4.11		21.56		18.18	8.40		14. 9		23. 7	31

TABLE

OF THE

SUN's DECLINATION

For the Years 1801, 1805, 1809.

Days.	Jan.	Feb.	March	April	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	South	South	South	North	North	North	North	North	North	South	South	South	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 2	17. 9	7.39	4.28	15. 1	22. 2	23. 9	18. 7	8.23	3. 6	14.23	21.48	1
2	22.57	16.51	7.16	4.51	15.19	22.10	23. 5	17.52	8. 2	3.29	14.42	21.58	2
3	22.51	16.34	6.53	5.14	15.37	22.18	23. 1	17.36	7.40	3.53	15. 1	22. 6	3
4	22.45	16.16	6.30	5.37	15.54	22.25	22.56	17.20	7.17	4.16	15.20	22.15	4
5	22.39	15.58	6. 7	6. 0	16.12	22.32	22.50	17. 4	6.55	4.39	15.39	22.23	5
6	22.32	15.40	5.44	0.23	16.29	22.39	22.45	16.48	6.33	5. 2	15.57	22.30	6
7	22.24	15.21	5.20	6.45	16.46	22.45	22.39	16.31	6.10	5.25	16.15	22.37	7
8	22.17	15. 2	4.57	7. 8	17. 2	22.51	22.32	16.15	5.48	5.48	16.32	22.44	8
9	22. 8	14.43	4.34	7.30	17.18	22.56	22.25	15.57	5.25	6.11	16.50	22.50	9
10	22. 0	14.24	4.10	7.53	17.34	23. 1	22.18	15.40	5. 3	6.34	17. 7	22.56	10
11	21.50	14. 4	3.47	8.15	17.50	23. 5	22.10	15.22	4.40	6.57	17.24	23. 1	11
12	21.41	13.44	3.23	8.37	18. 5	23. 9	22. 2	15. 5	4.17	7.20	17.40	23. 6	12
13	21.31	13.24	2.59	8.59	18.20	23.13	21.54	14.46	3.54	7.42	17.56	23.10	13
14	21.21	13. 4	2.36	9.20	18.35	23.16	21.45	14.28	3.31	8. 5	18.12	23.14	14
15	21.10	12.44	2.12	9.42	18.49	23.19	21.36	14. 9	3. 8	8.27	18.28	23.17	15
16	20.59	12.23	1.48	10. 3	19. 3	23.22	21.26	13.51	2.45	8.49	18.43	23.20	16
17	20.47	12. 2	1.25	10.24	19.17	23.24	21.16	13.32	2.21	9.11	18.58	23.23	17
18	20.35	11.41	1. 1	10.45	19.31	23.25	21. 6	13.12	1.58	9.33	19.13	23.25	18
19	20.22	11.20	0.37	11. 6	19.44	23.27	20.56	12.53	1.35	9.55	19.27	23.26	19
20	20.10	10.58	0.14S.	11.27	19.56	23.28	20.45	12.33	1.11	10.17	19.41	23.27	20
21	19.57	10.37	0.10N.	11.48	20. 9	23.28	20.33	12.13	0.48	10.38	19.54	23.28	21
22	19.43	10.15	0.34	12. 8	20.21	23.28	20.22	11.53	0.25	11. 0	20. 7	23.28	22
23	19.29	9.53	0.57	12.28	20.33	23.28	20.10	11.33	0. 1N.	11.21	20.20	23.28	23
24	19.15	9.31	1.21	12.48	20.44	23.27	19.57	11.13	0.22S.	11.42	20.33	23.27	24
25	19. 0	9. 9	1.45	13. 8	20.55	23.25	19.45	10.52	0.46	12.03	20.45	23.26	25
26	18.45	8.46	2. 8	13.27	21. 6	23.24	19.32	10.31	1. 9	12.23	20.56	23.24	26
27	18.30	8.24	2.32	13.46	21.16	23.22	19.18	10.10	1.32	12.44	21. 7	23.21	27
28	18.14	8. 1	2.55	14. 5	21.26	23.19	19. 5	9.49	1.56	13. 4	21.18	23.19	28
29	17.58		3.19	14.24	21.36	23.16	18.51	9.28	2.19	13.24	21.29	23.16	29
30	17.42		3.42	14.43	21.45	23.13	18.36	9. 7	2.43	13.44	21.39	23.12	30
31	17.26		4. 5		21.54		18.22	8.45		14. 4		23. 8	31

TABLE
OF THE
SUN's DECLINATION
For the Years 1802, 1806, 1810.

Days.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.	Days.
	South	South	South	North	North	North	North	North	North	South	South	South	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 3	17.13	7.44	4.23	14.57	22. 0	23.10	18.10	8.29	3. 0	14.19	21.46	1
2	22.58	16.56	7.21	4.46	15.15	22. 8	23. 6	17.55	8. 7	3.24	14.38	21.55	2
3	22.53	16.38	6.58	5. 9	15.33	22.16	23. 2	17.40	7.45	3.47	14.57	22. 4	3
4	22.47	16.20	6.35	5.32	15.50	22.24	22.57	17.24	7.23	4.10	15.16	22.13	4
5	22.40	16. 2	6.12	5.55	16. 8	22.31	22.52	17. 8	7. 1	4.34	15.34	22.21	5
6	22.34	15.44	5.49	6.17	16.25	22.37	22.46	16.52	6.38	4.57	15.53	22.28	6
7	22.26	15.26	5.26	6.40	16.42	22.43	22.40	16.35	6.16	5.20	16.11	22.35	7
8	22.18	15. 7	5. 2	7. 3	16.58	22.49	22.34	16.19	5.53	5.43	16.28	22.42	8
9	22.10	14.48	4.39	7.25	17.14	22.55	22.27	16. 2	5.31	6. 6	16.46	22.48	9
10	22. 2	14.28	4.16	7.47	17.30	23. 0	22.20	15.44	5. 8	6.29	17. 3	22.54	10
11	21.53	14. 9	3.52	8. 9	17.46	23. 4	22.12	15.27	4.45	6.51	17.20	23. 0	11
12	21.43	13.49	3.29	8.31	18. 1	23. 8	22. 4	15. 9	4.22	7.14	17.36	23. 5	12
13	21.33	13.29	3. 5	8.53	18.17	23.12	21.56	14.51	3.59	7.37	17.53	23. 9	13
14	21.23	13. 9	2.41	9.15	18.31	23.16	21.47	14.33	3.36	7.59	18. 9	23.13	14
15	21.12	12.49	2.18	9.37	18.46	23.19	21.38	14.14	3.13	8.22	18.24	23.16	15
16	21. 1	12.28	1.54	9.58	19. 0	23.21	21.29	13.55	2.50	8.44	18.39	23.19	16
17	20.50	12. 7	1.30	10.19	19.14	23.23	21.19	13.36	2.27	9. 6	18.54	23.22	17
18	20.38	11.46	1. 7	10.40	19.27	23.25	21. 9	13.17	2. 4	9.28	19. 9	23.24	18
19	20.25	11.25	0.43	11. 1	19.41	23.26	20.58	12.58	1.40	9.50	19.23	23.26	19
20	20.13	11. 3	0.19S.	11.22	19.53	23.27	20.47	12.38	1.17	10.11	19.37	23.27	20
21	20. 0	10.42	0. 4N.	11.43	20. 6	23.28	20.36	12.18	0.54	10.33	19.51	23.28	21
22	19.46	10.20	0.28	12. 3	20.18	23.28	20.24	11.58	0.30	10.54	20. 4	23.28	22
23	19.32	9.58	0.52	12.23	20.30	23.28	20.13	11.38	0. 7N.	11.16	20.17	23.28	23
24	19.18	9.36	1.15	12.43	20.41	23.27	20. 0	11.18	0.16S.	11.37	20.30	23.27	24
25	19. 4	9.14	1.39	13. 3	20.53	23.26	19.48	10.57	0.40	11.58	20.42	23.26	25
26	18.49	8.52	2. 2	13.22	21. 3	23.24	19.35	10.36	1. 3	12.18	20.53	23.24	26
27	18.34	8.29	2.26	13.42	21.14	23.22	19.21	10.15	1.27	12.39	21. 5	23.22	27
28	18.18	8. 7	2.49	14. 1	21.24	23.20	19. 8	9.54	1.50	12.59	21.16	23.19	28
29	18. 2		3.13	14.20	21.33	23.17	18.54	9.33	2.14	13.20	21.26	23.16	29
30	17.46		3.36	14.38	21.43	23.14	18.40	9.12	2.37	13.39	21.36	23.13	30
31	17.30		3.59		21.52		18.25	8.50		13.59		23. 9	31

TABLE

OF THE

SUN's DECLINATION

For the Years 1803, 1807, 1811.

Days.	Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	South	South	South	North	North	North	North	North	North.	South	South	South	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 4	17.17	7.49	4.17	14.52	21.58	23.11	18.14	8.34	2.55	14.14	21.44	1
2	22.59	17. 0	7.27	4.40	15.10	22. 6	23. 7	17.59	8.12	3.18	14.33	21.53	2
3	22.54	16.42	7. 4	5. 3	15.28	22.14	23. 3	17.44	7.50	3.41	14.52	22. 2	3
4	22.48	16.25	6.41	5.26	15.46	22.22	22.58	17.28	7.28	4. 5	15.11	22.11	4
5	22.42	16. 7	6.18	5.49	16. 3	22.29	22.53	17.12	7. 6	4.28	15.30	22.19	5
6	22.35	15.49	5.55	6.12	16.21	22.36	22.48	16.56	6.44	4.51	15.48	22.26	6
7	22.28	15.30	5.31	6.35	16.38	22.42	22.42	16.39	6.21	5.14	16. 6	22.34	7
8	22.20	15.11	5. 8	6.57	16.54	22.48	22.35	16.23	5.59	5.37	16.24	22.41	8
9	22.12	14.52	4.45	7.20	17.10	22.53	22.29	16. 6	5.36	6. 0	16.41	22.47	9
10	22. 4	14.33	4.21	7.42	17.27	22.58	22.21	15.48	5.14	6.23	16.59	22.53	10
11	21.55	14.14	3.58	8. 4	17.42	23. 3	22.14	15.31	4.51	6.46	17.16	22.58	11
12	21.46	13.54	3.34	8.26	17.58	23. 7	22. 6	15.13	4.28	7. 9	17.32	23. 3	12
13	21.36	13.34	3.11	8.48	18.13	23.11	21.58	14.55	4. 5	7.31	17.49	23. 8	13
14	21.26	13.14	2.47	9.10	18.28	23.15	21.49	14.37	3.42	7.54	18. 5	23.12	14
15	21.15	12.54	2.23	9.31	18.42	23.18	21.40	14.18	3.19	8.16	18.20	23.16	15
16	21. 4	12.33	2. 0	9.53	18.57	23.21	21.31	14. 0	2.56	8.38	18.36	23.19	16
17	20.53	12.12	1.36	10.14	19.11	23.23	21.21	13.41	2.33	9. 1	18.51	23.21	17
18	20.41	11.51	1.12	10.35	19.24	23.25	21.11	13.22	2. 9	9.23	19. 6	23.24	18
19	20.28	11.30	0.49	10.56	19.37	23.26	21. 1	13. 2	1.46	9.45	19.20	23.25	19
20	20.16	11. 9	0.25	11.17	19.50	23.27	20.50	12.43	1.23	10. 6	19.34	23.27	20
21	20. 3	10.47	0. 1S.	11.38	20. 3	23.28	20.39	12.23	0.59	10.28	19.48	23.28	21
22	19.50	10.25	0.22N.	11.58	20.15	23.28	20.27	12. 3	0.36	10.49	20. 1	23.28	22
23	19.36	10. 4	0.46	12.18	20.27	23.28	20.15	11.43	0.13N.	11.11	20.14	23.28	23
24	19.22	9.42	1.10	12.38	20.39	23.27	20. 3	11.23	0.11S.	11.32	20.27	23.27	24
25	19. 7	9.19	1.33	12.58	20.50	23.26	19.51	11. 2	0.34	11.53	20.39	23.26	25
26	18.52	8.57	1.57	13.18	21. 1	23.25	19.38	10.41	0.58	12.14	20.51	23.25	26
27	18.37	8.35	2.20	13.37	21.11	23.23	19.25	10.20	1.21	12.34	21. 2	23.23	27
28	18.22	8.12	2.44	13.56	21.21	23.20	19.11	9.59	1.45	12.54	21.13	23.20	28
29	18. 6		3. 7	14.15	21.31	23.18	18.57	9.38	2. 8	13.15	21.24	23.17	29
30	17.50		3.31	14.34	21.41	23.15	18.43	9.17	2.31	13.35	21.34	23.14	30
31	17.34		3.54		21.50		18.29	8.55		13.54		23.10	31

TABLE OF THE SUN's DECLINATION

For the Years 1804, 1808, 1812.

Days.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	South	South	South	North	North	North	North	North	North	South	South	South	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 5	17.21	7.32	4.35	15. 6	22. 4	23. 8	18. 3	8.17	3.12	14.29	21.51	1
2	23. 1	17. 4	7. 9	4.58	15.24	22.12	23. 4	17.47	7.55	3.36	14.48	22. 0	2
3	22.55	16.47	6.46	5.21	15.42	22.20	22.59	17.32	7.33	3.59	15. 7	22. 9	3
4	22.50	16.29	6.23	5.44	15.59	22.27	22.54	17.16	7.11	4.22	15.25	22.17	4
5	22.44	16.11	6. 0	6. 6	16.16	22.34	22.49	17. 0	6.49	4.45	15.44	22.25	5
6	22.37	15.53	5.37	6.29	16.33	22.40	22.43	16.43	6.27	5. 9	16. 2	22.32	6
7	22.30	15.35	5.14	6.52	16.50	22.46	22.37	16.27	6. 4	5.32	16.20	22.39	7
8	22.22	15.16	4.50	7.14	17. 7	22.52	22.30	16.10	5.42	5.55	16.37	22.45	8
9	22.14	14.57	4.27	7.37	17.23	22.57	22 23	15.53	5.19	6.18	16.55	22.51	9
10	22. 6	14.38	4. 3	7.59	17.39	23. 2	22.16	15.35	4.56	6.40	17.12	22.57	10
11	21.57	14.18	3.40	8.21	17.54	23. 6	22. 8	15.17	4.33	7. 3	17.28	23. 2	11
12	21.48	13.59	3.16	8.43	18. 9	23.10	22. 0	14.59	4.10	7.26	17.45	23. 7	12
13	21.38	13.39	2.53	9. 5	18.24	23.14	24.51	14.41	3.47	7.48	18. 1	23.11	13
14	21.28	13.19	2.29	9.26	18.39	23.17	21.42	14.23	3.24	8.11	18.17	23.15	14
15	21.18	12.58	2. 5	9.48	18.53	23.20	21.33	14. 4	3. 1	8.33	18.32	23.18	15
16	21. 7	12.38	1.42	10. 9	19. 7	23.22	21.24	13.45	2.38	8.55	18.47	23.21	16
17	20.55	12.17	1.18	10.30	19.21	23.24	21.14	13.26	2.15	9.17	19. 2	23.23	17
18	20.44	11.56	0.54	10.51	19.34	23.26	21. 3	13. 7	1.52	9.39	19.16	23.25	18
19	20.31	11.35	0.31	11.12	19.47	23.27	20.52	12.48	1.28	10. 1	19.31	23.26	19
20	20.19	11.14	0. 7S.	11.33	20. 0	23.28	20.41	12.28	1. 5	10.23	19.44	23.27	20
21	20. 6	10.52	0.17N.	11.53	20.12	23.28	20.30	12. 8	0.42	10.44	19.58	23.28	21
22	19.53	10.31	0.40	12.13	20.24	23.28	20.18	11.48	0.18N.	11. 5	20.11	23.28	22
23	19.39	10. 9	1. 4	12.33	20.36	23.27	20. 6	11.28	0. 5S.	11.27	20.23	23.27	23
24	19.25	9.47	1.28	12.53	20.47	23.26	19.54	11. 7	0.29	11.48	20.36	23.26	24
25	19.11	9.25	1.51	13.13	20.58	23.25	19.41	10.46	0.52	12. 8	20.48	23.25	25
26	18.56	9. 3	2.15	13.32	21. 9	23.23	19.28	10.26	1.15	12.29	20.59	23.23	26
27	18.41	8.40	2.38	13.52	21.19	23.21	19.14	10. 5	1.39	12.49	21.10	23.21	27
28	18.26	8.18	3. 2	14.11	21.29	23.18	19. 1	9.43	2. 2	13.10	21.21	23.18	28
29	18 10	7.55	3.25	14.29	21.38	23.15	18.47	9.22	2.26	13.30	21.31	23.15	29
30	17.54		3.48	14.48	21.47	23.12	18.32	9. 1	2.49	13.50	21.41	23.11	30
31	17.38		4.11		21.56		18.18	8.39		14. 9		23. 7	31

* NOTE TO TABLE VI. The day of the month is not placed in the bottom column of this Table, as it often leads to an erroneous application of the correction of declination. The numbers in the bottom column represent the correction from March 19 to March 25, and from September 17 to September 24:—to know whether to add or subtract it, observe the following rule:—If at the noon of the given day at Greenwich the sun has passed the equinoctial line (or changed his declination from North to South, or from South to North) you must apply the correction in the same manner as is directed in the Table for 10 or 12 days afterwards; but if the sun has not passed the equinoctial line, you must apply the correction as is directed in the Table for 10 or 12 days previous to the given time.

Thus, if the declination was required for March 21, 1800, at noon, in Long. 105° E.—By Table V. the declination at noon at Greenwich is 0° 16′ N. the sun having then passed the equinoctial line. The correction in the bottom column of Table VI. for the Long. 105° is 7′ 11″ or 7′; to know whether it is to be added or subtracted, I examine that Table and find the correction is subtractive on March 31st (which is ten days after the given time): therefore subtracting the correction 7′ from the declination 0° 16′, I obtain the true declination at the required time 0° 9′ N.

When the correction is subtractive, and greater than the declination taken from the Table, the difference between the two numbers will be the declination, which will be of a different name from that taken from the table.

A similar alteration might have been made in the top column of the Table; but the correction being small, it was unnecessary.

TAB. VI. For reducing the SUN's DECLINATION as given in the N. A. for noon at GREENWICH, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M 0.20	H. M 0.40	H. M 1. 0	H. M 1.20	H. M 1.40	H. M 2. 0	H. M 2.20	H. M 2.40	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	5 deg.	10 deg.	15 deg.	20 deg.	25 deg.	30 deg.	35 deg.	40 deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M. S	M. S	M. S	M. S	M. S	M. S	M. S	M. S	Days.	Days.
Decemb. 21	Dec. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 0	0. 1	0. 1	0. 1	0. 2	0. 2	0. 2	0. 3	22	20
19	23	0. 0	0. 1	0. 2	0. 2	0. 3	0. 4	0. 5	0. 6	23	19
18	24	0. 1	0. 2	0. 3	0. 4	0. 6	0. 7	0. 8	0. 9	24	18
17	25	0. 1	0. 3	0. 4	0. 6	0. 7	0. 9	0.11	0.12	25	17
16	26	0. 2	0. 4	0. 5	0. 7	0. 9	0.11	0.13	0.15	26	16
15	27	0. 2	0. 5	0. 6	0. 8	0.11	0.13	0.15	0.18	27	15
14	28	0. 3	0. 6	0. 7	0.10	0.12	0.15	0.18	0.21	28	14
13	29	0. 3	0. 7	0. 9	0.12	0.15	0.18	0.21	0.24	29	13
12	30	0. 3	0. 7	0.10	0.13	0.17	0.20	0.23	0.27	30 June	12
11	Dec. 31	0. 4	0. 8	0.11	0.15	0.19	0.22	0.26	0.30	1 July	11
10	Jan. 1	0. 4	0. 8	0.12	0.16	0.20	0.24	0.28	0.32	2	10
9	2	0. 4	0. 8	0.13	0.17	0.21	0.26	0.30	0.35	3	9
8	3	0. 5	0. 9	0.14	0.19	0.24	0.29	0.33	0.38	4	8
7	4	0. 5	0.10	0.15	0.21	0.26	0.31	0.36	0.41	5	7
6	5	0. 5	0.11	0.16	0.22	0.28	0.33	0.38	0.44	6	6
5	6	0. 6	0.12	0.17	0.24	0.30	0.35	0.41	0.47	7	5
4	7	0. 6	0.12	0.18	0.25	0.31	0.37	0.43	0.49	8	4
3	8	0. 6	0.13	0.19	0.26	0.33	0.39	0.45	0.52	9	3
2	9	0. 7	0.14	0.20	0.27	0.34	0.41	0.48	0.55	10	2
Dec. 1	10	0. 7	0.14	0.21	0.29	0.36	0.43	0.50	0.57	11	1 June
Nov. 30	11	0. 7	0.15	0.22	0.30	0.37	0.45	0.52	1. 0	12	31 May
29	12	0. 8	0.16	0.23	0.31	0.39	0.47	0.55	1. 3	13	30
28	13	0. 8	0.16	0.24	0.33	0.41	0.49	0.57	1. 6	14	29
27	14	0. 8	0.17	0.25	0.34	0.42	0.51	0.59	1. 8	15	28
26	15	0. 9	0.18	0.26	0.35	0.44	0.53	1. 2	1.11	16	27
25	16	0. 9	0.18	0.27	0.37	0.46	0.55	1. 4	1.13	17	26
24	17	0. 9	0.19	0.28	0.38	0.47	0.57	1. 6	1.16	18	25
23	18	0.10	0.20	0.29	0.39	0.49	0.58	1. 9	1.19	19	24
22	19	0.10	0.20	0.30	0.40	0.50	1. 0	1.10	1.20	20	23
21	20	0.10	0.21	0.31	0.41	0.51	1. 2	1.12	1.22	21	22
20	21	0.11	0.22	0.32	0.43	0.53	1. 4	1.14	1.25	22	21
19	22	0.11	0.22	0.33	0.44	0.55	1. 6	1.17	1.28	23	20
18	23	0.11	0.23	0.34	0.45	0.56	1. 7	1.19	1.30	24	19
17	24	0.12	0.23	0.34	0.46	0.57	1. 9	1.21	1.32	25	18
16	25	0.12	0.24	0.35	0.47	0.59	1.11	1.23	1.35	26	17
15	26	0.12	0.24	0.36	0.48	1. 0	1.12	1.24	1.36	27	16
14	27	0.12	0.25	0.37	0.49	1. 2	1.14	1.26	1.39	28	15
13	28	0.13	0.26	0.38	0.51	1. 4	1.16	1.28	1.41	29	14
11	Jan. 30	0.13	0.26	0.39	0.53	1. 6	1.19	1.32	1.45	31 July	12
9	Feb. 1	0.13	0.27	0.41	0.55	1. 9	1.22	1.36	1.50	2 August	10
7	3	0.14	0.28	0.42	0.57	1.11	1.25	1.39	1.53	4	8
5	5	0.14	0.29	0.43	0.58	1.13	1.27	1.42	1.56	6	6
3	7	0.15	0.30	0.45	1. 0	1.15	1.30	1.44	1.59	8	4
Nov. 1	9	0.15	0.31	0.46	1. 2	1.17	1.32	1.47	2. 3	10	2 May
Oct. 30	11	0.16	0.32	0.47	1. 3	1.19	1.35	1.50	2. 6	12	30 April
28	13	0.16	0.32	0.48	1. 5	1.21	1.37	1.53	2. 9	14	28
26	15	0.16	0.33	0.49	1. 6	1.22	1.39	1.56	2.12	16	26
24	17	0.17	0.34	0.50	1. 7	1.24	1.41	1.58	2.15	18	24
21	20	0.17	0.34	0.52	1. 9	1.27	1.44	2. 1	2.19	21	21
18	23	0.17	0.35	0.53	1.11	1.29	1.46	2. 4	2.22	24	18
15	Feb. 26	0.18	0.36	0.54	1.13	1.31	1.49	2. 7	2.25	27	15
12	March 1	0.18	0.37	0.55	1.14	1.32	1.51	2. 9	2.28	30 August	12
9	4	0.19	0.38	0.56	1.15	1.34	1.53	2.12	2.30	2 Sept.	9
6	7	0.19	0.38	0.57	1.16	1.35	1.54	2.13	2.32	5	6
Oct. 3	10	0.19	0.38	0.57	1.17	1.36	1.55	2.14	2.34	8	3 April
Sept. 30	13	0.19	0.39	0.58	1.17	1.37	1.56	2.15	2.35	11	31 March
27	16	0.19	0.39	0.58	1.18	1.38	1.57	2.16	2.36	14	28
24	19	0.20	0.39	0.58	1.18	1.38	1.57	2.16	2.36	17	25
*	*	0.20	0.40	0.59	1.19	1.39	1.58	2.17	2.36	*	*

* See the Note at the bottom of the table of the sun's declination for the year 1804.

Tab. VI. For reducing the Sun's Declin. as given in the N. A. for Noon at Greenwich, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M 3. 0	H. M 3.20	H. M 3.40	H. M 4. 0	H. M 4.20	H. M 4.40	H. M 5. 0	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	45 deg.	50 deg.	55 deg.	60 deg.	05 deg.	70 deg.	75 deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Dec. 21	Dec. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 3	0. 3	0. 4	0. 4	0. 4	0. 5	0. 5	22	20
19	23	0. 6	0. 7	0. 8	0. 9	0. 9	0.10	0.11	23	19
18	24	0.10	0.11	0.12	0.13	0.14	0.15	0.16	24	18
17	25	0.13	0.15	0.16	0.18	0.19	0.20	0.22	25	17
16	26	0.16	0.18	0.20	0.22	0.24	0.26	0.27	26	16
15	27	0.20	0.22	0.24	0.26	0.29	0.31	0.33	27	15
14	28	0.23	0.25	0.28	0.31	0.34	0.36	0.38	28	14
13	29	0.26	0.29	0.32	0.35	0.38	0.41	0.44	29	13
12	30	0.30	0.33	0.36	0.40	0.43	0.46	0.50	30 June	12
11	Dec. 31	0.33	0.37	0.40	0.44	0.48	0.51	0.55	1 July	11
10	Jan. 1	0.36	0.40	0.44	0.48	0.53	0.57	1. 1	2	10
9	2	0.39	0.44	0.48	0.53	0.57	1. 2	1. 6	3	9
8	3	0.43	0.48	0.53	0.57	1. 2	1. 7	1.11	4	8
7	4	0.46	0.51	0.56	1. 1	1. 7	1.12	1.17	5	7
6	5	0.49	0.55	1. 0	1. 6	1.11	1.17	1.22	6	6
5	6	0.52	0.58	1. 4	1.10	1.16	1.22	1.27	7	5
4	7	0.55	1. 1	1. 7	1.14	1.20	1.26	1.32	8	4
3	8	0.58	1. 5	1.11	1.18	1.24	1.31	1.37	9	3
2	9	1. 1	1. 8	1.15	1.22	1.29	1.36	1.43	10	2
Dec. 1	10	1. 4	1.12	1.19	1.26	1.33	1.41	1.48	11	1 June
Nov. 30	11	1. 7	1.15	1.23	1.30	1.37	1.45	1.52	12	31 May
29	12	1.10	1.18	1.26	1.34	1.42	1.50	1.57	13	30
28	13	1.13	1.22	1.30	1.38	1.46	1.54	2. 2	14	29
27	14	1.16	1.25	1.34	1.42	1.50	1.58	2. 7	15	28
26	15	1.19	1.28	1.37	1.46	1.55	2. 3	2.12	16	27
25	16	1.22	1.31	1.40	1.49	1.59	2. 8	2.17	17	26
24	17	1.25	1.35	1.44	1.53	2. 3	2.12	2.21	18	25
23	18	1.28	1.38	1.47	1.57	2. 7	2.16	2.26	19	24
22	19	1.30	1.41	1.51	2. 1	2.11	2.21	2.31	20	23
21	20	1.33	1.44	1.54	2. 4	2.15	2.25	2.35	21	22
20	21	1.36	1.47	1.57	2. 8	2.19	2.29	2.40	22	21
19	22	1.39	1.50	2. 0	2.11	2.22	2.33	2.44	23	20
18	23	1.41	1.53	2. 4	2.15	2.26	2.37	2.48	24	19
17	24	1.43	1.55	2. 7	2.18	2.30	2.41	2.52	25	18
16	25	1.46	1.58	2.10	2.21	2.33	2.45	2.56	26	17
15	26	1.48	2. 1	2.13	2.25	2.37	2.49	3. 1	27	16
14	27	1.51	2. 4	2.16	2.28	2.40	2.52	3. 5	28	15
13	28	1.54	2. 7	2.19	2.31	2.44	2.56	3. 9	29	14
11	Jan. 30	1.58	2.11	2.24	2.37	2.51	3. 4	3.17	31 July	12
9	Feb. 1	2. 3	2.17	2.30	2.43	2.57	3.11	3.24	2 Aug.	10
7	3	2. 7	2.21	2.35	2.49	3. 3	3.17	3.32	4	8
5	5	2.11	2.25	2.40	2.54	3. 9	3.23	3.38	6	6
3	7	2.14	2.29	2.44	2.59	3.14	3.29	3.44	8	4
Nov. 1	9	2.18	2.33	2.49	3. 4	3.19	3.35	3.50	10	2 May
Oct. 30	11	2.22	2.38	2.53	3. 9	3.25	3.41	3.56	12	30 April
28	13	2.25	2.41	2.58	3.14	3.30	3.46	4. 3	14	28
26	15	2.29	2.45	3. 2	3.18	3.35	3.51	4. 8	16	26
24	17	2.32	2.49	3. 5	3.22	3.39	3.56	4.13	18	24
21	20	2.36	2.53	3.11	3.28	3.45	4. 3	4.20	21	21
18	23	2.40	2.58	3.15	3.33	3.51	4. 8	4.26	24	18
15	Feb. 26	2.43	3. 1	3.20	3.38	3.56	4.14	4.32	27	15
12	March 1	2.46	3. 5	3.23	3.42	4. 1	4.19	4.38	30 Aug.	12
9	4	2.49	3. 8	3.26	3.45	4. 4	4.23	4.41	2 Sept.	9
6	7	2.51	3.10	3.29	3.48	4. 7	4.26	4.45	5	6
Oct. 3	10	2.53	3.13	3.32	3.51	4.10	4.29	4.49	8	3 April
Sept. 30	13	2.55	3.14	3.33	3.53	4.13	4.32	4.51	11	31 March
27	16	2.56	3.15	3.34	3.54	4.14	4.33	4.52	14	28
24	19	2.56	3.15	3.35	3.55	4.15	4.33	4.52	17	25
*	*	2.56	3.15	3.35	3.55	4.15	4.34	4.53	*	*

* See the Note at the bottom of the table of the sun's declination for the year 1804.

TAB. VI. For reducing the SUN'S DECLIN. as given in the N. A. for Noon at GREENWICH, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M 5.20	H. M 5.40	H. M 6. 0	H. M 6.20	H. M 6.40	H. M 7. 0	H. M 7.20	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	80 deg.	85 deg.	90 deg.	95 deg.	100 deg.	105 deg.	110 deg.	Sub. in W. Add in E.	Add. in W. Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Dec. 21	Dec. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 5	0. 6	0. 6	0. 7	0. 8	0. 8	0. 8	22	20
19	23	0.11	0.12	0.13	0.14	0.15	0.15	0.16	23	19
18	24	0.17	0.19	0.20	0.21	0.22	0.23	0.24	24	18
17	25	0.23	0.25	0.26	0.28	0.29	0.31	0.32	25	17
16	26	0.29	0.31	0.33	0.35	0.37	0.38	0.40	26	16
15	27	0.35	0.38	0.40	0.42	0.44	0.46	0.49	27	15
14	28	0.41	0.43	0.46	0.49	0.51	0.54	0.57	28	14
13	29	0.47	0.50	0.53	0.56	0.59	1. 2	1. 5	29	13
12	30	0.53	0.56	0.59	1. 3	1. 6	1. 9	1.12	30 June	12
11	Dec. 31	0.59	1. 2	1. 6	1.10	1.13	1.17	1.21	1 July	11
10	Jan. 1	1. 5	1. 9	1.13	1.17	1.21	1.25	1.29	2	10
9	2	1.11	1.15	1.19	1.24	1.28	1.32	1.37	3	9
8	3	1.16	1.21	1.26	1.31	1.35	1.40	1.45	4	8
7	4	1.22	1.27	1.32	1.37	1.42	1.47	1.53	5	7
6	5	1.27	1.33	1.38	1.44	1.49	1.54	2. 0	6	6
5	6	1.33	1.39	1.45	1.51	1.57	2. 2	2. 8	7	5
4	7	1.39	1.45	1.51	1.57	2. 3	2. 9	2.16	8	4
3	8	1.44	1.50	1.57	2. 4	2.10	2.16	2.23	9	3
2	9	1.50	1.56	2. 3	2.10	2.17	2.23	2.30	10	2
Dec. 1	10	1.55	2. 2	2. 9	2.16	2.23	2.30	2.38	11	1 June
Nov. 30	11	2. 0	2. 7	2.15	2.22	2.30	2.37	2.45	12	31 May
29	12	2. 5	2.13	2.21	2.29	2.37	2.44	2.52	13	30
28	13	2.10	2.19	2.27	2.35	2.43	2.51	3. 0	14	29
27	14	2.16	2.25	2.33	2.42	2.50	2.58	3. 7	15	28
26	15	2.21	2.30	2.38	2.47	2.56	3. 5	3.13	16	27
25	16	2.26	2.35	2.44	2.53	3. 2	3.11	3.21	17	26
24	17	2.31	2.40	2.50	2.59	3. 9	3.18	3.28	18	25
23	18	2.36	2.46	2.55	3. 5	3.15	3.24	3.34	19	24
22	19	2.41	2.51	3. 1	3.11	3.21	3.31	3.41	20	23
21	20	2.46	2.56	3. 6	3.17	3.27	3.37	3.48	21	22
20	21	2.50	3. 2	3.12	3.23	3.33	3.44	3.55	22	21
19	22	2.55	3. 6	3.17	3.28	3.39	3.50	4. 1	23	20
18	23	3. 0	3.11	3.22	3.33	3.45	3.56	4. 7	24	19
17	24	3. 4	3.16	3.27	3.39	3.50	4. 1	4.13	25	18
16	25	3. 8	3.20	3.32	3.44	3.56	4. 7	4.19	26	17
15	26	3.13	3.25	3.37	3.49	4. 1	4.13	4.26	27	16
14	27	3.17	3.29	3.42	3.54	4. 6	4.19	4.31	28	15
13	28	3.22	3.34	3.47	4. 0	4.12	4.25	4.38	29	14
11	Jan. 30	3.30	3.43	3.56	4. 9	4.22	4.36	4.49	31 July	12
9	Feb. 1	3.38	3.51	4. 5	4.18	4.32	4.46	4.59	2 Aug.	10
7	3	3.46	4. 0	4.14	4.28	4.42	4.56	5.10	4	8
5	5	3.52	4. 6	4.21	4.36	4.50	5. 5	5.19	6	6
3	7	3.59	4.14	4.29	4.44	4.59	5.14	5.29	8	4
Nov. 1	9	4. 5	4.21	4.36	4.52	5. 7	5.23	5.38	10	2 May
Oct. 30	11	4.12	4.28	4.44	5. 0	5.16	5.31	5.47	12	30 April
28	13	4.19	4.35	4.51	5. 7	5.23	5.40	5.56	14	28
26	15	4.24	4.41	4.57	5.14	5.30	5.47	6. 3	16	26
24	17	4.30	4.47	5. 3	5.21	5.38	5.55	6.12	18	24
21	20	4.37	4.55	5.12	5.29	5.47	6. 4	6.21	21	21
18	23	4.44	5. 2	5.19	5.37	5.55	6.13	6.31	24	18
15	Feb. 26	4.50	5. 8	5.26	5.44	6. 2	6.20	6.38	27	15
12	March 1	4.56	5.15	5.33	5.52	6.10	6.29	6.47	30 Aug.	12
9	4	5. 0	5.19	5.38	5.57	6.16	6.34	6.53	2 Sept.	9
6	7	5. 4	5.23	5.42	6. 1	6.20	6.39	6.58	5	6
Oct. 3	10	5. 8	5.27	5.46	6. 5	6.25	6.44	7. 3	8	3 April
Sept. 30	13	5.11	5.30	5.49	6. 8	6.28	6.47	7. 6	11	31 March
27	16	5.12	5.31	5.51	6.11	6.31	6.50	7. 9	14	28
24	19	5.12	5.32	5.52	6.12	6.32	6.51	7.11	17	25
*	*	5.13	5.33	5.53	6.13	6.33	6.52	7.11	*	*

* See the Note at the bottom of the table of the sun's declination for the year 1804.

TAB. VI. For reducing the SUN's DECLIN. as given in the N. A. for Noon at GREENWICH, to any other time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M 7.40	H. M 8. 0	H. M 8.20	H. M 8.40	H. M 9. 0	H. M 9.20	H. M 9.40	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add. in W. Sub. in E.	Sub. in W. Add in E.	115 deg.	120 deg.	125 deg.	130 deg.	135 deg.	140 deg.	145 deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Dec. 21	Dec. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 9	0. 9	0. 9	0.10	0.10	0.10	0.10	22	20
19	23	0.17	0.18	0.18	0.19	0.19	0.20	0.21	23	19
18	24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	24	18
17	25	0.34	0.35	0.36	0.38	0.39	0.41	0.43	25	17
16	26	0.42	0.44	0.46	0.48	0.49	0.51	0.53	26	16
15	27	0.51	0.53	0.55	0.57	0.59	1. 1	1. 3	27	15
14	28	0.59	1. 2	1. 5	1. 7	1. 9	1.12	1.14	28	14
13	29	1. 8	1.11	1.14	1.17	1.19	1.22	1.25	29	13
12	30	1.16	1.19	1.23	1.26	1.29	1.32	1.35	30 June	12
11	Dec. 31	1.24	1.28	1.32	1.35	1.39	1.43	1.46	1 July	11
10	Jan. 1	1.33	1.37	1.41	1.45	1.49	1.53	1.57	2	10
9	2	1.42	1.46	1.51	1.55	1.59	2. 3	2. 7	3	9
8	3	1.49	1.54	1.59	2. 4	2. 9	2.13	2.18	4	8
7	4	1.58	2. 3	2. 8	2 13	2.19	2.23	2.28	5	7
6	5	2. 5	2.11	2.16	2.22	2.28	2.33	2.39	6	6
5	6	2.14	2.20	2.26	2.32	2.38	2.43	2.49	7	5
4	7	2.22	2.28	2.34	2.41	2.47	2.53	2.59	8	4
3	8	2.29	2.36	2.43	2.49	2.56	3. 3	3. 9	9	3
2	9	2.37	2.44	2.51	2.58	3. 5	3.12	3.19	10	2
Dec. 1	10	2.45	2.52	2.59	3. 6	3.14	3.21	3.28	11	1 June
Nov. 30	11	2.52	3. 0	3. 7	3.15	3.23	3.30	3.38	12	31 May
29	12	3. 0	3. 8	3.16	3.24	3.32	3.39	3.47	13	30
28	13	3. 8	3.16	3.24	3.32	3.40	3.49	3.57	14	29
27	14	3.15	3.24	3.32	3.41	3.49	3.58	4. 6	15	28
26	15	3.22	3.31	3.40	3.49	3.58	4. 7	4.16	16	27
25	16	3.30	3.39	3.48	3.57	4. 7	4.16	4.25	17	26
24	17	3.37	3.46	3.56	4. 6	4.16	4.24	4.34	18	25
23	18	3.44	3.54	4. 4	4.14	4.24	4.33	4.43	19	24
22	19	3.51	4. 1	4.11	4.21	4.31	4.41	4.51	20	23
21	20	3.58	4. 8	4.19	4.29	4.39	4.50	5. 0	21	22
20	21	4. 5	4.16	4.27	4.37	4.48	4.59	5. 9	22	21
19	22	4.12	4.23	4.34	4.45	4.56	5. 7	5.18	23	20
18	23	4.19	4.30	4.41	4.53	5. 4	5.15	5.26	24	19
17	24	4.25	4.36	4.48	5. 0	5.12	5.23	5.34	25	18
16	25	4.31	4.43	4.55	5. 7	5.19	5.30	5.42	26	17
15	26	4.38	4.50	5. 2	5.14	5.26	5.38	5.50	27	16
14	27	4.43	4.56	5. 8	5.21	5.33	5.46	5.58	28	15
13	28	4.50	5. 3	5.16	5.28	5.40	5.54	6. 6	29	14
11	Jan. 30	5. 2	5.15	5.28	5.41	5.54	6. 8	6.21	31 July	12
9	Feb. 1	5.13	5.27	5.40	5.54	6. 8	6.22	6.35	2 Aug.	10
7	3	5.24	5.38	5.52	6. 6	6.20	6.35	6.49	4	8
5	5	5.34	5.49	6. 4	6.18	6.33	6.47	7. 2	6	6
3	7	5.44	5.59	6.14	6.29	6.44	6.59	7.14	8	4
Nov. 1	9	5.53	6. 9	6.24	6.40	6.55	7.11	7.26	10	2 May
Oct. 30	11	6. 3	6.18	6.34	6.50	7. 6	7.21	7.37	12	30 April
28	13	6.12	6.28	6.44	7. 0	7.16	7 32	7.48	14	28
26	15	6.20	6.36	6.53	7.10	7.26	7.42	7.58	16	26
24	17	6.29	6.45	7. 2	7.19	7.36	7.52	8. 9	18	24
21	20	6.39	6.56	7.13	7.31	7.48	8. 5	8.22	21	21
18	23	6.48	7. 6	7.24	7.42	8. 0	8.17	8.34	24	18
15	Feb. 26	6.57	7.15	7.34	7.52	8.10	8.28	8.46	27	15
12	March 1	7. 6	7.24	7.42	8. 1	8.20	8.38	8.57	30 Aug.	12
9	4	7.12	7.31	7.50	8. 9	8.28	8.46	9. 6	2 Sept.	9
6	7	7.17	7.36	7.55	8.14	8.33	8.53	9.12	5	6
Oct. 3	10	7.23	7.42	8. 1	8.20	8.39	8.59	9.18	8	3 April
Sept. 30	13	7.26	7.45	8. 4	8.24	8.43	9. 3	9.22	11	31 March
27	16	7.29	7.48	8. 7	8.27	8.47	9. 6	9.25	14	28
24	19	7.30	7.50	8.10	8.29	8.49	9. 8	9.27	17	25
*	*	7.31	7.50	8.10	8.30	8.50	9. 9	9.28	*	*

* See the Note at the bottom of the table of the sun's declination for the year 1804.

Tab. VI. For reducing the Sun's Declination as given in the N. A. for Noon at Greenwich, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M. 10. 0	H. M. 10.20	H. M. 10.40	H. M. 11. 0	H. M. 11.20	H. M. 11.40	H. M. 12. 0	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	150 deg.	155 deg.	160 deg.	165 deg.	170 deg.	175 deg.	180 deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Dec. 21	Dec. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0.11	0.11	0.12	0.12	0.12	0.13	0.13	22	20
19	23	0.22	0.23	0.24	0.24	0.25	0.26	0.26	23	19
18	24	0.33	0.34	0.35	0.36	0.37	0.38	0.39	24	18
17	25	0.44	0.46	0.47	0.48	0.50	0.51	0.53	25	17
16	26	0.55	0.57	0.58	1. 0	1. 2	1. 4	1. 6	26	16
15	27	1. 6	1. 8	1.11	1.13	1.15	1.17	1.19	27	15
14	28	1.17	1.20	1.23	1.25	1.27	1.30	1.32	28	14
13	29	1.28	1.31	1.34	1.37	1.40	1.43	1.46	29	13
12	30	1.39	1.42	1.45	1.49	1.52	1.55	1.59	30 June	12
11	Dec. 31	1.50	1.54	1.57	2. 1	2. 5	2. 8	2.12	1 July	11
10	Jan. 1	2. 1	2. 5	2. 9	2.13	2.17	2.21	2.25	2	10
9	2	2.12	2.16	2.20	2.25	2.30	2.34	2.38	3	9
8	3	2.23	2.27	2.32	2.37	2.42	2.47	2.51	4	8
7	4	2.34	2.39	2.44	2.49	2.54	2.59	3. 4	5	7
6	5	2.44	2.50	2.55	3. 0	3. 6	3.12	3.17	6	6
5	6	2.55	3. 1	3. 6	3.12	3.18	3.24	3.30	7	5
4	7	3. 5	3.11	3.17	3.23	3.29	3.36	3.42	8	4
3	8	3.15	3.21	3.28	3.34	3.41	3.48	3.54	9	3
2	9	3.25	3.32	3.38	3.45	3.52	3.59	4. 6	10	2
Dec. 1	10	3.35	3.42	3.49	3.56	4. 4	4.11	4.18	11	1 June
Nov. 30	11	3.45	3.52	3.59	4. 7	4.15	4.22	4.30	12	31 May
29	12	3.55	4. 3	4.10	4.18	4.26	4.34	4.42	13	30
28	13	4. 5	4.13	4.21	4.29	4.38	4.46	4.54	14	29
27	14	4.15	4.23	4.31	4.40	4.49	4.57	5. 5	15	28
26	15	4.24	4.33	4.41	4.50	4.59	5. 8	5.17	16	27
25	16	4.34	4.43	4.52	5. 1	5.10	5.19	5.28	17	26
24	17	4.43	4.53	5. 2	5.11	5.21	5.30	5.40	18	25
23	18	4.52	5. 2	5.12	5.22	5.32	5.41	5.51	19	24
22	19	5. 1	5.12	5.22	5.32	5.42	5.52	6. 2	20	23
21	20	5.10	5.21	5.31	5.42	5.53	6. 3	6.13	21	22
20	21	5.20	5.31	5.41	5.52	6. 3	6.14	6.24	22	21
19	22	5.29	5.40	5.51	6. 2	6.13	6.24	6.34	23	20
18	23	5.37	5.49	6. 0	6.11	6.23	6.34	6.44	24	19
17	24	5.45	5.57	6. 9	6.20	6.32	6.43	6.54	25	18
16	25	5.54	6. 6	6.17	6.29	6.41	6.53	7. 4	26	17
15	26	6. 2	6.14	6.26	6.38	6.51	7. 3	7.14	27	16
14	27	6.10	6.22	6.34	6.47	7. 0	7.12	7.24	28	15
13	28	6.19	6.31	6.43	6.56	7. 9	7.22	7.34	29	14
11	Jan. 30	6.34	6.47	7. 0	7.13	7.26	7.40	7.53	31 July	12
9	Feb. 1	6.49	7. 3	7.16	7.30	7.43	7.57	8.11	2 Aug.	10
7	3	7. 3	7.17	7.31	7.45	7.59	8.13	8.28	4	8
5	5	7.16	7.31	7.45	8. 0	8.14	8.28	8.43	6	6
3	7	7.29	7.44	7.59	8.14	8.28	8.43	8.58	8	4
Nov. 1	9	7.41	7.56	8.12	8.27	8.42	8.58	9.13	10	2 May
Oct. 30	11	7.53	8. 8	8.24	8.40	8.56	9.12	9.28	12	30 April
28	13	8. 4	8.20	8.36	8.53	9. 9	9.25	9.42	14	28
26	15	8.15	8.32	8.48	9. 5	9.21	9.38	9.54	16	26
24	17	8.26	8.43	9. 0	9.17	9.34	9.50	10. 7	18	24
21	20	8.40	8.57	9.14	9.32	9.49	10. 6	10.24	21	21
18	23	8.52	9.10	9.28	9.46	10. 3	10.21	10.39	24	18
15	Feb. 26	9. 4	9.22	9.40	9.58	10.16	10.34	10.53	27	15
12	March 1	9.15	9.33	9.51	10.10	10.29	10.47	11. 0	30 Aug.	12
9	4	9.24	9.43	10. 1	10.20	10.39	10.58	11.16	2 Sept.	9
6	7	9.30	9.50	10. 9	10.28	10.47	11. 6	11.24	5	6
Oct. 3	10	9.37	9.56	10.16	10.35	10.54	11.13	11.32	8	3 April
Sept. 30	13	9.41	10. 0	10.21	10.40	10.59	11.18	11.38	11	31 March
27	16	9.45	10. 4	10.24	10.44	11. 3	11.22	11.42	14	28
24	19	9.47	10. 6	10.26	10.46	11. 5	11.24	11.44	17	25
*	*	9.48	10. 7	10.27	10.47	11. 6	11.25	11.45	*	*

* See the Note at the bottom of the table of the sun's declination for the year 1804.

TABLE

OF THE

SUN's RIGHT ASCENSION.

Days.	Jan.	Feb.	Marc.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	
1	18.45	20.57	22.48	0.41	2.32	4.35	6.39	8.44	10.40	12.28	14.24	16.28	1
2	18.49	21. 1	22.51	0.45	2.36	4.39	6.43	8.48	10.44	12.32	14.28	16.33	2
3	18.54	21. 6	22.55	0.48	2.40	4.43	6.47	8.52	10.47	12.36	14.32	16.37	3
4	18.58	21.10	22.59	0.52	2.44	4.47	6.51	8.56	10.51	12.39	14.36	16.41	4
5	19. 3	21.14	23. 2	0.56	2.48	4.51	6.56	8.59	10.55	12.43	14.40	16.46	5
6	19. 7	21.18	23. 6	0.59	2.51	4.55	7. 0	9. 3	10.58	12.46	14.44	16.50	6
7	19.11	21.22	23.10	1. 3	2.55	4.59	7. 4	9. 7	11. 2	12.50	14.48	16.54	7
8	19.16	21.26	23.14	1. 7	2.59	5. 4	7. 8	9.11	11. 5	12.54	14.52	16.59	8
9	19.20	21.30	23.17	1.10	3. 3	5. 8	7.12	9.15	11. 9	12.57	14.56	17. 3	9
10	19.24	21.34	23.21	1.14	3. 7	5.12	7.16	9.19	11.13	13. 1	15. 0	17. 7	10
11	19.29	21.38	23.25	1.18	3.11	5.16	7.20	9.22	11.16	13. 5	15. 4	17.12	11
12	19.33	21.41	23.28	1.21	3.15	5.20	7.24	9.26	11.20	13. 8	15. 8	17.16	12
13	19.37	21.45	23.32	1.25	3.19	5.24	7.28	9.30	11.23	13.12	15.12	17.21	13
14	19.42	21.49	23.36	1.29	3.23	5.28	7.32	9.34	11.27	13.16	15.17	17.25	14
15	19.46	21.53	23.39	1.32	3.27	5.33	7.36	9.37	11.31	13.20	15.21	17.30	15
16	19.50	21.57	23.43	1.36	3.30	5.37	7.40	9.41	11.34	13.23	15.25	17.34	16
17	19.55	22. 1	23.47	1.40	3.34	5.41	7.45	9.45	11.38	13.27	15.29	17.38	17
18	19.59	22. 5	23.50	1.43	3.38	5.45	7.49	9.49	11.41	13.31	15.33	17.43	18
19	20. 3	22. 9	23.54	1.47	3.42	5.49	7.53	9.52	11.45	13.35	15.37	17.47	19
20	20. 7	22.13	23.58	1.51	3.46	5.53	7.57	9.56	11.49	13.38	15.41	17.52	20
21	20.12	22.16	0. 1	1.55	3.50	5.58	8. 1	10. 0	11.52	13.42	15.46	17.56	21
22	20.16	22.20	0. 5	1.58	3.54	6. 2	8. 5	10. 4	11.56	13.46	15.50	18. 1	22
23	20.20	22.24	0. 8	2. 2	3.58	6. 6	8. 9	10. 7	11.59	13.50	15.54	18. 5	23
24	20.24	22.28	0.12	2. 6	4. 2	6.10	8.13	10.11	12. 3	13.54	15.58	18. 9	24
25	20.28	22.32	0.16	2.10	4. 6	6.14	8.17	10.15	12. 7	13.57	16. 2	18.14	25
26	20.33	22.35	0.19	2.13	4.10	6.18	8.20	10.18	12.10	14. 1	16. 7	18.18	26
27	20.37	22.39	0.23	2.17	4.14	6.22	8.24	10.22	12.14	14. 5	16.11	18.23	27
28	20.41	22.43	0.27	2.21	4.19	6.27	8.28	10.26	12.17	14. 9	16.15	18.27	28
29	20.45	22.45	0.30	2.25	4.23	6.31	8.32	10.29	12.21	14.13	16.20	18.32	29
30	20.49		0.34	2.28	4.27	6.35	8.36	10.33	12.25	14.17	16.24	18.36	30
31	20.53		0.37		4.31		8.40	10.37		14.21		18.41	31

This Table gives nearly the Mean of the Sun's Right Aſcenſion for the years 1801, 1802, 1803, and 1804, and is ſufficiently exact for finding when any ſtar comes to the meridian, in order to obtain the latitude ; but in all calculations for determining the longitude by celeſtial obſervations, the Sun's right aſcenſion muſt be taken from the Nautical Almanac, where it is calculated to a greater degree of accuracy.

TABLE VIII. AMPLITUDES.

DECLINATION IN DEGREES.

Lat.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.28	Lat.
	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	
1°	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	8. 0	9. 0	10. 0	11. 0	12. 0	13. 0	14. 0	15. 0	16. 0	17. 0	18. 0	19. 0	20. 0	21. 0	22. 0	23. 0	23.28	1°
2	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	8. 0	9. 0	10. 0	11. 0	12. 0	13. 0	14. 1	15. 1	16. 1	17. 1	18. 1	19. 1	20. 1	21. 1	22. 1	23. 1	23.29	2
3	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 1	8. 1	9. 1	10. 1	11. 1	12. 1	13. 1	14. 1	15. 1	16. 1	17. 1	18. 2	19. 2	20. 2	21. 2	22. 2	23. 2	23.30	3
4	1. 0	2. 0	3. 0	4. 1	5. 1	6. 1	7. 1	8. 1	9. 1	10. 1	11. 2	12. 2	13. 2	14. 2	15. 2	16. 2	17. 3	18. 3	19. 3	20. 3	21. 3	22. 3	23. 4	23.32	4
5	1. 0	2. 0	3. 1	4. 1	5. 1	6. 1	7. 2	8. 2	9. 2	10. 2	11. 3	12. 3	13. 3	14. 3	15. 4	16. 4	17. 4	18. 4	19. 5	20. 5	21. 5	22. 5	23. 6	23.34	5
6	1. 0	2. 1	3. 1	4. 1	5. 2	6. 2	7. 2	8. 3	9. 3	10. 3	11. 4	12. 4	13. 4	14. 5	15. 5	16. 5	17. 6	18. 6	19. 7	20. 7	21. 7	22. 8	23. 8	23.36	6
7	1. 0	2. 1	3. 1	4. 2	5. 2	6. 3	7. 3	8. 4	9. 4	10. 5	11. 5	12. 5	13. 6	14. 6	15. 7	16. 7	17. 8	18. 8	19. 9	20. 9	21.10	22.10	23.11	23.39	7
8	1. 1	2. 1	3. 2	4. 2	5. 3	6. 4	7. 4	8. 5	9. 5	10. 6	11. 7	12. 7	13. 8	14. 8	15. 9	16.10	17.10	18.11	19.12	20.12	21.13	22.14	23.14	23.43	8
9	1. 1	2. 1	3. 2	4. 3	5. 4	6. 5	7. 5	8. 6	9. 7	10. 8	11. 8	12. 9	13.10	14.11	15.11	16.12	17.13	18.14	19.15	20.16	21.16	22.17	23.18	23.47	9
10	1. 1	2. 2	3. 3	4. 4	5. 5	6. 6	7. 7	8. 7	9. 8	10. 9	11.10	12.11	13.12	14.13	15.14	16.15	17.16	18.17	19.18	20.19	21.20	22.21	23.23	23.51	10
11	1. 1	2. 2	3. 3	4. 4	5. 6	6. 7	7. 8	8. 9	9.10	10.11	11.13	12.14	13.15	14.16	15.17	16.18	17.20	18.21	19.22	20.23	21.25	22.26	23.27	23.56	11
12	1. 1	2. 3	3. 4	4. 5	5. 7	6. 8	7. 9	8.11	9.12	10.14	11.15	12.16	13.18	14.19	15.21	16.22	17.24	18.25	19.26	20.28	21.30	22.31	23.33	24. 1	12
13	1. 2	2. 3	3. 5	4. 6	5. 8	6.10	7.11	8.13	9.14	10.16	11.18	12.19	13.21	14.23	15.24	16.26	17.28	18.29	19.31	20.33	21.35	22.37	23.38	24. 7	13
14	1. 2	2. 4	3. 6	4. 7	5. 9	6.11	7.13	8.15	9.17	10.19	11.20	12.22	13.24	14.26	15.28	16.30	17.32	18.34	19.36	20.38	21.40	22.43	23.45	24.14	14
15	1. 2	2. 4	3. 6	4. 8	5.11	6.13	7.15	8.17	9.19	10.21	11.24	12.26	13.28	14.30	15.33	16.35	17.37	18.39	19.42	20.44	21.47	22.49	23.52	24.21	15
16	1. 2	2. 5	3. 7	4.10	5.12	6.15	7.17	8.19	9.22	10.24	11.27	12.29	13.32	14.35	15.37	16.40	17.42	18.45	19.48	20.51	21.53	22.56	23.59	24.28	16
17	1. 3	2. 5	3. 8	4.11	5.14	6.17	7.19	8.22	9.25	10.28	11.31	12.33	13.36	14.39	15.42	16.45	17.48	18.51	19.54	20.57	22. 1	23. 4	24. 7	24.36	17
18	1. 3	2. 6	3. 9	4.12	5.15	6.19	7.22	8.25	9.28	10.31	11.34	12.38	13.41	14.44	15.47	16.51	17.54	18.58	20. 1	21. 5	22. 8	23.12	24.15	24.45	18
19	1. 3	2. 7	3.10	4.14	5.17	6.21	7.24	8.28	9.31	10.35	11.39	12.42	13.46	14.49	15.53	16.57	18. 1	19. 5	20. 8	21.12	22.16	23.20	24.25	24.54	19
20	1. 4	2. 8	3.12	4.15	5.19	6.23	7.27	8.31	9.35	10.39	11.43	12.47	13.51	14.55	15.59	17. 3	18. 8	19.12	20.16	21.21	22.25	23.30	24.34	25. 4	20
21	1. 4	2. 9	3.13	4.17	5.21	6.26	7.30	8.34	9.39	10.43	11.48	12.52	13.57	15. 1	16. 6	17.10	18.15	19.20	20.25	21.29	22.34	23.39	24.45	25.15	21
22	1. 5	2. 9	3.14	4.19	5.24	6.28	7.33	8.38	9.43	10.48	11.53	12.57	14. 2	15. 7	16.13	17.18	18.23	19.28	20.33	21.39	22.44	23.50	24.55	25.26	22
23	1. 5	2.10	3.16	4.21	5.26	6.31	7.36	8.42	9.47	10.52	11.58	13. 3	14. 9	15.14	16.20	17.25	18.31	19.37	20.43	21.49	22.55	24. 1	25. 7	25.38	23
24	1. 6	2.11	3.17	4.23	5.28	6.34	7.40	8.46	9.52	10.57	12. 3	13. 9	14.15	15.21	16.27	17.34	18.40	19.46	20.53	21.59	23. 6	24.13	25.19	25.51	24
25	1. 6	2.12	3.19	4.25	5.31	6.37	7.44	8.50	9.56	11. 3	12. 9	13.16	14.22	15.29	16.36	17.42	18.49	19.56	21. 3	22.10	23.18	24.25	25.32	26. 4	25
26	1. 7	2.14	3.20	4.27	5.34	6.41	7.48	8.54	10. 1	11. 8	12.15	13.22	14.30	15.37	16.44	17.52	18.59	20. 7	21.14	22.22	23.30	24.38	25.46	26.18	26
27	1. 7	2.15	3.22	4.29	5.37	6.44	7.52	8.59	10. 7	11.14	12.22	13.30	14.37	15.45	16.53	18. 1	19. 9	20.18	21.26	22.34	23.43	24.52	26. 1	26.33	27
28	1. 8	2.16	3.24	4.32	5.40	6.48	7.56	9. 4	10.12	11.21	12.29	13.37	14.46	15.54	17. 3	18.11	19.20	20.29	21.38	22.47	23.57	25. 6	26.16	26.48	28
29	1. 9	2.17	3.26	4.34	5.43	6.52	8. 1	9. 9	10.18	11.27	12.36	13.45	14.54	16. 3	17.13	18.22	19.32	20.41	21.51	23. 1	24.11	25.22	26.32	27. 5	29
30	1. 9	2.19	3.28	4.37	5.47	6.56	8. 5	9.15	10.24	11.34	12.44	13.53	15. 3	16.13	17.23	18.34	19.44	20.54	22. 5	23.16	24.27	25.38	26.49	27.23	30
31	1.10	2.20	3.30	4.40	5.50	7. 0	8.10	9.21	10.31	11.41	12.52	14. 2	15.13	16.24	17.34	18.45	19.57	21. 8	22.19	23.31	24.43	25.55	27. 7	27.41	31
32	1.11	2.22	3.32	4.43	5.54	7. 5	8.16	9.27	10.38	11.49	13. 0	14.11	15.23	16.34	17.46	18.58	20.10	21.22	22.35	23.47	25. 0	26.13	27.26	28. 0	32
33	1.12	2.23	3.35	4.46	5.58	7.10	8.21	9.33	10.45	11.57	13. 9	14.21	15.34	16.46	17.59	19.11	20.24	21.37	22.51	24. 4	25.18	26.32	27.46	28.21	33

TABLE VIII. AMPLITUDES.

Lat.	1 DM	2 DM	3 DM	4 DM	5 D M	6 D M	7 D M	8 D M	9 D M	10 D M	11 D M	12 D M	13 D M	14 D M	15 D M	16 D M	17 D M	18 D M	19 D M	20 D M	21 D M	22 D M	23 D M	23.28 D M	Lat.
34°	1.12	2.25	3.37	4.50	6. 2	7.15	8.27	9.40	10.53	12. 5	13.18	14.31	15.45	16.58	18.11	19.25	20.39	21.53	23. 7	24.22	25.37	26.52	28. 7	28.42	34°
35	1.13	2.27	3.40	4.53	6. 6	7.20	8.33	9.47	11. 1	12.14	13.28	14.42	15.56	17.11	18.25	19.40	20.55	22.10	23.25	24.41	25.57	27.13	28.29	29. 5	35
36	1.14	2.28	3.43	4.57	6.11	7.25	8.40	9.54	11. 9	12.24	13.39	14.54	16. 9	17.24	18.39	19.55	21.11	22.27	23.44	25. 1	26.18	27.35	28.53	29.29	36
37	1.15	2.30	3.45	5. 1	6.16	7.31	8.47	10. 2	11.18	12.33	13.49	15. 5	16.22	17.38	18.55	20.11	21.28	22.46	24. 3	25.21	26.40	27.58	29.17	29.55	37
38	1.16	2.32	3.48	5. 5	6.21	7.37	8.54	10.10	11.27	12.44	14. 1	15.18	16.35	17.53	19.10	20.28	21.47	23. 5	24.24	25.43	27. 3	28.23	29.44	30.21	38
39	1.17	2.34	3.52	5. 9	6.26	7.44	9. 1	10.19	11.37	12.55	14.13	15.31	16.50	18. 8	19.27	20.46	22. 6	23.26	24.46	26. 7	27.28	28.49	30.11	30.49	39
40	1.18	2.37	3.55	5.13	6.32	7.51	9. 9	10.28	11.47	13. 6	14.25	15.45	17. 5	18.25	19.45	21. 5	22.26	23.47	25. 9	26.31	27.54	29.17	30.40	31.19	40
41	1.20	2.39	3.59	5.18	6.38	7.58	9.18	10.38	11.58	13.18	14.39	15.59	17.20	18.42	20. 3	21.25	22.48	24.10	25.33	26.57	28.21	29.46	31.11	31.51	41
42	1.21	2.42	4. 2	5.23	6.44	8. 5	9.26	10.48	12. 9	13.31	14.53	16.15	17.37	19. 0	20.23	21.46	23.10	24.34	25.59	27.24	28.50	30.16	31.43	32.24	42
43	1.22	2.44	4. 6	5.28	6.51	8.13	9.36	10.58	12.21	13.44	15. 7	16.31	17.55	19.19	20.44	22. 8	23.34	25.00	26.26	27.53	29.20	30.49	32.18	32.59	43
44	1.23	2.47	4.10	5.34	6.58	8.21	9.45	11. 9	12.34	13.58	15.23	16.48	18.13	19.39	21. 5	22.32	23.59	25.26	26.55	28.23	29.53	31.23	32.54	33.37	44
45	1.25	2.50	4.15	5.40	7. 5	8.30	9.55	11.21	12.47	14.13	15.39	17. 6	18.33	20.00	21.28	22.57	24.25	25.55	27.25	28.56	30.27	31.59	33.33	34.16	45
46	1.26	2.53	4.19	5.46	7.12	8.39	10. 6	11.33	13. 1	14.29	15.57	17.25	18.54	20.23	21.53	23.23	24.53	26.25	27.57	29.30	31. 3	32.38	34.14	34.59	46
47	1.28	2.56	4.24	5.52	7.21	8.49	10.18	11.46	13.16	14.45	16.15	17.45	19.16	20.47	22.18	23.50	25.23	26.57	28.31	30. 6	31.42	33.19	34.57	35.43	47
48	1.30	2.59	4.29	5.59	7.29	8.59	10.30	12. 0	13.31	15. 2	16.34	18. 6	19.39	21.12	22.45	24.20	25.55	27.30	29. 7	30.44	32.23	34. 3	35.44	36.31	48
49	1.31	3. 3	4.35	6. 6	7.38	9.10	10.42	12.15	13.48	15.21	16.54	18.29	20. 3	21.38	23.14	24.51	26.28	28. 6	29.45	31.25	33. 7	34.49	36.33	37.22	49
50	1.33	3. 7	4.40	6.14	7.48	9.22	10.56	12.30	14. 5	15.40	17.16	18.52	20.29	22. 7	23.45	25.24	27. 3	28.44	30.26	32. 9	33.53	35.39	37.26	38.17	50
51	1.35	3.11	4.46	6.22	7.58	9.34	11.10	12.47	14.24	16. 1	17.39	19.17	20.57	22.36	24.17	25.59	27.41	29.25	31. 9	32.55	34.43	36.32	38.23	39.15	51
52	1.37	3.15	4.53	6.30	8. 8	9.47	11.25	13. 4	14.43	16.23	18. 3	19.44	21.26	23. 8	24.52	26.36	28.21	30. 8	31.56	33.45	35.36	37.29	39.24	40.18	52
53	1.40	3.19	4.59	6.39	8.20	10. 0	11.41	13.22	15. 4	16.46	18.29	20.13	21.57	23.42	25.28	27.16	29. 4	30.54	32.45	34.38	36.33	38.30	40.29	41.26	53
54	1.42	3.24	5. 7	6.49	8.32	10.15	11.58	13.42	15.26	17.11	18.57	20.43	22.30	24.18	26. 7	27.58	29.50	31.43	33.38	35.35	37.34	39.36	41.40	42.39	54
55	1.45	3.29	5.14	6.59	8.44	10.30	12.16	14. 3	15.50	17.37	19.26	21.15	23. 5	24.57	26.49	28.43	30.39	32.36	34.35	36.36	38.40	40.47	42.56	43.58	55
56	1.47	3.35	5.22	7.10	8.58	10.46	12.35	14.25	16.15	18. 5	19.57	21.50	23.43	25.38	27.34	29.32	31.31	33.33	35.36	37.42	39.51	42. 4	44.20	45.24	56
57	1.50	3.40	5.31	7.22	9.13	11. 4	12.56	14.48	16.42	18.36	20.30	22.26	24.24	26.22	28.22	30.24	32.28	34.34	36.43	38.54	41. 9	43.27	45.50	46.59	57
58	1.53	3.47	5.40	7.34	9.28	11.23	13.18	15.14	17.10	19. 8	21. 6	23. 6	25. 7	27.10	29.14	31.21	33.29	35.40	37.54	40.12	42.33	44.59	47.30	48.43	58
59	1.57	3.53	5.50	7.47	9.45	11.43	13.41	15.41	17.41	19.42	21.45	23.49	25.54	28. 1	30.10	32.21	34.35	36.52	39.12	41.37	44. 6	46.40	49.21	50.38	59
60	2. 0	4. 0	6. 0	8. 1	10. 2	12. 4	14. 6	16.10	18.14	20.19	22.26	24.34	26.44	28.56	31.10	33.27	35.47	38.10	40.38	43.10	45.47	48.31	51.24	52.47	60
61	2. 4	4. 8	6.12	8.16	10.21	12.27	14.34	16.41	18.49	20.59	23.11	25.24	27.39	29.56	32.16	34.39	37. 5	39.36	42.11	44.52	47.40	50.36	53.42	55.13	61
62	2. 8	4.16	6.24	8.33	10.42	12.52	15. 3	17.15	19.28	21.42	23.59	26.17	28.38	31. 1	33.27	35.57	38.31	41.10	43.54	46.46	49.46	52.56	56.20	58. 1	62
63	2.12	4.25	6.37	8.50	11. 4	13.19	15.34	17.51	20. 9	22.29	24.51	27.15	29.42	32.12	34.45	37.23	40. 5	42.54	45.49	48.53	52. 8	55.36	59.23	61.18	63
64	2.17	4.34	6.51	9. 9	11.28	13.48	16. 8	18.31	20.54	23.20	25.48	28.19	30.52	33.30	36.11	38.58	41.50	44.49	47.58	51.17	54.50	58.43	63. 2	65.17	64
65	2.22	4.44	7. 7	9.30	11.54	14.19	16.46	19.14	21.44	24.16	26.50	29.2	32.10	34.55	37.46	40.43	43.46	46.59	50.23	54. 2	57.59	62.25	67.36	70.26	65
66	2.28	4.55	7.24	9.53	12.22	14.54	17.26	20. 1	22.37	25.16	27.59	30.4	33.35	36.30	39.31	42.40	45.57	49.27	53.10	57.14	61.46	67. 4	73.52	78.15	66

Declination columns 1–23.28 are headed "DECLINATION IN DEGREES."

Table IX.

Right Aſcenſion and Declination of ſome of the principal fixed Stars adapted to the beginning of the year 1800, with their annual variation.

Names and Declinations of the STARS.	Characters.	Magnitudes.	Right Aſcenſion.	Ann. var. R. A. add.	Declin.	Annual variation.
			H.M.S	S. $\frac{1}{100}$	D. M.	S. $\frac{1}{10}$
Extremity of the wing of Pegaſus, *Algenib* -	γ	2	0. 2.57	3.06	14.4 N.	+20.1
In the head of the Phenix	α	2,3	0.16.22	2.99	43.22 S.	—20.0
Bright Star in the tail of the Whale - -	β	2,3	0.33.32	3.00	19.5 S.	—19.9
Polar Star, tail of the Great Bear	α	2,3	0.52.15	12.50	88.14 N.	+19.6
In the girdle of Andromeda	β	2	0.58.34	3.30	34.33 N.	+19.5
The ſpring of the river Erida, *Achernar* - -	α	1	1.30.16	2.25	58.15 S.	—18.5
Almaach in the foot of Andromeda - -	γ	2	1.51.41	3.62	41.22 N.	+17.7
* In the preceding horn of the Ram, α ARIETIS	α	2	1.55.55	3.34	22.31 N.	+17.6
In the neck of the Whale	ο	2	2. 9.15	3.02	3.54 S.	—17.0
In the jaw of the Whale	α	2	2.51.50	3.12	3.18 N.	+14.8
In the head of Meduſa, *Algol*	β	2	2.55.12	3.85	40.11 N.	+14.6
The bright Star in Perſeus	α	2	3.10. 7	4.20	49. 8 N.	+13.6
The bright Star of the Pleiades, or Seven Stars -	η	3	3.35.37	3.54	23.29 N.	+11.8
*The Southern eye of the Bull, ALDEBARAN -	α	1	4.24.27	3.42	16. 6 N.	+8.2
In the left ſhoulder of Auriga, *Capella* -	α	1	5. 1.56	4.41	45.47 N.	+5.0
The bright foot of Orion, *Rigel*	β	1	5. 4.56	2.87	8.27 S.	—4.8
The northern horn of the Bull	β	2	5.13.39	3.78	28.26 N.	+4.1
The weſtern ſhoulder of Orion	γ	2	5.14.25	3.21	6. 9 N.	+4.0
In the belt of Orion	δ	2	5.21.47	3.06	0.28 S.	—3.3
	ε	2	5.26. 4	3.03	1.20 S.	—3.0
	ζ	2	5.30.41	3.02	2. 4 S.	—2.6
Bright Star in the Dove	α	2	5.32.25	2.17	34.11 S.	—2.4
The eaſtern ſhoulder of Orion	α	1	5.44.21	3.24	7.21 N.	+1.4
In the foot of the Great Dog	β	2.3	6.13.54	2.64	17.52 S.	+1.2
In the poop of the ſhip Argo, *Canopus* - -	α	1	6.19.31	1.33	52.35 S.	+1.7
In the ancle of Pollux -	γ	2.3	6.26. 9	3.46	16.34 N.	—2.3
In the mouth of the Greater Dog, *Sirius* - -	α	1	6.36.20	2.65	16.27 S.	+4.3
In the thigh of the Greater Dog	ε	2.3	6.50.46	2.35	28.42 S.	+4.4
In the back of the Greater Dog	δ	2.3	7. 0.15	2.44	26. 5 S.	+5.2
In the tail of the Greater Dog	η	2	7.16.11	2.38	28.55 S.	+6.5
In the head of the northern Twin, *Caſtor* -	α	1.2	7.21.49	3.86	32.19 N.	—7.0

Table IX.

Right Ascension and Declination of some of the principal fixed Stars adapted to the beginning of the year 1800, with their annual variation.

Names and Declinations of the STARS.	Characters.	Magnitudes.	Right Ascension.	Ann. var R. A. add.	Declin.	Annual variation
			H.M.S.	S. $\frac{1}{100}$	D. M.	S. $\frac{1}{10}$
The Lesser Dog, *Procyon*	α	1.2	7.28.49	3.14	5.44N.	− 7.6
*In the head of the southern Twin, POLLUX	β	1.2	7.33. 3	3.69	28.30N.	− 7.9
In the row lock of the ship Argo - -	ζ	2	7.56.34	2.12	39.27 S.	+ 9.7
In the poop of the ship Argo	γ	2	8. 3.23	1.86	46.45 S.	+10.3
In the middle of the ship Argo	δ	2.3	8.39.11	1.66	53.59 S.	+12.9
In the oars of the ship Argo	β	2.3	9.10.59	0.75	68.54 S.	+14.9
The heart of the female Hydra *Alphard* - -	α	2	9.17.45	2.94	7.48 S.	+15.2
* The Lion's heart, REGULUS	α	1.2	9.57.42	3.20	12.56N.	−17.2
South pointer in the sq. of the Great Bear -	β	2	10.49.40	3.71	57.27N.	−19.1
North pointer in the sq. of the Great Bear -	α	1.2	10.51.16	3.85	62.50N.	−19.2
The Lion's tail—*Denebola*	β	1.2	11.38.50	3.06	15.41N.	−20.0
S. E. Star of □ of the Great Bear - -	γ	2	11.43.14	3.22	54.48N.	−20.0
N. E. Star of □ of the Great Bear - -	δ	3	12. 5.27	3.02	58. 9N.	−20.1
In the foot of the Cross	α	1	12.15.37	3.24	61.59 S.	+20.0
In the top of the Cross	γ	2	12.20. 9	3.24	55.59 S.	+20.0
In the following arm of the Cross - -	β	2	12.36.10	3.41	58.36 S.	+19.8
Alioth, first Star in the tail of the Great Bear	ε	2.3	12.45.13	2.75	57. 3N.	−19.7
* The Virgin's Spike—SPICA	α	1	13.14.40	3.14	10. 7 S.	+19.0
The second Star in the tail of the Great Bear -	ζ	2.3	13.15.50	2.43	55.59N.	−10.0
Last Star in the tail of the Great Bear -	η	2	13.39.39	2.40	50.19N.	−18.2
The western foot of the Centaur - -	β	2	13.49.52	4.10	59.24 S.	+17.8
In the tail of the Dragon	α	2.3	13.58.59	1.63	65.20N.	−17.4
The bright Star in Bootes *Arcturus* -	α	1	14. 6.32	2.72	20.14N.	−18.9
The eastern foot of the Centaur	α	1	14.26.32	4.44	60. 1 S.	+16.1
The southern scale of the balance -	α	2.3	14.39.50	3.29	15.12 S.	+15.4
The northern scale of the balance - -	β	2.3	15. 6.16	3.22	8.38 S.	+13.8
Bright Star in the Crown *Gemma* -	α	2	15.26.13	2.54	27.24N.	−12.5

Right Ascension and Declination of some of the principal fixed Stars adapted to the beginning of the year 1800, with their annual variation.

Names and Declinations of the STARS.	Characters.	Magnitudes.	Right Ascension.	Ann. var. R. A. add.	Declin.	Annual variation
			H.M.S.	S. $\frac{1}{100}$	D. M.	S. $\frac{1}{10}$
In the neck of the Serpent	α	2	15.34.25	2.94	7. 4N.	—11.9
The northernmost Star of the Scorpion's forehead	β	2	15.53.50	3.47	19.15 S.	+10.5
* The Scorpion's heart, ANTARES - -	α	1	16.17.10	3.65	25.58 S.	+ 8.7
In the eastern knee of Ophiuchus - -	η	2.3	16.58.55	3.42	15.28 S.	+ 5.3
In the head of Hercules	α	2	17. 5.32	2.73	14.38N.	— 4.7
In the head of Ophiuchus	α	2	17.25.39	2.77	12.43N	— 3.0
In the head of the Dragon	γ	2.3	17.51.58	1.39	51.31N.	— 0.8
In the bow of Sagittarius	ε	2.3	18.10.54	3.98	34.28 S.	— 0.9
The bright Star in the Harp, Wega, LYRA -	α	1	18.30.10	1.99	38.36N.	+ 2.6
* Bright Star in the Eagle, *Atair*, α AQUILÆ -	α	1	19.41. 1	2.92	8.21N.	+ 8.5
The eye of the Peacock	α	2	20. 9.44	4.85	57.22 S.	—10.8
The tail of the Swan, *Deneb*	α	1.2	20.34.37	2.03	44.34N.	+12.5
The western wing of the Crane	α	2	21.55.33	3.85	47.55 S.	—17.2
* In the mouth of the southern fish, FOMALHAUT	α	1	22.46.34	3.33	30.41 S.	—19.1
In the shoulder of Pegasus	β	2	22.54. 5	2.87	27. 0N.	+19.2
* In the wing of Pegasus, *Markab*, α PEGASI -	α	2	22.54.48	2.96	14. 8N.	+19.2
In the head of Andromeda	α	2	23.58. 4	3.07	27.59N.	+20.2
Near the shoulder of Cassiopea	β	2.3	23.58.34	3.05	58. 3N.	+20.1

NOTE. If the places of these stars are wanted for any time before the beginning of the year 1800, multiply the annual variation, both in right ascension and declination, by the number of years before 1800, and subtract the product from the right ascension standing in the table; but the product of the annual variation in declination must be added to, or subtracted from, the declination, according as the sign — or + precede it; but for any years after 1800, the variation in right ascension must be added to the right ascension in the Table, and the variation in declination must be either added to or subtracted from it, according as their signs are, to fit the declination to any succeeding year.—The annual variation is set down for seconds, and decimals of a second. An asterisk is prefixed to the stars whose distances from the moon are given in the Nautical Almanac.

EXAMPLES TO EXPLAIN THE USE OF THE PRECEDING TABLE.

To find the Right Ascension of a Star at any time.

EXAMPLE I.

Required the Right Ascension of Aldebaran, January 1, 1804?

		h. m. sec.
R. A. by the Table in 1800		4 24 27
Variation in 4 years,	add	14
R. A. in January, 1804		4 24 41

EXAMPLE II.

Required the Right Ascension of Aldebaran, January 1, 1790?

		h. m. sec.
R. A. by the Table in 1800		4 24 27
Variation in 10 years,	sub.	34
R. A. in January, 1790		4 23 53

EXAMPLE III.

Required the Right Afcenfion of Spica, May 20, 1806?

	h.	m.	fec.
R. A. by the Table in 1800	13	14	40
Variation in 6 years 4⅔ months, add			20
R. A. May 20, 1806	13	15	0

EXAMPLE IV.

Required the Right Afcenfion of Sirius, Nov. 6, 1797?

	h.	m.	fec.
R. A. by the Table in 1800	6	36	20
Variation in 3 years, fub.			8
R. A. in January, 1797	6	36	12
Var. for 10 months and 6 days, add			2
R. A. Nov. 6, 1797	6	36	14

The fun's right afcenfion for any time may be found by the Nautical Almanac to any degree of accuracy; by taking proportional parts of its daily difference; as will be explained in the precepts of Table XXIX. But in cafes where no great accuracy is required, the right afcenfion may be obtained within 2 or 3 minutes by means of Table VII.

To find the Declination of a Star at any time.

EXAMPLE I.

Required the declination of Aldebaran, January 1, 1804?

Declination by the Table in 1800		16° 6' N.
Variation in 4 years 33'' add		1
Declination in 1804		16 7 N.

EXAMPLE II.

Required the declination of Aldebaran, January 1, 1790?

Declination by the Tab. in 1800		16° 6' N.
Var. in 10 years 1' 22'' fub.		1
Declination Jan. 1, 1790		16 5 N.

EXAMPLE III.

Required the declination of Spica, May 20, 1806?

Declination by the Tab. in 1800	10° 7' S.
Variation in 6 years 4⅔ months	2
Declin. May 20, 1806	10 9 S.

EXAMPLE IV.

Required the declination of Sirius, Nov. 6, 1787?

Declin. by Tab. in 1800	16° 27' S.
Var. in 12 yrs. 1 mo. 24 d. is, fub.	1
Declination Nov. 6, 1787	16 26 S.

The right afcenfions and declinations obtained by the preceding calculations, are the mean values, to which muft be applied the corrections for the Nutation and Aberration in cafes where great accuracy is required.

To find when a ftar will be on the meridian.

Rule. Find the right afcenfion of the fun and ftar in the preceding table; fubtract the fun's right afcenfion from the ftar's, having previoufly increafed the latter by 24 hours when the fun's right afcenfion is the greateft; the remainder will be the time of the ftar's coming to the meridian. If the remainder be greater than 12 hours, the ftar will come to the meridian after midnight; but if it be lefs than 12 hours, the ftar will come to the meridian before midnight.

EXAMPLE I.

At what time will Aldebaran be on the meridian Jan. 1?

	h.	m.
Aldebaran's right afcenfion	4	24
Add - -	24	
	28	24
Sun's right afcenfion - -	18	45
Aldebaran fouths in the evening	9	39

EXAMPLE II.

At what time will Pollux be on the meridian March 31?

	h.	m.
Pollux's Right Afcenfion	7	33
Sun's Right Afcenfion	0	37
Comes to the meridian in the evening	6	56

EXAMPLE III.

At what time will the ftar Regulus be on the meridian December 12?

	h.	m.
Regulus' Right Afcenfion	9	58
Add - - -	24	
	33	58
Sun's Right Afcenfion	17	16
After midnight	16	42
Subtract	12	
In the morning	4	42

EXAMPLE IV.

Required the time when the ftar Fomalhaut comes on the meridian June 1?

	h.	m.
Fomalhaut's Right Afcenfion	22	47
Sun's Right Afcenfion	4	35
After midnight	18	12
Subtract	12	
In the morning	6	12

To find what Star will come upon the Meridian at any given Time.

Rule. Add the time from noon to the right afcenfion of the fun, the fum (rejecting 24 hours when it exceeds 24) will be the right afcenfion of the ftar required to be known; with which enter the table of the ftar's right afcenfion, and find what ftar's right afcenfion agrees with, or comes the neareft to it, and that is the ftar required.

EXAMPLE I.

I would know what ftar would be on the meridian about 10 at night, January 26?

	h.	m.
Sun's Right Afcenfion January 26	20	33
Given time 10 hours P. M.	10	0
	30	33
Subtract	24	0
Nearly anfwers to Sirius	6	33

EXAMPLE II.

What ftar will be upon the meridian 30 minutes paft 4 in the morning May 10?

	h.	m.
Sun's Right Afcenfion May 10	3	7
Given time 16 hours 30 minutes	16	30
Right Afcenfion of mid. heaven	19	37

Anfwers nearly to Atair in the Eagle.

EXAMPLE III.

What ftar will be on the meridian at 6 H. 51 M. P. M. April 1?

	h.	m.
Sun's Right Afcenfion April 1	0	41
Given time	6	51
Right Afcenfion of the meridian	7	32

Anfwers nearly to Pollux.

EXAMPLE IV.

What ftar will be on the meridian Sept. 1, at 5 H. 37 M. P. M.?

	h.	m.
Sun's Right Afcention Sept. 1	10	40
Given time	5	37
Right Afcenfion of the meridian	16	17

Anfwers nearly to Antares.

In all the preceding examples, the right afcenfion of the fun ought to have been calculated for the moment of paffing the meridian, as we fhall more fully explain in the precepts of Table XXIX.

A TABLE shewing the time of the Sun's setting, when the latitude and declination are of the same name, and the time of its rising, when the latitude and declination are of different names.

DEGREES OF DECLINATION.

Lat.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.28	Lat.
	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	HM.	H M	
1°	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	1°
2	6.00	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.03	6.03	6.03	2
3	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.03	6.04	6.04	6.04	6.04	6.05	6.05	6.05	6.05	3
4	6.00	6.00	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.04	6.04	6.04	6.05	6.05	6.05	6.06	6.06	6.06	6.06	6.07	6.07	4
5	6.00	6.00	6.01	6.01	6.01	6.02	6.02	6.02	6.03	6.03	6.04	6.04	6.04	6.05	6.05	6.05	6.06	6.06	6.07	6.07	6.07	6.08	6.08	6.09	6.09	5
6	6.00	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.03	6.04	6.04	6.05	6.05	6.06	6.06	6.06	6.07	6.07	6.08	6.08	6.09	6.09	6.10	6.10	6.10	6
7	6.00	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.04	6.04	6.05	6.05	6.06	6.06	6.07	6.08	6.08	6.09	6.09	6.10	6.10	6.11	6.11	6.12	6.12	7
8	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.04	6.05	6.05	6.06	6.06	6.07	6.07	6.08	6.09	6.09	6.10	6.10	6.11	6.12	6.12	6.13	6.14	6.14	8
9	6.00	6.01	6.01	6.02	6.03	6.03	6.04	6.04	6.05	6.06	6.06	6.07	6.08	6.08	6.09	6.10	6.10	6.11	6.12	6.13	6.13	6.14	6.15	6.15	6.16	9
10	6.00	6.01	6.01	6.02	6.03	6.04	6.04	6.05	6.06	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.12	6.13	6.14	6.15	6.16	6.16	6.17	6.18	10
11	6.00	6.01	6.02	6.02	6.03	6.04	6.05	6.05	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.13	6.14	6.14	6.15	6.16	6.17	6.18	6.19	6.19	11
12	6.00	6.01	6.02	6.03	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.18	6.19	6.20	6.21	6.21	12
13	6.00	6.01	6.02	6.03	6.04	6.05	6.06	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.18	6.19	6.20	6.21	6.22	6.23	13
14	6.00	6.01	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.19	6.20	6.21	6.22	6.23	6.24	6.25	14
15	6.00	6.01	6.02	6.03	6.04	6.05	6.06	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.18	6.19	6.20	6.21	6.22	6.24	6.25	6.26	6.27	15
16	6.00	6.01	6.02	6.03	6.05	6.06	6.07	6.08	6.09	6.10	6.12	6.13	6.14	6.15	6.16	6.18	6.19	6.20	6.21	6.23	6.24	6.25	6.27	6.28	6.29	16
17	6.00	6.01	6.02	6.04	6.05	6.06	6.07	6.09	6.10	6.11	6.12	6.14	6.15	6.16	6.17	6.19	6.20	6.21	6.23	6.24	6.26	6.27	6.28	6.30	6.31	17
18	6.00	6.01	6.03	6.04	6.05	6.07	6.08	6.09	6.10	6.12	6.13	6.14	6.16	6.17	6.19	6.20	6.21	6.23	6.24	6.26	6.27	6.29	6.30	6.32	6.32	18
19	6.00	6.01	6.03	6.04	6.06	6.07	6.08	6.10	6.11	6.13	6.14	6.15	6.17	6.18	6.20	6.21	6.23	6.24	6.26	6.27	6.29	6.30	6.32	6.34	6.34	19
20	6.00	6.01	6.03	6.04	6.06	6.07	6.09	6.10	6.12	6.13	6.15	6.16	6.18	6.19	6.21	6.22	6.24	6.26	6.27	6.29	6.30	6.32	6.34	6.36	6.36	20
21	6.00	6.02	6.03	6.05	6.06	6.08	6.09	6.11	6.12	6.14	6.16	6.17	6.19	6.20	6.22	6.24	6.25	6.27	6.29	6.30	6.32	6.34	6.36	6.38	6.38	21
22	6.00	6.02	6.03	6.05	6.06	6.08	6.10	6.11	6.13	6.15	6.16	6.18	6.20	6.21	6.23	6.25	6.27	6.28	6.30	6.32	6.34	6.36	6.38	6.39	6.40	22
23	6.00	6.02	6.03	6.05	6.07	6.09	6.10	6.12	6.14	6.15	6.17	6.19	6.21	6.22	6.24	6.26	6.28	6.30	6.32	6.34	6.36	6.38	6.39	6.42	6.42	23
24	6.00	6.02	6.04	6.05	6.07	6.09	6.11	6.13	6.14	6.16	6.18	6.20	6.22	6.24	6.25	6.27	6.29	6.31	6.33	6.35	6.37	6.39	6.41	6.44	6.45	24
25	6.00	6.02	6.04	6.06	6.07	6.09	6.11	6.13	6.15	6.17	6.19	6.21	6.23	6.25	6.27	6.29	6.31	6.33	6.35	6.37	6.39	6.41	6.43	6.46	6.47	25
26	6.00	6.02	6.04	6.06	6.08	6.10	6.12	6.14	6.16	6.18	6.20	6.22	6.24	6.26	6.28	6.30	6.32	6.34	6.36	6.39	6.41	6.43	6.45	6.48	6.49	26
27	6.00	6.02	6.04	6.06	6.08	6.10	6.12	6.14	6.16	6.19	6.21	6.23	6.25	6.27	6.29	6.31	6.34	6.36	6.38	6.40	6.43	6.45	6.48	6.50	6.51	27
28	6.00	6.02	6.04	6.06	6.09	6.11	6.13	6.15	6.17	6.19	6.22	6.24	6.26	6.28	6.30	6.33	6.35	6.37	6.40	6.42	6.45	6.47	6.50	6.52	6.53	28
29	6.00	6.02	6.04	6.07	6.09	6.11	6.13	6.16	6.18	6.20	6.22	6.25	6.27	6.29	6.32	6.34	6.37	6.39	6.42	6.44	6.47	6.49	6.52	6.54	6.56	29
30	6.00	6.02	6.05	6.07	6.09	6.12	6.14	6.16	6.19	6.21	6.23	6.26	6.28	6.31	6.33	6.36	6.38	6.41	6.43	6.46	6.49	6.51	6.54	6.57	6.58	30

A TABLE shewing the time of the Sun's setting, when the latitude and declination are of the same name, and the time of its rising, when the latitude and declination are of different names.

Lat.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.28	Lat.
	DEGREES OF DECLINATION.																									
	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	HM	H M	
31°	6.00	6.02	6.05	6.07	6.10	6.12	6.14	6.17	6.19	6.22	6.24	6.27	6.29	6.32	6.34	6.37	6.40	6.42	6.45	6.48	6.51	6.53	6.56	6.59	7.00	31°
32	6.00	6.02	6.05	6.08	6.10	6.13	6.15	6.18	6.20	6.23	6.25	6.28	6.31	6.33	6.36	6.39	6.41	6.44	6.47	6.50	6.53	6.56	6.58	7.02	7.03	32
33	6.00	6.03	6.05	6.08	6.10	6.13	6.16	6.18	6.21	6.24	6.26	6.29	6.32	6.34	6.37	6.40	6.43	6.46	6.49	6.52	6.55	6.58	7.01	7.04	7.05	33
34	6.00	6.03	6.05	6.08	6.11	6.14	6.16	6.19	6.22	6.25	6.27	6.30	6.33	6.36	6.39	6.42	6.45	6.48	6.51	6.54	6.57	7.00	7.03	7.07	7.08	34
35	6.00	6.03	6.06	6.08	6.11	6.14	6.17	6.20	6.23	6.25	6.28	6.31	6.34	6.37	6.40	6.43	6.46	6.49	6.53	6.56	6.59	7.02	7.06	7.09	7.11	35
36	6.00	6.03	6.06	6.09	6.12	6.15	6.18	6.20	6.23	6.26	6.29	6.32	6.36	6.39	6.42	6.45	6.48	6.51	6.55	6.58	7.01	7.05	7.08	7.12	7.14	36
37	6.00	6.03	6.06	6.09	6.12	6.15	6.18	6.21	6.24	6.27	6.31	6.34	6.37	6.40	6.43	6.47	6.50	6.53	6.57	7.00	7.04	7.07	7.11	7.15	7.16	37
38	6.00	6.03	6.06	6.09	6.13	6.16	6.19	6.22	6.25	6.28	6.32	6.35	6.38	6.42	6.45	6.48	6.52	6.55	6.59	7.02	7.06	7.10	7.14	7.17	7.19	38
39	6.00	6.03	6.06	6.10	6.13	6.16	6.20	6.23	6.26	6.29	6.33	6.36	6.40	6.43	6.47	6.50	6.54	6.57	7.01	7.05	7.09	7.12	7.16	7.20	7.22	39
40	6.00	6.03	6.07	6.10	6.13	6.17	6.20	6.24	6.27	6.31	6.34	6.38	6.41	6.45	6.48	6.52	6.56	6.59	7.03	7.07	7.11	7.15	7.19	7.23	7.25	40
41	6.00	6.03	6.07	6.10	6.14	6.17	6.21	6.25	6.28	6.32	6.35	6.39	6.43	6.46	6.50	6.54	6.58	7.02	7.06	7.10	7.14	7.18	7.22	7.27	7.29	41
42	6.00	6.04	6.07	6.11	6.14	6.18	6.22	6.25	6.29	6.33	6.37	6.40	6.44	6.48	6.52	6.56	7.00	7.04	7.08	7.12	7.17	7.21	7.25	7.30	7.32	42
43	6.00	6.04	6.07	6.11	6.15	6.19	6.22	6.26	6.30	6.34	6.38	6.42	6.46	6.50	6.54	6.58	7.02	7.06	7.11	7.15	7.19	7.24	7.29	7.33	7.36	43
44	6.00	6.04	6.08	6.12	6.15	6.19	6.23	6.27	6.31	6.35	6.39	6.43	6.47	6.52	6.56	7.00	7.04	7.09	7.13	7.18	7.22	7.27	7.32	7.37	7.39	44
45	6.00	6.04	6.08	6.12	6.16	6.20	6.24	6.28	6.32	6.36	6.41	6.45	6.49	6.53	6.58	7.02	7.07	7.11	7.16	7.21	7.25	7.30	7.35	7.40	7.43	45
46	6.00	6.04	6.08	6.12	6.17	6.21	6.25	6.29	6.33	6.38	6.42	6.46	6.51	6.55	7.00	7.04	7.09	7.14	7.19	7.24	7.29	7.34	7.39	7.44	7.47	46
47	6.00	6.04	6.09	6.13	6.17	6.22	6.26	6.30	6.35	6.39	6.44	6.48	6.53	6.57	7.02	7.07	7.12	7.17	7.22	7.27	7.32	7.37	7.43	7.48	7.51	47
48	6.00	6.04	6.09	6.13	6.18	6.22	6.27	6.31	6.36	6.41	6.45	6.50	6.55	6.59	7.04	7.09	7.14	7.19	7.25	7.30	7.35	7.41	7.47	7.53	7.55	48
49	6.00	6.05	6.09	6.14	6.18	6.23	6.28	6.32	6.37	6.42	6.47	6.52	6.57	7.02	7.07	7.12	7.17	7.22	7.28	7.33	7.39	7.45	7.51	7.57	8.00	49
50	6.00	6.05	6.10	6.14	6.19	6.24	6.29	6.34	6.39	6.44	6.49	6.54	6.59	7.04	7.09	7.14	7.20	7.25	7.31	7.37	7.43	7.49	7.55	8.02	8.05	50
51	6.00	6.05	6.10	6.15	6.20	6.25	6.30	6.35	6.40	6.45	6.50	6.56	7.01	7.06	7.12	7.17	7.23	7.29	7.35	7.41	7.47	7.53	8.00	8.06	8.10	51
52	6.00	6.05	6.10	6.15	6.21	6.26	6.31	6.36	6.41	6.47	6.52	6.58	7.03	7.09	7.14	7.20	7.26	7.32	7.38	7.45	7.51	7.58	8.05	8.12	8.15	52
53	6.00	6.05	6.11	6.16	6.21	6.27	6.32	6.38	6.43	6.49	6.54	7.00	7.06	7.11	7.17	7.23	7.29	7.36	7.42	7.49	7.56	8.02	8.10	8.17	8.21	53
54	6.00	6.06	6.11	6.17	6.22	6.28	6.33	6.39	6.45	6.50	6.56	7.02	7.08	7.14	7.20	7.27	7.33	7.40	7.46	7.53	8.00	8.08	8.15	8.23	8.27	54
55	6.00	6.06	6.11	6.17	6.23	6.29	6.35	6.40	6.46	6.52	6.58	7.04	7.11	7.17	7.23	7.30	7.37	7.44	7.51	7.58	8.05	8.13	8.21	8.29	8.33	55
56	6.00	6.06	6.12	6.18	6.24	6.30	6.36	6.42	6.48	6.54	7.01	7.07	7.13	7.20	7.27	7.34	7.41	7.48	7.55	8.03	8.11	8.19	8.27	8.36	8.40	56
57	6.00	6.06	6.12	6.19	6.25	6.31	6.37	6.44	6.50	6.56	7.03	7.10	7.16	7.23	7.30	7.37	7.45	7.52	8.00	8.08	8.16	8.25	8.34	8.43	8.48	57
58	6.00	6.06	6.13	6.19	6.26	6.32	6.39	6.45	6.52	6.59	7.06	7.12	7.20	7.27	7.34	7.42	7.49	7.57	8.05	8.14	8.22	8.32	8.41	8.51	8.56	58
59	6.00	6.07	6.13	6.20	6.27	6.33	6.40	6.47	6.54	7.01	7.08	7.15	7.23	7.30	7.38	7.46	7.54	8.02	8.11	8.20	8.29	8.39	8.49	9.00	9.05	59
60	6.00	6.07	6.14	6.21	6.28	6.35	6.42	6.49	6.56	7.04	7.11	7.19	7.26	7.34	7.42	7.51	7.59	8.08	8.17	8.26	8.36	8.47	8.58	9.09	9.15	60

To find the Time of the Sun's Rising, Setting, and the Length of the Day and Night, by this Table.

First. Find the sun's declination at the top of the page (marked with the degrees of declination) and the latitude in the right or left hand columns (marked lat.) and in the common angle of meeting is the time of sun setting, if the latitude and declination are of the same name; but if they are of different names, it is the time of its rising.

EXAMPLE I.

Let it be required to find the time of the sun's rising and setting, with the length of the day and night, in latitude 51° north, the 19th of July, 1804.

I first seek the sun's declination for the given day, and find it 20° 52' north, which I here call 21°, then under the declination 21°, and against the latitude 51°, stands 7 H. 53 M. the time the sun sets on the given day, in lat. 51 north, which being doubled, gives 15 H. 46 M. the length of the day; and if 7 H. 53 M. the time of the sun's setting be subtracted from 12 H. the remainder 4 H. 7 M. gives the time of the sun's rising, which being doubled gives 8 H. 14 M. length of the night.

But, when the sun has 21° south declination in this latitude, the time of sun setting becomes the time of sun rising, and the length of the day will then become the length of the night.

Thus, the 26th of November, 1804, the sun's declination was 20° 59' south, or 21°, then the time of sun-rising is 7 H. 53 M. his setting 4 H. 7 M. and the length of the night 15 H. 46 M. and day 8 H. 14 M.

EXAMPLE II.

Let it be required to find the time of the sun's rising, setting, and the length of the day and night, at Boston, the 12th of July, 1804.

Under 22° N. the declination of that day, and against 42° 23' or 42° N. the latitude of Boston, stands the time of the sun's setting

	h.	m.
Boston, stands the time of the sun's setting	7	25
Subtracted from 12 h. leaves sun-rising	4	35
Sun-setting doubled is the length of day	14	50
Sun-rising doubled is the length of night	9	10

EXAMPLE III.

Required the time of the sun's rising and setting, and length of day at the Cape of Good Hope, in latitude 34° 29' S. May 15th, 1804.

Under the declination 18° 53' or 19° N. and against the lat. 34° S.	12	0
Stands the sun's rising	6	54
Time of sun's setting	5	6
		2
The length of the day	10	12
And 6h. 54m. doub. is length of night	13	48

When a greater degree of accuracy is required, proportional parts may be taken for the and minutes of latitude and declination.

To find the Rising and Setting of the Stars.

By this table the rising and setting of any star may be found, whose declination does not exceed 23° 30' north or south, in the following manner.

If you are in north lat. and the star has north declination, look for the declination at the top, and the lat. in the right or left hand columns, in the angle of meeting, is half the time of the star's continuance above the horizon in that latitude, or the time it takes in ascending from the eastern side of the horizon to the meridian, and descending from the meridian to the western part of the horizon.

Therefore, if these hours and minutes be subtracted from the time of the star's coming to the meridian, the remainder will be the time of the star's rising, and if added, the sum will be the time of the star's setting.

EXAMPLE.

	h.	m.
Required when the star Arcturus rises and sets December 1, in latitude 51° N.		
The time of the star's coming to the meridian, or southing in the morning *	9	39
Then under star's declination 20° nearly, and against latitude 51° stand	7	47
Time of star's rising in the morning	1	52
Added, gives the time of the star's setting	17	26
	12	
Star sets 26 minutes after 5 in the evening	5	26

When the latitude is north, and the star has south declination, or the latitude south and the star has north declination, find the latitude in the side columns as before, against which and under

* *To find this time, see the precepts to Table IX.*

under the degrees of declination, ſtands half the time the ſtar is under the horizon, which being ſubtracted from 12, the remainder will be half the time the ſtar will be above the horizon in that latitude; by which the time of riſing and ſetting may be found, as in the laſt example.

EXAMPLE.

What time will the Dog-Star Sirius riſe and ſet at Philadelphia, February 1?

Under the declination, which is nearly 16° S. and againſt the latitude, which is nearly 40° N. ſtand	12 0 6 56
Subtracted from 12h. leaves half the time the ſtar is above the horizon	5 4
The ſtar comes to the meridian in the evening, at	9 39
Sum, rejecting 12 hours, is the time of ſetting in the morning	2 43
Difference is the time of riſing in the evening	4 35

In like manner may the riſing and ſetting of the planets be found when their declination does not exceed 23½°, and the time of their paſſage over the meridian is known.

Suppoſe it was required to find the time of Jupiter's riſing and ſetting, March 2, 1804, civil account, in the latitude of 52° N.

In the Nautical Almanac for 1804, I find that Jupiter paſſes the meridian March 1 D. 15 H. 24 M. or March 2 D. 3 H. 24 M. A. M. civil account, his declination being 12° 6' S. or nearly 12°. Under the declination 12°, and oppoſite to the latitude 52°, ſtand 7 H. 3 M. which is half the time Jupiter is below the horizon; this ſubtracted from 12 H. leaves half the time that he is above the horizon 4 H. 57 M.; this ſubtracted from 3 H. 24 M. A. M. leaves 10 H. 27 M. P. M of March 1, for the time of Jupiter's riſing; and added to 3 H. 24 M. gives 8 H. 21 M. A. M. March 2, for the time of Jupiter's ſetting.

Suppoſe it was required to find the time of the moon's riſing and ſetting, May 2, 1804, civil account, in the latitude of 52° N.

In the Nautical Almanac page 6, I find that the moon paſſes the meridian May 1 D. 17 H. 45 M. or May 2 D. 5 H. 45 M. A. M. civil account; her declination being about 21° S. Under the declination 21° and oppoſite to the latitude 52°, ſtand 7 H. 58 M. half the time the moon is below the horizon, which ſubtracted from 12 H. leaves half the time ſhe is above the horizon 4 H. 2 M. this ſubtracted from 5 H. 45 M. leaves 1 H. 43 M. A. M. the time of the moon's riſing, and added to 5 H. 45 M. give 9 H. 47 M. A. M. the time of her ſetting, nearly.

If greater accuracy is required, you muſt find the time at Greenwich correſponding to this approximate time of her riſing or ſetting; then find the moon's declination, and the difference between the right aſcenſions of the ſun and moon for that moment of time; and with theſe data repeat the operation. In this way we may obtain the time of riſing and ſetting to any degree of accuracy. Inſtead of taking the difference of the right aſcenſions of the ſun and moon, you may take the daily difference in the time of her coming to the meridian of Greenwich, and take a proportional part for the longitude of the place of obſervation (by means of Table XXVI); and another proportional part, for the interval between the hour of paſſing the meridian, and the time of riſing or ſetting.

It were to be wiſhed, that gentlemen belonging to the ſea would carry a celeſtial globe with them, upon which all the above may be found in an eaſy manner; for they would have nothing more to do but to ſet the globe north and ſouth, raiſe the poles as many degrees above the horizon as the latitude is; bring the ſun's place to the brazen meridian, and ſet the index to the upper 12; then turn the globe round, and note what ſtars come to the meridian, and the hour index will point to the time; when they come above the horizon, it will point to the time of their riſing, and when they deſcend below the horizon, it will point to their ſetting; for as each ſtar on the globe will point directly to one of the ſame name in the heavens, they may be viewed at any time of the night; or, if a planet, turn the globe until the index points to the time of their paſſage over the meridian, and make a mark on the globe with a pencil, under their declination, then turn the globe eaſt until the mark comes to the horizon, and the index will point to the time of their riſing; and turned weſterly till it comes to the horizon, the index will point to the time of their ſetting.

It may be noted, that the numbers of this table were calculated for the moment of the ſun's centre appearing in the true horizon; where the refraction makes that luminary appear nearly half a degree above the viſible horizon.

TABLE XI.

For finding the Diftance of Terreftrial Objects at Sea.

Height in Feet.	Diftance Mil. Dec.	Height in Feet.	Diftance. Mil. Dec.	Height in Feet.	Diftance. Mil. Dec.	Height in Feet.	Diftance. M. Tenths.
1	1.32	44	8.78	320	23.67	1000	41.8
2	1.87	45	8.87	330	24.03	1100	43.9
3	2.29	46	8.97	340	24.39	1200	45.8
4	2.65	47	9.07	350	24.75	1300	47.7
5	2.96	48	9.17	360	25.10	1400	49.5
6	3.24	49	9.26	370	25.45	1500	51.2
7	3.50	50	9.35	380	25.79	1600	52.9
8	3.74	55	9.81	390	26.13	1700	54.5
9	3.97	60	10.25	400	26.46	1800	56.1
10	4.18	65	10.67	410	26.79	1900	57.7
11	4.39	70	11.07	420	27.11	2000	59.2
12	4.58	75	11.46	430	27.43	2100	60.6
13	4.77	80	11.83	440	27.75	2200	62.1
14	4.95	85	12.20	450	28.06	2300	63.4
15	5.12	90	12.55	460	28.37	2400	64.8
16	5.29	95	12.89	470	28.68	2500	66.1
17	5.45	100	13.23	480	28.98	2600	67.5
18	5.61	105	13.56	490	29.29	2700	68.7
19	5.77	110	13.88	500	29.58	2800	70.0
20	5.92	115	14.19	520	30.17	2900	71.2
21	6.06	120	14.49	540	30.74	3000	72.5
22	6.21	125	14.79	560	31.31	3100	73.7
23	6.34	130	15.08	580	31.86	3200	74.8
24	6.48	135	15.37	600	32.41	3300	76.0
25	6.61	140	15.65	620	32.94	3400	77.1
26	6.75	145	15.93	640	33.47	3500	78.3
27	6.87	150	16.20	660	33.99	3600	79.4
28	7.00	160	16.73	680	34.50	3700	80.5
29	7.12	170	17.25	700	35.00	3800	81.6
30	7.25	180	17.75	720	35.50	3900	82.6
31	7.37	190	18.24	740	35.99	4000	83.7
32	7.48	200	18.71	760	36.47	4100	84.7
33	7.60	210	19.17	780	36.95	4200	85.7
34	7.71	220	19.62	800	37.42	4300	86.8
35	7.83	230	20.06	820	37.88	4400	87.8
36	7.94	240	20.50	840	38.34	4500	88.7
37	8.05	250	20.92	860	38.80	4600	89.7
38	8.16	260	21.33	880	39.25	4700	90.7
39	8.26	270	21.74	900	39.69	4800	91.7
40	8.37	280	22.14	920	40.13	4900	92.6
41	8.47	290	22.53	940	40.56	5000	93.5
42	8.57	300	22.91	960	40.99	1 mile	96.1
43	8.68	310	23.29	980	41.42		

Table XII.

Seek the neareſt hour of the reduced time in the top column, and the difference of parallax, proportional logarithm, or ſemidiameter for 12 hours in the ſide column, the correſponding number in the angle of meeting is the correction.

Variation in 12 hours.	Reduced Time in Hours. 1 / 13	2 / 14	3 / 15	4 / 16	5 / 17	6 / 18	7 / 19	8 / 20	9 / 21	10 / 22	11 / 23	12 / 24
1	0	0	0	0	0	0	1	1	1	1	1	1
2	0	0	0	1	1	1	1	1	1	2	2	2
3	0	0	1	1	1	1	2	2	2	2	3	3
4	0	1	1	1	2	2	2	3	3	3	4	4
5	0	1	1	2	2	2	3	3	4	4	5	5
6	0	1	1	2	2	3	3	4	4	5	5	6
7	1	1	2	2	3	3	4	5	5	6	6	7
8	1	1	2	3	3	4	5	5	6	7	7	8
9	1	1	2	3	4	4	5	6	7	7	8	9
10	1	2	2	3	4	5	6	7	7	8	9	10
11	1	2	3	4	5	5	6	7	8	9	10	11
12	1	2	3	4	5	6	7	8	9	10	11	12
13	1	2	3	4	5	6	8	9	10	11	12	13
14	1	2	3	5	6	7	8	9	10	12	13	14
15	1	2	4	5	6	7	9	10	11	12	14	15
16	1	3	4	5	7	8	9	11	12	13	15	16
17	1	3	4	6	7	8	10	11	13	14	16	17
18	1	3	4	6	7	9	10	12	13	15	16	18
19	2	3	5	6	8	9	11	13	14	16	17	19
20	2	3	5	7	8	10	12	13	15	17	18	20
21	2	3	5	7	9	10	12	14	16	17	19	21
22	2	4	5	7	9	11	13	15	16	18	20	22
23	2	4	6	8	10	11	13	15	17	19	21	23
24	2	4	6	8	10	12	14	16	18	20	22	24
25	2	4	6	8	10	12	15	17	19	21	23	25
26	2	4	6	9	11	13	15	17	19	22	24	26
27	2	4	7	9	11	13	16	18	20	22	25	27
28	2	5	7	9	12	14	16	19	21	23	26	28
29	2	5	7	10	12	14	17	19	22	24	27	29
30	2	5	7	10	12	15	17	20	22	25	27	30
31	3	5	8	10	13	15	18	21	23	26	28	31
32	3	5	8	11	13	16	19	21	24	27	29	32
33	3	5	8	11	14	16	19	22	25	27	30	33
34	3	6	8	11	14	17	20	23	25	28	31	34
35	3	6	9	12	15	17	20	23	26	29	32	35
36	3	6	9	12	15	18	21	24	27	30	33	36
37	3	6	9	12	15	18	22	25	28	31	34	37
38	3	6	9	13	16	19	22	25	28	32	35	38
39	3	6	10	13	16	19	23	26	29	32	36	39
40	3	7	10	13	17	20	23	27	30	33	37	40
41	3	7	10	14	17	20	24	27	31	34	38	41
42	3	7	10	14	17	21	24	28	31	35	38	42
43	4	7	11	14	18	21	25	29	32	36	39	43
44	4	7	11	15	18	22	26	29	33	37	40	44
45	4	7	11	15	19	22	26	30	34	37	41	45

Tables XIII. XIV. XV. XVI. XVII.

Tab. XIII. The Refraction of the Heavenly Bodies in Altitude.

App. Alt.	Ref.	App. Alt.	Ref.	App. Alt.	Ref.
D.M.	M.S.	D.M.	M.S.	D.	M.S.
0. 0	33. 0	6.30	7.52	30	1.38
0. 5	32.11	6.40	7.41	31	1.35
0.10	31.22	6.50	7.31	32	1.31
0.15	30.36	7. 0	7.21	33	1.28
0.20	29.50	7.10	7.12	34	1.24
0.25	29. 6	7.20	7. 3	35	1.21
0.30	28.23	7.30	6.54	36	1.18
0.35	27.41	7.40	6.46	37	1.16
0.40	27. 0	7.50	6.38	38	1.13
0.45	26.20	8. 0	6.30	39	1.10
0.50	25.42	8.10	6.22	40	1. 8
0.55	25. 5	8.20	6.15	41	1. 5
1. 0	24.29	8.30	6. 8	42	1. 3
1. 5	23.54	8.40	6. 1	43	1. 1
1.10	23.20	8.50	5.55	44	0.59
1.15	22.47	9. 0	5.49	45	0.57
1.20	22.15	9.10	5.43	46	0.55
1.25	21.44	9.20	5.37	47	0.53
1.30	21.15	9.30	5.31	48	0.51
1.35	20.46	9.40	5.26	49	0.50
1.40	20.18	9.50	5.20	50	0.48
1.45	19.51	10. 0	5.15	51	0.46
1.50	19.25	10.15	5. 8	52	0.45
1.55	18.59	10.30	5. 0	53	0.43
2. 0	18.35	10.45	4.54	54	0.41
2. 5	18.11	11. 0	4.47	55	0.40
2.10	17.48	11.15	4.41	56	0.38
2.15	17.26	11.30	4.35	57	0.37
2.20	17. 4	11.45	4.29	58	0.36
2.25	16.44	12. 0	4.23	59	0.34
2.30	16.23	12.20	4.16	60	0.33
2.35	16. 4	12.40	4. 9	61	0.32
2.40	15.45	13. 0	4. 3	62	0.30
2.45	15.27	13.20	3.57	63	0.29
2.50	15. 9	13.40	3.51	64	0.28
2.55	14.52	14. 0	3.46	65	0.27
3. 0	14.35	14.20	3.40	66	0.25
3. 5	14.19	14.40	3.35	67	0.24
3.10	14. 3	15. 0	3.30	68	0.23
3.15	13.48	15.30	3.23	69	0.22
3.20	13.33	16. 0	3.17	70	0.21
3.25	13.19	16.30	3.11	71	0.20
3.30	13. 5	17. 0	3. 5	72	0.19
3.40	12.39	17.30	2.59	73	0.17
3.50	12.14	18. 0	2.54	74	0.16
4. 0	11.50	18.30	2.49	75	0.15
4.10	11.28	19. 0	2.44	76	0.14
4.20	11. 7	19.30	2.40	77	0.13
4.30	10.47	20. 0	2.36	78	0.12
4.40	10.28	20.30	2.32	79	0.11
4.50	10.10	21. 0	2.28	80	0.10
5. 0	9.53	21.30	2.24	81	0. 9
5.10	9.37	22. 0	2.20	82	0. 8
5.20	9.21	23. 0	2.14	83	0. 7
5.30	9. 7	24. 0	2. 7	84	0. 6
5.40	8.53	25. 0	2. 2	85	0. 5
5.50	8.39	26. 0	1.56	86	0. 4
6. 0	8.27	27. 0	1.51	87	0. 3
6.10	8.15	28. 0	1.47	88	0. 2
6.20	8. 3	29. 0	1.43	89	0. 1

Table XIV. Depression or Dip of the Horizon of the Sea.

Height of the Eye.	Dip of the Horizon.
Feet.	M. S.
1	0.59
2	1.24
3	1.42
4	1.58
5	2.12
6	2.25
7	2.36
8	2.47
9	2.57
10	3. 7
11	3.16
12	3.25
13	3.33
14	3.41
15	3.49
16	3.56
17	4. 3
18	4.11
19	4.17
20	4.24
21	4.31
22	4.37
23	4.43
24	4.49
26	5. 1
28	5.13
30	5.23
35	5.49
40	6.14
45	6.36
50	6.58
60	7.37
70	8.14
80	8.48
90	9.20
100	9.51

Table XV. The Sun's Parallax in Altitude.

Sun's Alt.	Sun's Parallax.
D.	S.
0	9
10	9
20	8
30	8
40	7
50	6
55	5
60	4
65	4
70	3
75	2
80	2
85	1
90	0

Table XVI. Augmentation of the Moon's Semidiameter.

Moon's Alt.	Augmentation.
D.	S.
0	0
5	1
10	3
15	4
20	5
25	7
30	8
35	9
40	10
45	11
50	12
55	13
60	14
70	15
80	15
90	16

Table XVII. Dip of the Sea at different Distances from the Observer.

Dist. of the land in sea miles.	Height of the Eye above the Sea in Feet.							
	5	10	15	20	25	30	35	40
	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.
	M.	M.	M.	M.	M.	M.	M.	M.
¼	11	23	34	45	57	68	79	91
½	6	12	17	23	28	34	40	45
¾	4	8	12	15	19	23	27	30
1	3	6	9	12	15	17	20	23
1¼	3	5	7	10	12	14	16	19
1½	3	4	6	8	10	12	14	16
2	2	4	5	7	8	9	11	12
2½	2	3	4	6	7	8	9	10
3	2	3	4	5	6	7	8	9
3½	2	3	4	5	6	6	7	8
4	2	3	4	5	5	6	7	7
5	2	3	4	4	5	6	6	7
6	2	3	4	4	5	5	6	6

Note to Table XVII.—The numbers of this table below the black lines, are the same as are given in Table XIV. For the visible horizon corresponding to those heights is not so far distant as the land.

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax. M.	S.	1° Corr. M.S.	2° Corr. M.S.	3° Corr. M.S.	4° Corr. M.S.	5° Corr. M.S.	6° Corr. M.S.	7° Corr. M.S.	8° Corr. M.S.	9° Corr. M.S.
53	0	0.55	1.49	2.43	3.38	4.32	5.26	6.21	7.15	8. 9
	10	0.55	1.49	2.44	3.39	4.33	5.28	6.22	7.16	8.10
	20	0.55	1.50	2.45	3.39	4.34	5.29	6.23	7.17	8.12
	30	0.55	1.50	2.45	3.40	4.35	5.30	6.24	7.19	8.13
	40	0.55	1.50	2.46	3.41	4.36	5.31	6.26	7.20	8.15
	50	0.55	1.51	2.46	3.41	4.37	5.32	6.27	7.22	8.16
54	0	0.56	1.51	2.47	3.42	4.37	5.33	6.28	7.23	8.18
	10	0.56	1.51	2.47	3.43	4.38	5.34	6.29	7.24	8.20
	20	0.56	1.52	2.48	3.43	4.39	5.35	6.30	7.26	8.21
	30	0.56	1.52	2.48	3.44	4.40	5.36	6.32	7.27	8.23
	40	0.56	1.53	2.49	3.45	4.41	5.37	6.33	7.29	8.24
	50	0.56	1.53	2.49	3.46	4.42	5.38	6.34	7.30	8.26
55	0	0.57	1.53	2.50	3.46	4.43	5.39	6.35	7.31	8.27
	10	0.57	1.54	2.50	3.47	4.44	5.40	6.36	7.33	8.29
	20	0.57	1.54	2.51	3.48	4.44	5.41	6.38	7.34	8.30
	30	0.57	1.54	2.51	3.48	4.45	5.42	6.39	7.36	8.32
	40	0.57	1.55	2.52	3.49	4.46	5.43	6.40	7.37	8.34
	50	0.57	1.55	2.52	3.50	4.47	5.44	6.41	7.38	8.35
56	0	0.58	1.55	2.53	3.50	4.48	5.45	6.43	7.40	8.37
	10	0.58	1.56	2.53	3.51	4.49	5.46	6.44	7.41	8.38
	20	0.58	1.56	2.54	3.52	4.50	5.47	6.45	7.43	8.40
	30	0.58	1.56	2.54	3.53	4.51	5.48	6.46	7.44	8.41
	40	0.58	1.57	2.55	3.53	4.51	5.49	6.47	7.45	8.43
	50	0.59	1.57	2.56	3.54	4.52	5.51	6.49	7.47	8.45
57	0	0.59	1.57	2.56	3.55	4.53	5.52	6.50	7.48	8.46
	10	0.59	1.58	2.57	3.55	4.54	5.53	6.51	7.49	8.48
	20	0.59	1.58	2.57	3.56	4.55	5.54	6.52	7.51	8.49
	30	0.59	1.58	2.58	3.57	4.56	5.55	6.54	7.52	8.51
	40	0.59	1.59	2.58	3.57	4.57	5.56	6.55	7.54	8.52
	50	1. 0	1.59	2.59	3.58	4.58	5.57	6.56	7.55	8.54
58	0	1. 0	1.59	2.59	3.59	4.58	5.58	6.57	7.56	8.55
	10	1. 0	2. 0	3. 0	4. 0	4.59	5.59	6.58	7.58	8.57
	20	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	7.59	8.59
	30	1. 0	2. 1	3. 1	4. 1	5. 1	6. 1	7. 1	8. 1	9. 0
	40	1. 0	2. 1	3. 1	4. 2	5. 2	6. 2	7. 2	8. 2	9. 2
	50	1. 1	2. 1	3. 2	4. 2	5. 3	6. 3	7. 3	8. 3	9. 3
59	0	1. 1	2. 2	3. 2	4. 3	5. 4	6. 4	7. 5	8. 5	9. 5
	10	1. 1	2. 2	3. 3	4. 4	5. 4	6. 5	7. 6	8. 6	9. 6
	20	1. 1	2. 2	3. 3	4. 4	5. 5	6. 6	7. 7	8. 8	9. 8
	30	1. 1	2. 3	3. 4	4. 5	5. 6	6. 7	7. 8	8. 9	9.10
	40	1. 1	2. 3	3. 4	4. 6	5. 7	6. 8	7. 9	8.10	9.11
	50	1. 2	2. 3	3. 5	4. 6	5. 8	6. 9	7.11	8.12	9.13
60	0	1. 2	2. 4	3. 5	4. 7	5. 9	6.10	7.12	8.13	9.14
	10	1. 2	2. 4	3. 6	4. 8	5.10	6.11	7.13	8.15	9.16
	20	1. 2	2. 4	3. 7	4. 9	5.11	6.12	7.14	8.16	9.17
	30	1. 2	2. 5	3. 7	4. 9	5.11	6.14	7.15	8.17	9.19
	40	1. 3	2. 5	3. 8	4.10	5.12	6.15	7.17	8.19	9.21
	50	1. 3	2. 5	3. 8	4.11	5.13	6.16	7.18	8.20	9.22
61	0	1. 3	2. 6	3. 9	4.11	5.14	6.17	7.19	8.21	9.24
	10	1. 3	2. 6	3. 9	4.12	5.15	6.18	7.20	8.23	9.25
	20	1. 3	2. 6	3.10	4.13	5.16	6.19	7.22	8.24	9.27
	30	1. 3	2. 7	3.10	4.13	5.17	6.20	7.23	8.26	9.28
	40	1. 4	2. 7	3.11	4.14	5.18	6.21	7.24	8.27	9.30
	50	1. 4	2. 8	3.11	4.15	5.18	6.22	7.25	8.28	9.31
62	0	1. 4	2. 8	3.12	4.16	5.19	6.23	7.26	8.30	9.33
		1°	2°	3°	4°	5°	6°	7°	8°	9°

(Apparent Zenith Distance of the Moon's Centre.)

Par. Add.

S.	0	1	2
1	0	0	0
2	0	0	0
3	0	0	1
4	0	0	1
5	0	0	1
6	0	1	1
7	0	1	1
8	0	1	2
9	0	1	2

Zen. Dis. Add.

M	53	54	55
5	4	4	5
10	9	9	9
15	13	13	14
20	18	18	18
25	22	22	23
30	26	27	27
35	31	31	32
40	35	36	37
45	40	40	41
50	44	45	46
55	49	49	50

M	56	57	58
5	5	5	5
10	9	9	10
15	14	14	14
20	19	19	19
25	23	24	24
30	28	28	29
35	33	33	34
40	37	38	39
45	42	43	43
50	47	47	48
55	51	52	53

M	59	60	61
5	5	5	5
10	10	10	10
15	15	15	15
20	20	20	20
25	25	25	25
30	29	30	30
35	34	35	36
40	39	40	41
45	44	45	46
50	49	50	51
55	54	55	56

M	62	63	64
5	5	5	5
10	10	10	11
15	15	16	16
20	21	21	21
25	26	26	27
30	31	31	32
35	36	37	37
40	41	42	43
45	46	47	48
50	52	52	53
55	57	58	59

Table XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax. M	S	10° Corr. M S	11° Corr. M S	12° Corr. M S	13° Corr. M S	14° Corr. M S	15° Corr. M S	16° Corr. M S	17° Corr. M S	18° Corr. M S
		Apparent Zenith Distance of the Moon's Centre.								
53	0	9. 2	9.56	10.49	11.42	12.35	13.28	14.20	15.13	16. 4
	10	9. 4	9.58	10.51	11.45	12.38	13.31	14.23	15.15	16. 7
	20	9. 6	10. 0	10.53	11.47	12.40	13.33	14.26	15.18	16.11
	30	9. 7	10. 2	10.55	11.49	12.43	13.36	14.29	15.21	16.14
	40	9. 9	10. 3	10.58	11.51	12.45	13.38	14.31	15.24	16.17
	50	9.11	10. 5	11. 0	11.54	12.47	13.41	14.34	15.27	16.20
54	0	9.13	10. 7	11. 2	11.56	12.50	13.44	14.37	15.30	16.23
	10	9.14	10. 9	11. 4	11.58	12.52	13.46	14.40	15.33	16.26
	20	9.16	10.11	11. 6	12. 0	12.55	13.49	14.42	15.36	16.29
	30	9.18	10.13	11. 8	12. 3	12.57	13.51	14.45	15.39	16.32
	40	9.20	10.15	11.10	12. 5	12.59	13.54	14.48	15.42	16.35
	50	9.21	10.17	11.12	12. 7	13. 2	13.56	14.51	15.45	16.38
55	0	9.23	10.19	11.14	12. 9	13. 4	13.59	14.53	15.48	16.41
	10	9.25	10.21	11.16	12.12	13. 7	14. 2	14.56	15.51	16.45
	20	9.27	10.23	11.18	12.14	13. 9	14. 4	14.59	15.53	16.48
	30	9.28	10.24	11.20	12.16	13.12	14. 7	15. 2	15.56	16.51
	40	9.30	10.26	11.22	12.18	13.14	14. 9	15. 5	15.59	16.54
	50	9.32	10.28	11.25	12.21	13.16	14.12	15. 7	16. 2	16.57
56	0	9.34	10.30	11.27	12.23	13.19	14.15	15.10	16. 5	17. 0
	10	9.35	10.32	11.29	12.25	13.21	14.17	15.13	16. 8	17. 3
	20	9.37	10.34	11.31	12.27	13.24	14.20	15.16	16.11	17. 6
	30	9.39	10.36	11.33	12.30	13.26	14.22	15.18	16.14	17. 9
	40	9.40	10.38	11.35	12.32	13.29	14.25	15.21	16.17	17.12
	50	9.42	10.40	11.37	12.34	13.31	14.28	15.24	16.20	17.15
57	0	9.44	10.42	11.39	12.36	13.33	14.30	15.27	16.23	17.19
	10	9.46	10.44	11.41	12.39	13.36	14.33	15.29	16.26	17.22
	20	9.47	10.45	11.43	12.41	13.38	14.35	15.32	16.29	17.25
	30	9.49	10.47	11.45	12.43	13.41	14.38	15.35	16.31	17.28
	40	9.51	10.49	11.47	12.45	13.43	14.40	15.38	16.34	17.31
	50	9.53	10.51	11.50	12.48	13.45	14.43	15.40	16.37	17.34
58	0	9.54	10.53	11.52	12.50	13.48	14.46	15.43	16.40	17.37
	10	9.56	10.55	11.54	12.52	13.50	14.48	15.46	16.43	17.40
	20	9.58	10.57	11.56	12.54	13.53	14.51	15.49	16.46	17.43
	30	10. 0	10.59	11.58	12.57	13.55	14.53	15.51	16.49	17.46
	40	10. 1	11. 1	12. 0	12.59	13.58	14.56	15.54	16.52	17.49
	50	10. 3	11. 3	12. 2	13. 1	14. 0	14.59	15.57	16.55	17.53
59	0	10. 5	11. 5	12. 4	13. 3	14. 2	15. 1	16. 0	16.58	17.56
	10	10. 7	11. 6	12. 6	13. 6	14. 5	15. 4	16. 2	17. 1	17.59
	20	10. 8	11. 8	12. 8	13. 8	14. 7	15. 6	16. 5	17. 4	18. 2
	30	10.10	11.10	12.10	13.10	14.10	15. 9	16. 8	17. 7	18. 5
	40	10.12	11.12	12.12	13.12	14.12	15.12	16.11	17.10	18. 8
	50	10.13	11.14	12.14	13.15	14.14	15.14	16.13	17.12	18.11
60	0	10.15	11.16	12.17	13.17	14.17	15.17	16.16	17.15	18.14
	10	10.17	11.18	12.19	13.19	14.19	15.19	16.19	17.18	18.17
	20	10.19	11.20	12.21	13.21	14.22	15.22	16.22	17.21	18.20
	30	10.20	11.22	12.23	13.24	14.24	15.24	16.24	17.24	18.23
	40	10.22	11.24	12.25	13.26	14.27	15.27	16.27	17.27	18.27
	50	10.24	11.26	12.27	13.28	14.29	15.30	16.30	17.30	18.30
61	0	10.26	11.27	12.29	13.30	14.31	15.32	16.33	17.33	18.33
	10	10.27	11.29	12.31	13.33	14.34	15.35	16.35	17.36	18.36
	20	10.29	11.31	12.33	13.35	14.36	15.37	16.38	17.39	18.39
	30	10.31	11.33	12.35	13.37	14.39	15.40	16.41	17.42	18.42
	40	10.33	11.35	12.37	13.39	14.41	15.43	16.44	17.45	18.45
	50	10.34	11.37	12.39	13.42	14.44	15.45	16.47	17.48	18.48
62	0	10.36	11.39	12.41	13.44	14.46	15.48	16.49	17.50	18.51
		10°	11°	12°	13°	14°	15°	16°	17°	18°

Par. Add.

S	1	2	3	4
1	0	0	0	0
2	0	0	1	1
3	0	1	1	1
4	0	1	1	2
5	0	1	1	2
6	1	1	2	2
7	1	1	2	3
8	1	2	2	3
9	1	2	3	4

Zen. Dist. Add.

M	51	52	53	54
5	4	4	4	4
10	8	9	9	9
15	13	13	13	13
20	17	17	18	18
25	21	22	22	22
30	25	26	26	27
35	30	30	31	31
40	34	35	35	36
45	38	39	40	40
50	42	43	44	45
55	47	48	49	49

M	55	56	57
5	5	5	5
10	9	9	9
15	14	14	14
20	18	19	19
25	23	23	24
30	27	28	28
35	32	33	33
40	37	37	38
45	41	42	43
50	46	47	47
55	50	51	52

M	58	59	60
5	5	5	5
10	10	10	10
15	14	15	15
20	19	20	20
25	24	25	25
30	29	29	30
35	34	34	35
40	39	39	40
45	43	44	45
50	48	49	50
55	53	54	55

M	61	62	63
5	5	5	5
10	10	10	10
15	15	15	16
20	20	21	21
25	25	26	26
30	30	31	31
35	36	36	37
40	41	41	42
45	46	46	47
50	51	52	52
55	56	57	58

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax.		Apparent Zenith Distance of the Moon's Centre.								
		19°	20°	21°	22°	23°	24°	25°	26°	27°
		Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.
M	S	M S	M S	M S	M S	M S	M S	M S	M S	M S
53	0	16.56	17.47	18.38	19.29	20.19	21. 8	21.58	22.47	23.35
	10	16.59	17.51	18.42	19.32	20.23	21.12	22. 2	22.51	23.40
	20	17. 2	17.54	18.45	19.36	20.26	21.17	22. 6	22.55	23.44
	30	17. 6	17.57	18.49	19.40	20.30	21.21	22.10	23. 0	23.49
	40	17. 9	18. 1	18.52	19.44	20.34	21.25	22.15	23. 4	23.53
	50	17.12	18. 4	18.56	19.47	20.38	21.29	22.19	23. 8	23.58
54	0	17.15	18. 8	19. 0	19.51	20.42	21.33	22.23	23.13	24. 2
	10	17.19	18.11	19. 3	19.55	20.46	21.37	22.27	23.17	24. 7
	20	17.22	18.15	19. 7	19.58	20.50	21.41	22.31	23.22	24.11
	30	17.25	18.18	19.10	20. 2	20.54	21.45	22.36	23.26	24.16
	40	17.28	18.21	19.14	20. 6	20.58	21.49	22.40	23.30	24.20
	50	17.32	18.25	19.17	20.10	21. 2	21.53	22.44	23.35	24.25
55	0	17.35	18.28	19.21	20.13	21. 6	21.57	22.48	23.39	24.30
	10	17.38	18.32	19.25	20.17	21. 9	22. 1	22.53	23.44	24.34
	20	17.42	18.35	19.28	20.21	21.13	22. 5	22.57	23.48	24.39
	30	17.45	18.38	19.32	20.25	21.17	22. 9	23. 1	23.52	24.43
	40	17.48	18.42	19.35	20.28	21.21	22.13	23. 5	23.57	24.48
	50	17.51	18.45	19.39	20.32	21.25	22.18	23.10	24. 1	24.52
56	0	17.55	18.49	19.43	20.36	21.29	22.22	23.14	24. 5	24.57
	10	17.58	18.52	19.46	20.40	21.33	22.26	23.18	24.10	25. 1
	20	18. 1	18.56	19.50	20.43	21.37	22.30	23.22	24.14	25. 6
	30	18. 4	18.59	19.53	20.47	21.41	22.34	23.26	24.19	25.10
	40	18. 8	19. 2	19.57	20.51	21.45	22.38	23.31	24.23	25.15
	50	18.11	19. 6	20. 0	20.55	21.49	22.42	23.35	24.27	25.19
57	0	18.14	19. 9	20. 4	20.58	21.52	22.46	23.39	24.32	25.24
	10	18.17	19.13	20. 8	21. 2	21.56	22.50	23.43	24.36	25.29
	20	18.21	19.16	20.11	21. 6	22. 0	22.54	23.48	24.41	25.33
	30	18.24	19.20	20.15	21.10	22. 4	22.58	23.52	24.45	25.38
	40	18.27	19.23	20.18	21.13	22. 8	23. 2	23.56	24.49	25.42
	50	18.30	19.26	20.22	21.17	22.12	23. 6	24. 0	24.54	25.47
58	0	18.34	19.30	20.26	21.21	22.16	23.10	24. 4	24.58	25.51
	10	18.37	19.33	20.29	21.25	22.20	23.14	24. 9	25. 2	25.56
	20	18.40	19.37	20.33	21.28	22.24	23.19	24.13	25. 7	26. 0
	30	18.43	19.40	20.36	21.32	22.28	23.23	24.17	25.11	26. 5
	40	18.47	19.43	20.40	21.36	22.32	23.27	24.21	25.16	26. 9
	50	18.50	19.47	20.43	21.40	22.35	23.31	24.26	25.20	26.14
59	0	18.53	19.50	20.47	21.43	22.39	23.35	24.30	25.24	26.18
	10	18.56	19.54	20.51	21.47	22.43	23.39	24.34	25.29	26.23
	20	19. 0	19.57	20.54	21.51	22.47	23.43	24.38	25.33	26.28
	30	19. 3	20. 1	20.58	21.55	22.51	23.47	24.43	25.38	26.32
	40	19. 6	20. 4	21. 1	21.58	22.55	23.51	24.47	25.42	26.37
	50	19. 9	20. 7	21. 5	22. 2	22.59	23.55	24.51	25.46	26.41
60	0	19.13	20.11	21. 9	22. 6	23. 3	23.59	24.55	25.51	26.46
	10	19.16	20.14	21.12	22.10	23. 7	24. 3	24.59	25.55	26.50
	20	19.19	20.18	21.16	22.13	23.11	24. 7	25. 4	25.59	26.55
	30	19.22	20.21	21.19	22.17	23.14	24.11	25. 8	26. 4	26.59
	40	19.26	20.25	21.23	22.21	23.18	24.15	25.12	26. 8	27. 4
	50	19.29	20.28	21.26	22.25	23.22	24.20	25.16	26.13	27. 8
61	0	19.32	20.31	21.30	22.28	23.26	24.24	25.21	26.17	27.13
	10	19.35	20.35	21.34	22.32	23.30	24.28	25.25	26.21	27.18
	20	19.39	20.38	21.37	22.36	23.34	24.32	25.29	26.26	27.22
	30	19.42	20.42	21.41	22.40	23.38	24.36	25.33	26.30	27.27
	40	19.45	20.45	21.44	22.43	23.42	24.40	25.37	26.35	27.31
	50	19.49	20.48	21.48	22.47	23.46	24.44	25.42	26.39	27.36
62	0	19.52	20.52	21.52	22.51	23.50	24.48	25.46	26.43	27.40
		19°	20°	21°	22°	23°	24°	25°	26°	27°

Par. Add.

S.	3	4	5
1	0	0	0
2	1	1	1
3	1	1	1
4	1	2	2
5	1	2	2
6	2	2	3
7	2	3	3
8	2	3	4
9	3	4	4

Zen. Dist. Add.

M	48	49	50	51
5	4	4	4	4
10	8	8	8	8
15	12	12	12	13
20	16	16	17	17
25	20	20	21	21
30	24	24	25	25
35	28	29	29	30
40	32	33	33	34
45	36	37	37	38
50	40	41	42	42
55	44	45	46	47

M	52	53	54
5	4	4	4
10	9	9	9
15	13	13	13
20	17	18	18
25	22	22	22
30	26	26	27
35	30	31	31
40	35	35	36
45	39	40	40
50	43	44	45
55	48	49	49

M	55	56	57
5	5	5	5
10	9	9	9
15	14	14	14
20	18	19	19
25	23	23	24
30	27	28	28
35	32	33	33
40	37	37	38
45	41	42	43
50	46	47	47
55	50	51	52

M	58	59	60
5	5	5	5
10	10	10	10
15	14	15	15
20	19	20	20
25	24	25	25
30	29	29	30
35	34	34	35
40	39	39	40
45	43	44	45
50	48	49	50
55	53	54	55

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax.		Apparent Zenith Distance of the Moon's Centre.								
		28°	29°	30°	31°	32°	33°	34°	35°	36°
		Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.
M	S	M S	M S	M S	M S	M S	M S	M S	M S	M S
53	0	24.23	25.10	25.57	26.44	27.30	28.15	29. 0	29.45	30.28
	10	24.28	25.15	26. 2	26.49	27.35	28.21	29. 6	29.50	30.34
	20	24.32	25.20	26. 8	26.54	27.41	28.26	29.11	29.56	30.40
	30	24.37	25.25	26.13	26.59	27.46	28.32	29.17	30. 2	30.46
	40	24.42	25.30	26.18	27. 5	27.51	28.37	29.23	30. 7	30.52
	50	24.46	25.35	26.23	27.10	27.56	28.43	29.28	30.13	30.58
54	0	24.51	25.40	26.28	27.15	28. 2	28.48	29.34	30.19	31. 4
	10	24.56	25.44	26.33	27.20	28. 7	28.54	29.39	30.25	31. 9
	20	25. 1	25.49	26.38	27.25	28.12	28.59	29.45	30.30	31.15
	30	25. 5	25.54	26.43	27.30	28.18	29. 4	29.51	30.36	31.21
	40	25.10	25.59	26.48	37.36	28.23	29.10	29.56	30.42	31.27
	50	25.15	26. 4	26.53	27.41	28.28	29.15	30. 2	30.48	31.33
55	0	25.19	26. 9	26.58	27.46	28.34	29.21	30. 7	30.53	31.39
	10	25.24	26.14	27. 3	27.51	28.39	29.26	30.13	30.59	31.45
	20	25.29	26.18	27. 8	27.56	28.44	29.32	30.19	31. 5	31.51
	30	25.33	26.23	27.13	28. 1	28.49	29.37	30.24	31.11	31.56
	40	25.38	26.28	27.18	28. 6	28.55	29.43	30.30	31.16	32. 2
	50	25.43	26.33	27.23	28.12	29. 0	29.48	30.35	31.22	32. 8
56	0	25.48	26.38	27.28	28.17	29. 5	29.53	30.41	31.28	32.14
	10	25.52	26.43	27.33	28.22	29.11	29.59	30.47	31.34	32.20
	20	25.57	26.47	27.38	28.27	49.16	30. 4	30.52	31.39	32.26
	30	26. 2	26.52	27.43	28.32	29.21	30.10	30.58	31.45	32.32
	40	26. 6	26.57	27.48	28.37	29.27	30.15	31. 3	31.51	32.38
	50	26.11	27. 2	27.53	28.42	29.32	30.21	31. 9	31.56	32.43
57	0	26.16	27. 7	27.58	28.48	29.37	30.26	31.14	32. 2	32.49
	10	26.20	27.12	28. 3	28.53	29.42	30.32	31.20	32. 8	32.55
	20	26.25	27.17	28. 8	28.58	29.48	30.37	31.26	32.14	33. 1
	30	26.30	27.21	28.13	29. 3	29.53	30.42	31.31	32.19	33. 7
	40	26.34	27.26	28.18	29. 8	29.58	30.48	31.37	32.25	33.13
	50	26.39	27.31	28.23	29.13	30. 4	30.53	31.42	32.31	33.19
58	0	26.44	27.36	28.28	29.19	30. 9	30.59	31.48	32.37	33.25
	10	26.49	27.41	28.33	29.24	30.14	31. 4	31.54	32.42	33.30
	20	26.53	27.46	28.38	29.29	30.20	31.10	31.59	32.48	33.36
	30	26.58	27.51	28.43	29.34	30.25	31.15	32. 5	32.54	33.42
	40	27. 3	27.55	28.48	29.39	30.30	31.21	32.10	33. 0	33.48
	50	27. 7	28. 0	28.53	29.44	30.35	31.26	32.16	33. 5	33.54
59	0	27.12	28. 5	28.58	29.49	30.41	31.31	32.22	33.11	34. 0
	10	27.17	28.10	29. 3	29.55	30.46	31.37	32.27	33.17	34. 6
	20	27.21	28.15	29. 8	30. 0	30.51	31.42	32.33	33.23	34.12
	30	27.26	28.20	29.13	30. 5	30.57	31.48	32.38	33.28	34.18
	40	27.31	28.24	29.18	30.10	31. 2	31.53	32.44	33.34	34.23
	50	27.36	28.29	29.23	30.15	31. 7	31.59	32.50	33.40	34.29
60	0	27.40	28.34	29.28	30.20	31.13	32. 4	32.55	33.45	34.35
	10	27.45	28.39	29.33	30.25	31.18	32.10	33. 1	33.51	34.41
	20	27.50	28.44	29.38	30.31	31.23	32.15	33. 6	33.57	34.47
	30	27.54	28.49	29.43	30.36	31.28	32.21	33.12	34. 3	34 53
	40	27.59	28.54	29.48	30.41	31.34	32.26	33.18	34. 8	34.59
	50	28. 4	28.58	29.53	30.46	31.39	32.31	33.23	34.14	35. 5
61	0	28. 8	29. 3	29.58	30.51	31.44	32.37	33.29	34.20	35.10
	10	28.13	29. 8	30. 3	30.56	31.50	32.42	33.34	34.26	35.16
	20	28.18	29.13	30. 8	31. 2	31.55	32.48	33.40	34.31	35.22
	30	28.22	29.18	30.13	31. 7	32. 0	32.53	33.45	34.37	35.28
	40	28.27	29.23	30.18	31.12	32. 6	32.59	33.51	34.43	35.34
	50	28.32	29.27	30.23	31.17	32.11	33. 4	33.57	34.49	35.40
62	0	28.37	29.32	30.28	31.22	32.16	33.10	34. 2	34.54	35.46
		28°	29°	30°	31°	32°	33°	34°	35°	36°

Par. Add.

S.	4	5	6
1	0	0	1
2	1	1	1
3	1	1	2
4	2	2	2
5	2	2	3
6	2	3	4
7	3	3	4
8	3	4	5
9	4	4	5

Zen. Dist. Add.

M	43	44	45	46
5	4	4	4	4
10	7	7	7	8
15	11	11	11	11
20	14	15	15	15
25	18	18	19	19
30	21	22	22	23
35	25	26	26	27
40	29	29	30	31
45	32	33	34	34
50	36	37	37	38
55	39	40	41	42

M	47	48	49	50
5	4	4	4	4
10	8	8	8	8
15	12	12	12	12
20	16	16	16	17
25	20	20	20	21
30	23	24	24	25
35	27	28	29	29
40	31	32	33	33
45	35	36	37	37
50	39	40	41	42
55	43	44	45	46

M	51	52	53
5	4	4	4
10	8	9	9
15	13	13	13
20	17	17	18
25	21	22	22
30	25	26	26
35	30	30	31
40	34	35	35
45	38	39	40
50	42	43	44
55	47	48	49

M	54	55	56
5	4	5	5
10	9	9	9
15	13	14	14
20	18	18	19
25	22	23	23
30	27	27	28
35	31	32	33
40	36	37	37
45	40	41	42
50	45	46	47
55	49	50	51

Table XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax.		Apparent Zenith Distance of the Moon's Centre.								
		37°	38°	39°	40°	41°	42°	43°	44°	45°
		Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.
M.	S.	M S	M S	M S	M S	M S	M S	M S	M S	M S
53	0	31.11	31.54	32.36	33.17	33.57	34.37	35.16	35.55	36.32
	10	31.17	32. 0	32.42	33.23	34. 4	34.44	35.23	36. 2	36.39
	20	31.23	32. 6	32.48	33.30	34.10	34.50	35.30	36. 8	36.46
	30	31.29	32.12	32.55	33.36	34.17	34.57	35.37	36.15	36.53
	40	31.35	32.18	33. 1	33.43	34.24	35. 4	35.43	36.22	37. 1
	50	31.41	32.25	33. 7	33.49	34.30	35.11	35.50	36.29	37. 8
54	0	31.47	32.31	33.13	33.55	34.37	35.17	35.57	36.36	37.15
	10	31.53	32.37	33.20	34. 2	34.43	35.24	36. 4	36.43	37.22
	20	31.59	32.43	33.26	34. 8	34.50	35.31	36.11	36.50	37.29
	30	32. 6	32.49	33.32	34.15	34.56	35.37	36.18	36.57	37.36
	40	32 12	32.55	33.39	34.21	35. 3	35.44	36.24	37. 4	37.43
	50	32.18	33. 2	33.45	34.28	35. 9	35.51	36.31	37.11	37.50
55	0	32.24	33. 8	33.51	34.34	35.16	35.57	36.38	37.18	37.57
	10	32.30	33.14	33.57	34.40	35.23	36. 4	36.45	37.25	38. 4
	20	32.36	33.20	34. 4	34.47	35.29	36.11	36.52	37.32	38.11
	30	32.42	33.26	34.10	34.53	35.36	36.17	36.59	37.39	38.18
	40	32.48	33.32	34.16	35. 0	35.42	36.24	37. 5	37.46	38.25
	50	32.54	33.38	34.23	35. 6	35.49	36.31	37.12	37.53	38.32
56	0	33. 0	33.45	34.29	35.13	35.55	36.38	37.19	38. 0	38.40
	10	33. 6	33.51	34.35	35.19	36. 2	36.44	37.26	38. 7	38.47
	20	33.12	33.57	34.42	35.25	36. 9	36.51	37.33	38.14	38.54
	30	33.18	34. 3	34.48	35.32	36.15	36.58	37.39	38.20	39. 1
	40	33.24	34. 9	34.54	35.38	36.22	37. 4	37.46	38.27	39. 8
	50	33.30	34.15	35. 0	35.45	36.28	37.11	37.53	38.34	39.15
57	0	33.36	34.22	35. 7	35.51	36.35	37.18	38. 0	38.41	39.22
	10	33.42	34.28	35.13	35.58	36.41	37.24	38. 7	38.48	39.29
	20	33.48	34.34	35.19	36. 4	36.48	37.31	38.14	38.55	39.36
	30	33.54	34.40	35.26	36.10	36.54	37.38	38.20	39. 2	39.43
	40	34. 0	34.46	35.32	36.17	37. 1	37.44	38.27	39. 9	39.50
	50	34. 6	34.52	35.38	36.23	37. 8	37.51	38.34	39.16	39.57
58	0	34.12	34.59	35.44	36.30	37.14	37.58	38.41	39.23	40. 4
	10	34.18	35. 5	35.51	36.36	37.21	38. 5	38.48	39.30	40.11
	20	34.24	35.11	35.57	36.43	37.27	38.11	38.54	39.37	40.19
	30	34.30	35.17	36. 3	36.49	37.34	38.18	39. 1	39.44	40.26
	40	34.36	35.23	36.10	36.55	37.40	38.25	39. 8	39.51	40.33
	50	34.42	35.29	36.16	37. 2	37.47	38.31	39.15	39.58	40.40
59	0	34.48	35.35	36.22	37. 8	37.54	38.38	39.22	40. 5	40.47
	10	34.54	35.42	36.29	37.15	38. 0	38.45	39.29	40.12	40.54
	20	35. 0	35.48	36.35	37.21	38. 7	38.51	39.35	40.19	41. 1
	30	35. 6	35.54	36.41	37.28	38.13	38.58	39.42	40.26	41. 8
	40	35.12	36. 0	36.47	37.34	38.20	39. 5	39.49	40.33	41.15
	50	35.18	36. 6	36.54	37.40	38.26	39.11	39.56	40.39	41.22
60	0	35.24	36.12	37. 0	37.47	38.33	39.18	40. 3	40.46	41.29
	10	35.30	36.19	37. 6	37.53	38.39	39.25	40.10	40.53	41.36
	20	35.36	36.25	37.13	38. 0	38.46	39.32	40.16	41. 0	41.43
	30	35.42	36.31	37.19	38. 6	38.53	39.38	40.23	41. 7	41.50
	40	35.48	36.37	37.25	38.13	38.59	39.45	40.30	41.14	41.58
	50	35.54	36.43	37.31	38.19	39. 6	39.52	40.37	41.21	42. 5
61	0	36. 0	36.49	37.38	38.25	39.12	39.58	40.44	41.28	42.12
	10	36. 6	36.56	37.44	38.32	39.19	40. 5	40.50	41.35	42.19
	20	36.12	37. 2	37.50	38.38	39.25	40.12	40.57	41.42	42.26
	30	36.18	37. 8	37.57	38.45	39.32	40.18	41. 4	41.49	42.33
	40	36.24	37.14	38. 3	38.51	39.39	40.25	41.11	41.56	42.40
	50	36.30	37.20	38. 9	38.58	39.45	40.32	41.18	42. 3	42.47
62	0	36.36	37.26	38.16	39. 4	39.52	40.39	41.25	42.10	42.54
		37°	38°	39°	40°	41°	42°	43°	44°	45°

Par. Add.

S.	6	7	8
1	1	1	1
2	1	1	2
3	2	2	2
4	2	3	3
5	3	3	4
6	4	4	5
7	4	5	6
8	5	6	6
9	5	6	7

Zen. Dis. Add.

″	37	38	39
5	3	3	3
10	6	6	6
15	9	9	10
20	12	13	13
25	15	16	16
30	18	19	19
35	22	22	23
40	25	25	26
45	28	28	29
50	31	32	32
55	34	35	36

M	40	41	42	43
5	3	3	3	4
10	7	7	7	7
15	10	10	10	11
20	13	14	14	14
25	17	17	17	18
30	20	20	21	21
35	23	24	24	25
40	27	27	28	29
45	30	31	31	32
50	33	34	35	36
55	37	38	38	39

M	44	45	46	47
5	4	4	4	4
10	7	7	8	8
15	11	11	11	12
20	15	15	15	16
25	18	19	19	20
30	22	22	23	23
35	26	26	27	27
40	29	30	31	31
45	33	34	34	35
50	37	37	38	39
55	40	41	42	43

M	48	49	50
5	4	4	4
10	8	8	8
15	12	12	12
20	16	16	17
25	20	20	21
30	24	24	25
35	28	29	29
40	32	33	33
45	36	37	37
50	40	41	42
55	44	45	46

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax.		Apparent Zenith Distance of the Moon's Centre.								
		46°	47°	48°	49°	50°	51°	52°	53°	54°
		Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.
M	S	M S	M S	M S	M S	M S	M S	M S	M S	M S
53	0	37. 9	37.45	38.21	38.55	39.29	40. 2	40.34	41. 5	41.35
	10	37.16	37.53	38.28	39. 3	39.36	40. 9	40.42	41.13	41.43
	20	37.24	38. 0	38.35	39.10	39.44	40.17	40.49	41.21	41.51
	30	37.31	38. 7	38.43	39.18	39.52	40.25	40.57	41.29	41.59
	40	37.38	38.15	38.50	39.25	39.59	40.33	41. 5	41.37	42. 7
	50	37.45	38.22	38.58	39.33	40. 7	40.41	41.13	41.45	42.15
54	0	37.52	38.29	39. 5	39.40	40.15	40.48	41.21	41.53	42.24
	10	37.59	38.36	39.13	39.48	40.22	40.56	41.29	42. 1	42.32
	20	38. 7	38.44	39.20	39.56	40.30	41. 4	41.37	42. 9	42.40
	30	38.14	38.51	39.27	40. 3	40.38	41.12	41.45	42.17	42.48
	40	38.21	38.58	39.35	40.11	40.45	41.19	41.53	42.25	42.56
	50	38.28	39. 6	39.42	40.18	40.53	41.27	42. 0	42.33	43. 4
55	0	38.35	39.13	39.50	40.26	41. 1	41.35	42. 8	42.41	43.12
	10	38.43	39.20	39.57	40.33	41. 8	41.43	42.16	42.49	43.20
	20	38.50	39.28	40. 5	40.41	41.16	41.51	42.24	42.57	43.28
	30	38.57	39.35	40.12	40.48	41.24	41.58	42.32	43. 5	43.36
	40	39. 4	39.42	40.20	40.56	41.31	42. 6	42.40	43.13	43.45
	50	39.11	39.50	40.27	41. 3	41.39	42.14	42.48	43.21	43.53
56	0	39.19	39.57	40.34	41.11	41.47	42.22	42.56	43.29	44. 1
	10	39.26	40. 4	40.42	41.19	41.54	42.29	43. 3	43.37	44. 9
	20	39.33	40.12	40.49	41.26	42. 2	42.37	43.11	43.45	44.17
	30	39.40	40.19	40.57	41.34	42.10	42.45	43.19	43.53	44.25
	40	39.47	40.26	41. 4	41.41	42.17	42.53	43.27	44. 1	44.33
	50	39.55	40.33	41.12	41.49	42.25	43. 0	43.35	44. 9	44.41
57	0	40. 2	40.41	41.19	41.56	42.33	43. 8	43.43	44.17	44.49
	10	40. 9	40.48	41.26	42. 4	42.41	43.16	43.51	44.25	44.57
	20	40.16	40.55	41.34	42.11	42.48	43.24	43.59	44.33	45. 5
	30	40.23	41. 3	41.41	42.19	42.56	43.32	44. 6	44.40	45.14
	40	40.31	41.10	41.49	42.26	43. 3	43.39	44.14	44.48	45.22
	50	40.38	41.17	41.56	42.34	43.11	43.47	44.22	44.56	45.30
58	0	40.45	41.25	42. 4	42.42	43.19	43.55	44.30	45. 4	45.38
	10	40.52	41.32	42.11	42.49	43.26	44. 3	44.38	45.12	45.46
	20	40.59	41.39	42.18	42.57	43.34	44.10	44.46	45.20	45.54
	30	41. 7	41.47	42.26	43. 4	43.42	44.18	44.54	45.28	46. 2
	40	41.14	41.54	42.33	43.12	43.49	44.26	45. 2	45.36	46.10
	50	41.21	42. 1	42.41	43.19	43.57	44.34	45.10	45.44	46.18
59	0	41.28	42. 9	42.48	43.27	44. 5	44.42	45.17	45.52	46.26
	10	41.35	42.16	42.56	43.34	44.12	44.49	45.25	46. 0	46.34
	20	41.43	42.23	43. 3	43.42	44.20	44.57	45.33	46. 8	46.43
	30	41.50	42.31	43.10	43.50	44.28	45. 5	45.41	46.16	46.51
	40	41.57	42.38	43.18	43.57	44.35	45.13	45.49	46.24	46.59
	50	42. 4	42.45	43.25	44. 5	44.43	45.20	45.57	46.32	47. 7
60	0	42.11	42.52	43.33	44.12	44.51	45.28	46. 5	46.40	47.15
	10	42.19	43. 0	43.40	44.20	44.58	45.36	46.13	46.48	47.23
	20	42.26	43. 7	43.48	44.27	45. 6	45.44	46.20	46.56	47.31
	30	42.33	43.14	43.55	44.35	45.14	45.51	46.28	47. 4	47.39
	40	42.40	43.22	44. 2	44.42	45.21	45.59	46.36	47.12	47.47
	50	42.47	43.29	44.10	44.50	45.29	46. 7	46.44	47.20	47.55
61	0	42.54	43.36	44.17	44.57	45.37	46.15	46.52	47.28	48. 3
	10	43. 2	43.44	44.25	45. 5	45.44	46.23	47. 0	47.36	48.12
	20	43. 9	43.51	44.32	45.13	45.52	46.30	47. 8	47.44	48.20
	30	43.16	43.58	44.40	45.20	46. 0	46.38	47.16	47.52	48.28
	40	43.23	44. 6	44.47	45.28	46. 7	46.46	47.24	48. 0	48.36
	50	43.30	44.13	44.55	45.35	46.15	46.54	47.31	48. 8	48.44
62	0	43.38	44.20	45. 2	45.43	46.23	47. 1	47.39	48.16	48.52
		46°	47°	48°	49°	50°	51°	52°	53°	54°

Par. Add.

S.	7	8	9
1	1	1	1
2	1	2	2
3	2	2	3
4	3	3	4
5	3	4	4
6	4	5	5
7	5	6	6
8	6	6	7
9	6	7	8

Zen. Dist. Add.

M	29	30	31	32
5	2	2	3	3
10	5	5	5	5
15	7	7	8	8
20	10	10	10	11
25	12	12	13	13
30	14	15	15	16
35	17	17	18	19
40	19	20	21	21
45	22	22	23	24
50	24	25	26	27
55	27	27	28	29

M	33	34	35	36
5	3	3	3	3
10	5	6	6	6
15	8	8	9	9
20	11	11	12	12
25	14	14	15	15
30	16	17	17	18
35	19	20	20	21
40	22	23	23	24
45	25	25	26	27
50	27	28	29	30
55	30	31	32	33

M	37	38	39	40
5	3	3	3	3
10	6	6	6	7
15	9	9	10	10
20	12	13	13	13
25	15	16	16	17
30	18	19	19	20
35	22	22	23	23
40	25	25	26	27
45	28	28	29	30
50	31	32	32	33
55	34	35	36	37

M	41	42	43
5	3	3	4
10	7	7	7
15	10	10	11
20	14	14	14
25	17	17	18
30	20	21	21
35	24	24	25
40	27	28	29
45	31	31	32
50	34	35	36
55	38	38	39

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's Horizontal Parallax. M	S.	55° Corr. M S	56° Corr. M S	57° Corr. M S	58° Corr. M S	59° Corr. M S	60° Corr. M S	61° Corr. M S	62° Corr. M S	63° Corr. M S	64° Corr. M S
		Apparent Zenith Distance of the Moon's Centre.									
53	0	42. 4	42.33	43. 0	43.26	43.52	44.16	44.39	45. 2	45.23	45.42
	10	42.13	42.41	43. 8	43.35	44. 0	44.25	44.48	45.10	45.32	45.51
	20	42.21	42.49	43.17	43.43	44. 9	44.34	44.57	45.19	45.40	46. 0
	30	42.29	42.58	43.25	43.52	44.18	44.42	45. 6	45.28	45.49	46. 9
	40	42.37	43. 6	43.34	44. 0	44.26	44.51	45.14	45.37	45.58	46.18
	50	42.45	43.14	43.42	44. 9	44.35	45. 0	45.23	45.46	46. 7	46.27
54	0	42.53	43.22	43.50	44.17	44.43	45. 8	45.32	45.55	46.16	46.36
	10	43. 2	43.31	43.59	44.26	44.52	45.17	45.41	46. 3	46.25	46.45
	20	43.10	43.39	44. 7	44.34	45. 0	45.26	45.49	46.12	46.34	46.54
	30	43.18	43.47	44.16	44.43	45. 9	45.34	45.58	46.21	46.43	47. 3
	40	43.26	43.56	44.24	44.51	45.18	45.43	46. 7	46.30	46.52	47.12
	50	43.34	44. 4	44.32	45. 0	45.26	45.52	46.16	46.39	47. 1	47.21
55	0	43.43	44.12	44.41	45. 8	45.35	46. 0	46.24	46.48	47.10	47.30
	10	43.51	44.20	44.49	45.17	45.43	46. 9	46.33	46.56	47.19	47.39
	20	43.59	44.29	44.58	45.25	45.52	46.18	46.42	47. 5	47.27	47.48
	30	44. 7	44.37	45. 6	45.34	46. 0	46.26	46.51	47.14	47.36	47.57
	40	44.15	44.45	45.14	45.42	46. 9	46.35	46.59	47.23	47.45	48. 6
	50	44.24	44.54	45.23	45.51	46.18	46.43	47. 8	47.32	47.54	48.15
56	0	44.32	45. 2	45.31	45.59	46.26	46.52	47.17	47.41	48. 3	48.24
	10	44.40	45.10	45.39	46. 8	46.35	47. 1	47.26	47.49	48.12	48.33
	20	44.48	45.19	45.48	46.16	46.43	47. 9	47.34	47.58	48.21	48.42
	30	44.56	45.27	45.56	46.25	46.52	47.18	47.43	48. 7	48.30	48.51
	40	45. 5	45.35	46. 5	46.33	47. 1	47.27	47.52	48.16	48.39	49. 0
	50	45.13	45.43	46.13	46.42	47. 9	47.35	48. 1	48.25	48.48	49. 9
57	0	45.21	45.52	46.21	46.50	47.18	47.44	48. 9	48.34	48.57	49.18
	10	45.29	46. 0	46.30	46.59	47.26	47.53	48.18	48.42	49. 5	49.27
	20	45.37	46. 8	46.38	47. 7	47.35	48. 1	48.27	48.51	49.14	49.36
	30	45.46	46.17	46.47	47.16	47.43	48.10	48.36	49. 0	49.23	49.45
	40	45.54	46.25	46.55	47.24	47.52	48.19	48.44	49. 9	49.32	49.54
	50	46. 2	46.33	47. 3	47.32	48. 1	48.27	48.53	49.18	49.41	50. 3
58	0	46.10	46.41	47.12	47.41	48. 9	48.36	49. 2	49.27	49.50	50.12
	10	46.18	46.50	47.20	47.49	48.18	48.45	49.11	49.35	49.59	50.21
	20	46.27	46.58	47.29	47.58	48.26	48.53	49.19	49.44	50. 8	50.30
	30	46.35	47. 6	47.37	48. 6	48.35	49. 2	49.28	49.53	50.17	50.39
	40	46.43	47.15	47.45	48.15	48.43	49.11	49.37	50. 2	50.26	50.48
	50	46.51	47.23	47.54	48.23	48.52	49.19	49.46	50.11	50.35	50.57
59	0	46.59	47.31	48. 2	48.32	49. 1	49.28	49.54	50.20	50.44	51. 6
	10	47. 7	47.40	48.10	48.40	49. 9	49.37	50. 3	50.28	50.52	51.15
	20	47.16	47.48	48.19	48.49	49.18	49.45	50.12	50.37	51. 1	51.24
	30	47.24	47.56	48.27	48.57	49.26	49.54	50.21	50.46	51.10	51.33
	40	47.32	48. 4	48.36	49. 6	49.35	50. 3	50.29	50.55	51.19	51.42
	50	47.40	48.13	48.44	49.14	49.43	50.11	50.38	51. 4	51.28	51.51
60	0	47.48	48.21	48.52	49.23	49.52	50.20	50.47	51.13	51.37	52. 0
	10	47.57	48.29	49. 1	49.31	50. 1	50.29	50.56	51.21	51.46	52. 9
	20	48. 5	48.38	49. 9	49.40	50. 9	50.37	51. 4	51.30	51.55	52.18
	30	48.13	48.46	49.18	49.48	50.18	50.46	51.13	51.39	52. 4	52.27
	40	48.21	48.54	49.26	49.57	50.26	50.55	51.22	51.48	52.13	52.36
	50	48.29	49. 2	49.34	50. 5	50.35	51. 3	51.31	51.57	52.22	52.45
61	0	48.38	49.11	49.43	50.14	50.43	51.12	51.39	52. 6	52.30	52.54
	10	48.46	49.19	49.51	50.22	50.52	51.21	51.48	52.14	52.39	53. 3
	20	48.54	49.27	50. 0	50.31	51. 1	51.29	51.57	52.23	52.48	53.12
	30	49. 2	49.36	50. 8	50.39	51. 9	51.38	52. 6	52.32	52.57	53.21
	40	49.10	49.44	50.16	50.48	51.18	51.47	52.14	52.41	53. 6	53.30
	50	49.19	49.52	50.25	50.56	51.26	51.55	52.23	52.50	53.15	53.39
62	0	49.27	50. 0	50.33	51. 5	51.35	52. 4	52.32	52.59	53.24	53.48
		55°	56°	57°	58°	59°	60°	61°	62°	63°	64°

Par. Add.

S.	8	9
1	1	1
2	2	2
3	2	3
4	3	4
5	4	4
6	5	5
7	6	6
8	6	7
9	7	8

Zen. Dist. Add.

M	19	20	21	22
5	2	2	2	2
10	3	3	3	4
15	5	5	5	5
20	6	7	7	7
25	8	8	9	9
30	9	10	10	11
35	11	12	12	13
40	13	13	14	15
45	14	15	16	16
50	16	17	17	18
55	17	18	19	20

M	23	24	25	26
5	2	2	2	2
10	4	4	4	4
15	6	6	6	6
20	8	8	8	9
25	10	10	10	11
30	11	12	12	13
35	13	14	15	15
40	15	16	17	17
45	17	18	19	19
50	19	20	21	22
55	21	22	23	24

M	27	28	29	30
5	2	2	2	2
10	4	5	5	5
15	7	7	7	7
20	9	9	10	10
25	11	12	12	12
30	13	14	14	15
35	16	16	17	17
40	18	19	19	20
45	20	21	32	22
50	22	23	24	25
55	25	26	27	27

M	31	32	33	34
5	3	3	3	3
10	5	5	5	6
15	8	8	8	8
20	10	11	11	11
25	13	13	14	14
30	15	16	16	17
35	18	19	19	20
40	21	21	22	23
45	23	24	25	25
50	26	27	27	28
55	28	29	30	31

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax. M.	S.	65° Corr. M S	66° Corr. M S	67° Corr. M S	68° Corr. M S	69° Corr. M S	70° Corr. M S	71° Corr. M S	72° Corr. M S	73° Corr. M S	74° Corr. M S
53	0	46. 1	46.18	46.34	46.49	47. 2	47.13	47.23	47.31	47.37	47.41
	10	46.10	46.28	46.44	46.58	47.11	47.23	47.33	47.41	47.47	47.50
	20	46.19	46.37	46.53	47. 7	47.21	47.32	47.42	47.50	47.56	48. 0
	30	46.28	46.46	47. 2	47.17	47.30	47.42	47.52	48. 0	48. 6	48.10
	40	46.37	46.55	47.11	47.26	47.39	47.51	48. 1	48. 9	48.15	48.19
	50	46.46	47. 4	47.20	47.35	47.49	48. 0	48.10	48.19	48.25	48.29
54	0	46.55	47.13	47.30	47.45	47.58	48.10	48.20	48.28	48.34	48.39
	10	47. 5	47.22	47.39	47.54	48. 7	48.19	48.29	48.38	48.44	48.48
	20	47.14	47.31	47.48	48. 3	48.17	48.29	48.39	48.47	48.54	48.58
	30	47.23	47.41	47.57	48.12	48.26	48.38	48.48	48.57	49. 3	49. 7
	40	47.32	47.50	48. 6	48.22	48.35	48.47	48.58	49. 6	49.13	49.17
	50	47.41	47.59	48.16	48.31	48.45	48.57	49. 7	49.16	49.22	49.27
55	0	47.50	48. 8	48.25	48.40	48.54	49. 6	49.17	49.25	49.32	49.36
	10	47.59	48.17	48.34	48.49	49. 3	49.16	49.26	49.35	49.41	49.46
	20	48. 8	48.26	48.43	48.59	49.13	49.25	49.36	49.44	49.51	49.55
	30	48.17	48.35	48.52	49. 8	49.22	49.34	49.45	49.54	50. 1	50. 5
	40	48.26	48.45	49. 2	49.17	49.31	49.44	49.55	50. 3	50.10	50.15
	50	48.35	48.54	49.11	49.27	49.41	49.53	50. 4	50.13	50.20	50.24
56	0	48.44	49. 3	49.20	49.36	49.50	50. 3	50.13	50.22	50.29	50.34
	10	48.53	49.12	49.29	49.45	49.59	50.12	50.23	50.32	50.39	50.44
	20	49. 2	49.21	49.38	49.54	50. 9	50.21	50.32	50.41	50.48	50.53
	30	49.11	49.30	49.48	50. 4	50.18	50.31	50.42	50.51	50.58	51. 3
	40	49.21	49.39	49.57	50.13	50.27	50.40	50.51	51. 0	51. 8	51.12
	50	49.30	49.49	50. 6	50.22	50.37	50.50	51. 1	51.10	51.17	51.22
57	0	49.39	49.58	50.15	50.31	50.46	50.59	51.10	51.19	51.27	51.32
	10	49.48	50. 7	50.25	50.41	50.55	51. 8	51.20	51.29	51.36	51.41
	20	49.57	50.16	50.34	50.50	51. 5	51.18	51.29	51.38	51.46	51.51
	30	50. 6	50.25	50.43	50.59	51.14	51.27	51.39	51.48	51.55	52. 0
	40	50.15	50.34	50.52	51. 9	51.23	51.37	51.48	51.58	52. 5	52.10
	50	50.24	50.43	51. 1	51.18	51.33	51.46	51.57	52. 7	52.14	52.20
58	0	50.33	50.53	51.11	51.27	51.42	51.55	52. 7	52.17	52.24	52 29
	10	50.42	51. 2	51.20	51.36	51.51	52. 5	52.16	52.26	52.34	52.39
	20	50.51	51.11	51.29	51.46	52. 1	52.14	52.26	52.36	52.43	52.49
	30	51. 0	51.20	51.38	51.55	52.10	52.24	52.35	52.45	52.53	52.58
	40	51. 9	51.29	51.47	52. 4	52.19	52.33	52.45	52.55	53. 2	53. 8
	50	51.18	51.38	51.57	52.13	52.29	52.42	52.54	53. 4	53.12	53.17
59	0	51.27	51.47	52. 6	52.23	52.38	52.52	53. 4	53.14	53.21	53.27
	10	51.36	51.56	52.15	52.32	52.47	53. 1	53.13	53.23	53.31	53.37
	20	51.46	52. 6	52.24	52.41	52.57	53.11	53.23	53.33	53.41	53.46
	30	51.55	52.15	52.33	52.51	53. 6	53.20	53.32	53.42	53.50	53.56
	40	52. 4	52.24	52.43	53. 0	53.15	53.29	53.42	53.52	54. 0	54. 5
	50	52.13	52.33	52.52	53. 9	53.25	53.39	53.51	54. 1	54. 9	54.15
60	0	52.22	52.42	53. 1	53.18	53.34	53.48	54. 0	54.11	54.19	54.25
	10	52.31	52.51	53.10	53.28	53.43	53.58	54.10	54.20	54.28	54.34
	20	52.40	53. 0	53.19	53.37	53.53	54. 7	54.19	54.30	54.38	54.44
	30	52.49	53.10	53.29	53.46	54. 2	54.16	54.29	54.39	54.48	54.54
	40	52.58	53.19	53.38	53.56	54.12	54.26	54.38	54.49	54.57	55. 3
	50	53. 7	53.28	53.47	54. 5	54.21	54.35	54.48	54.58	55. 7	55.13
61	0	53.16	53.37	53.56	54.14	54.30	54.45	54.57	55. 8	55.16	55.22
	10	53.25	53.46	54. 5	54.23	54.40	54.54	55. 7	55.17	55.26	55.32
	20	53.34	53.55	54.15	54.33	54.49	55. 3	55.16	55.27	55.35	55.42
	30	53.43	54. 4	54.24	54.42	54.58	55.13	55.26	55.36	55.45	55.51
	40	53.52	54.14	54.33	54.51	55. 8	55.22	55.35	55.46	55.55	56. 1
	50	54. 2	54.23	54.42	55. 0	55.17	55.32	55.44	55.55	56. 4	56 10
62	0	54.11	54.32	54.52	55.10	55.26	55.41	55.54	56. 5	56.14	56.20
		65°	66°	67°	68°	69°	70°	71°	72°	73°	74°

Par. Add.

S.	9	10
1	1	1
2	2	2
3	3	3
4	4	4
5	4	5
6	5	6
7	6	7
8	7	8
9	8	9

Zen. Dist. Add.

M	1	2	3	4	5	6	7
5	0	0	0	0	0	0	1
10	0	0	0	1	1	1	1
15	0	0	1	1	1	1	2
20	0	1	1	1	2	2	2
25	0	1	1	2	2	2	3
30	0	1	1	2	2	3	3
35	1	1	2	2	3	3	4
40	1	1	2	3	3	4	5
45	1	1	2	3	4	4	5
50	1	2	2	3	4	5	6
55	1	2	3	4	5	5	6

M	8	9	10	11	12
5	1	1	1	1	1
10	1	1	2	2	2
15	2	2	2	3	3
20	3	3	3	4	4
25	3	4	4	5	5
30	4	4	5	5	6
35	5	5	6	6	7
40	5	6	7	7	8
45	6	7	7	8	9
50	7	7	8	9	10
55	7	8	9	10	11

M	13	14	15	16	17
5	1	1	1	1	1
10	2	2	2	3	3
15	3	3	4	4	4
20	4	5	5	5	6
25	5	6	6	7	7
30	6	7	7	8	8
35	8	8	9	9	10
40	9	9	10	11	11
45	10	10	11	12	13
50	11	12	12	13	14
55	12	13	14	15	16

M	18	19	20	21	22
5	1	2	2	2	2
10	3	3	3	3	4
15	4	5	5	5	5
20	6	6	7	7	7
25	7	8	8	9	9
30	9	9	10	10	11
35	10	11	12	12	13
40	12	13	13	14	15
45	13	14	15	16	16
50	15	16	17	17	18
55	16	17	18	19	20

TABLE XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizont. Parallax. M	S	75° Corr. M S	76° Corr. M S	77° Corr. M S	78° Corr. M S	79° Corr. M S	80° Corr. M S
		Apparent Zenith Distance of the Moon's Centre.					
53	0	47.42	47.41	47.36	47.28	47.15	46.58
	10	47.52	47.50	47.46	47.38	47.25	47. 7
	20	48. 2	48. 0	47.56	47.48	47.35	47.17
	30	48.11	48.10	48. 5	47.57	47.45	47.27
	40	48.21	48.20	48.15	48. 7	47.55	47.37
	50	48.30	48.29	48.25	48.17	48. 4	47.47
54	0	48.40	48.39	48.35	48.27	48.14	47.57
	10	48.50	48.49	48.44	48.36	48.24	48. 6
	20	48.59	48.58	48.54	48.46	48.34	48.16
	30	49. 9	49. 8	49. 4	48.56	48.44	48.26
	40	49.19	49.18	49.14	49. 6	48.54	48.36
	50	49.28	49.28	49.23	49.16	49. 3	48.46
55	0	49.38	49.37	49.33	49.25	49.13	48.56
	10	49.48	49.47	49.43	49.35	49.23	49. 6
	20	49.57	49.57	49.53	49.45	49.33	49.15
	30	50. 7	50. 6	50. 2	49.55	49.43	49.25
	40	50.17	50.16	50.12	50. 5	49.52	49.35
	50	50.26	50.26	50.22	50.14	50. 2	49.45
56	0	50.36	50.35	50.32	50.24	50.12	49.55
	10	50.46	50.45	50.41	50.34	50.22	50. 5
	20	50.55	50.55	50.51	50.44	50.32	50.15
	30	51. 5	51. 5	51. 1	50.53	50.42	50.24
	40	51.15	51.14	51.11	51. 3	50.51	50.34
	50	51.24	51.24	51.20	51.13	51. 1	50.44
57	0	51.34	51.34	51.30	51.23	51.11	50.54
	10	51.44	51.43	51.40	51.33	51.21	51. 4
	20	51.53	51.53	51.50	51.42	51.31	51.14
	30	52. 3	52. 3	51.59	51.52	51.41	51.23
	40	52.13	52.13	52. 9	52. 2	51.50	51.33
	50	52.22	52.22	52.19	52.12	52. 0	51.43
58	0	52.32	52.32	52.29	52.22	52.10	51.53
	10	52.42	52.42	52.38	52.31	52.20	52. 3
	20	52.51	52.51	52.48	52.41	52.30	52.13
	30	53. 1	53. 1	52.58	52.51	52.39	52.23
	40	53.11	53.11	53. 8	53. 1	52.49	52.32
	50	53.20	53.20	53.17	53.10	52.59	52.42
59	0	53.30	53.30	53.27	53.20	53. 9	52.52
	10	53.40	53.40	53.37	53.30	53.19	53. 2
	20	53.49	53.50	53.47	53.40	53.29	53.12
	30	53.59	53.59	53.56	53.50	53.38	53.22
	40	54. 9	54. 9	54. 6	53.59	53.48	53.32
	50	54.18	54.19	54.16	54. 9	53.58	53.41
60	0	54.28	54.28	54.26	54.19	54. 8	53.51
	10	54.38	54.38	54.35	54.29	54.18	54. 1
	20	54.47	54.48	54.45	54.38	54.27	54.11
	30	54.57	54.58	54.55	54.48	54.37	54.21
	40	55. 7	55. 7	55. 5	54.58	54.47	54.31
	50	55.16	55.17	55.14	55. 8	54.57	54.40
61	0	55.26	55.27	55.24	55.18	55. 7	54.50
	10	55.36	55.36	55.34	55.27	55.17	55. 0
	20	55.45	55.46	55.44	55.37	55.26	55.10
	30	55.55	55.56	55.53	55.47	55.36	55.20
	40	56. 5	56. 5	56. 3	55.57	55.46	55.30
	50	56.14	56.15	56.13	56. 7	55.56	55.40
62	0	56.24	56.25	56.23	56.16	56. 6	55.49
		75°	76°	77°	78°	79°	80°

Par. Add.

8	9	10
1	1	1
2	2	2
3	3	3
4	4	4
5	4	5
6	5	6
7	6	7
8	7	8
9	8	9

Zen. Dist. Subtract.

M	0	*1	2	3	4	5	6
5	0	0	0	0	0	0	0
10	0	0	0	0	1	1	1
15	0	0	0	1	1	1	1
20	0	0	1	1	1	2	2
25	0	0	1	1	2	2	2
30	0	0	1	1	2	2	3
35	0	1	1	2	2	3	3
40	0	1	1	2	3	3	4
45	0	1	1	2	3	4	4
50	0	1	2	2	3	4	5
55	0	1	2	3	4	5	5

M	7	8	9	10	11	12	13
5	1	1	1	1	1	1	1
10	1	1	1	2	2	2	2
15	2	2	2	2	3	3	3
20	2	3	3	3	4	4	4
25	3	3	4	4	5	5	5
30	3	4	4	5	5	6	6
35	4	5	5	6	6	7	8
40	5	5	6	7	7	8	9
45	5	6	7	7	8	9	10
50	6	7	7	8	9	10	11
55	6	7	8	9	10	11	12

M	14	15	16	17	18	19	20
5	1	1	1	1	1	2	2
10	2	2	3	3	3	3	3
15	3	4	4	4	4	5	5
20	5	5	5	6	6	6	7
25	6	6	7	7	7	8	8
30	7	7	8	8	9	9	10
35	8	9	9	10	10	11	12
40	9	10	11	11	12	13	13
45	10	11	12	13	13	14	15
50	12	12	13	14	15	16	17
55	13	14	15	16	16	17	18

M	21	22	23	24	25
5	2	2	2	2	2
10	3	4	4	4	4
15	5	5	6	6	6
20	7	7	8	8	8
25	9	9	10	10	10
30	10	11	11	12	12
35	12	13	13	14	15
40	14	15	15	16	17
45	16	16	17	18	19
50	17	18	19	20	21
55	19	20	21	22	23

* The numbers in this column are sometimes additive.

Table XVIII. For finding the Correction of the Moon's Altitude for Parallax and Refraction.

Moon's horizontal Parallax.		Apparent Zenith Distance of the Moon's Centre.						
		81°	82°	83°	84°	85°	86°	87°
		Corr.	Corr.	Corr.	Corr.	Corr.	Corr.	Corr.
M	S	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.
53	0	46.33	46. 0	45.16	44.17	42.56	41. 3	38.21
	10	46.43	46.10	45.26	44.27	43. 6	41.13	38.31
	20	46.53	46.20	45.36	44.37	43.16	41.23	38.41
	30	47. 3	46.30	45.46	44.47	43.26	41.33	38.51
	40	47.13	46.40	45.56	44.56	43.36	41.43	39. 1
	50	47.22	46.50	46. 6	45. 6	43.46	41.53	39.11
54	0	47.32	47.00	46.16	45.16	43.55	42. 3	39.21
	10	47.42	47. 9	46.26	45.26	44. 5	42.13	39.31
	20	47.52	47.19	46.35	45.36	44.15	42.23	39.41
	30	48. 2	47.29	46.45	45.46	44.25	42.33	39.51
	40	48.12	47.39	46.55	45.56	44.35	42.43	40. 1
	50	48.22	47.49	47. 5	46. 6	44.45	42.53	40.11
55	0	48.32	47.59	47.15	46.16	44.55	43. 3	40.21
	10	48.41	48. 9	47.25	46.26	45. 5	43.13	40.31
	20	48.51	48.19	47.35	46.36	45.15	43.23	40.41
	30	49. 1	48.29	47.45	46.46	45.25	43.33	40.51
	40	49.11	48.39	47.55	46.56	45.35	43.42	41. 1
	50	49.21	48.48	48. 5	47. 6	45.45	43.52	41.11
56	0	49.31	48.58	48.15	47.16	45.55	44. 2	41.21
	10	49.41	49. 8	48.25	47.26	46. 5	44.12	41.31
	20	49.51	49.18	48.35	47.36	46.15	44.22	41.41
	30	50.00	49.28	48.45	47.46	46.25	44.32	41.51
	40	50.10	49.38	48.54	47.56	46.35	44.42	42. 1
	50	50.20	49.48	49. 4	48. 5	46.45	44.52	42.11
57	0	50.30	49.58	49.14	48.15	46.55	45. 2	42.21
	10	50.40	50. 8	49.24	48.25	47. 5	45.12	42.31
	20	50.50	50.18	49.34	48.35	47.15	45.22	42.41
	30	51.00	50.28	49.44	48.45	47.25	45.32	42.51
	40	51.10	50.37	49.54	48.55	47.35	45.42	43. 1
	50	51.20	50.47	50. 4	49. 5	47.45	45.52	43.11
58	0	51.29	50.57	50.14	49.15	47.55	46. 2	43.21
	10	51.39	51. 7	50.24	49.25	48. 5	46.12	43.31
	20	51.49	51.17	50.34	49.35	48.15	46.22	43.41
	30	51.59	51.27	50.44	49.45	48.25	46.32	43.51
	40	52. 9	51.37	50.54	49.55	48.34	46.42	44. 1
	50	52.19	51.47	51. 3	50. 5	48.44	46.52	44.11
59	0	52.29	51.57	51.13	50.15	48.54	47. 2	44.21
	10	52.39	52. 7	51.23	50.25	49. 4	47.12	44.31
	20	52.48	52.16	51.33	50.35	49.14	47.22	44.41
	30	52.58	52.26	51.43	50.45	49.24	47.32	44.51
	40	53. 8	52.36	51.53	50.55	49.34	47.42	45. 1
	50	53.18	52.46	52. 3	51. 5	49.44	47.52	45.11
60	0	53.28	52.56	52.13	51.14	49.54	48. 2	45.21
	10	53.38	53. 6	52.23	51.24	50. 4	48.12	45.31
	20	53.48	53.16	52.33	51.34	50.14	48.22	45.41
	30	53.58	53.26	52.43	51.44	50.24	48.32	45.51
	40	54. 7	53.36	52.53	51.54	50.34	48.42	46. 1
	50	54.17	53.46	53. 3	52. 4	50.44	48.52	46.11
61	0	54.27	53.56	53.13	52.14	50.54	49. 2	46.21
	10	54.37	54. 5	53.22	52.24	51. 4	49.12	46.31
	20	54.47	54.15	53.32	52.34	51.14	49.22	46.41
	30	54.57	54.25	53.42	52.44	51.24	49.32	46.51
	40	55. 7	54.35	53.52	52.54	51.34	49.42	47. 1
	50	55.17	54.45	54. 2	53. 4	51.44	49.52	47.11
62	0	55.27	54.55	54.12	53.14	51.54	50. 2	47.21
		81°	82°	83°	84°	85°	86°	87°

Par. Add.

S.	9	10
1	1	1
2	2	2
3	3	3
4	4	4
5	4	5
6	5	6
7	6	7
8	7	8
9	8	9

Subtract.

Zen. Dis. 81°

M	31	32	33
5	3	3	3
10	5	5	5
15	8	8	8
20	10	11	11
25	13	13	14
30	15	16	16
35	18	19	19
40	21	21	22
45	23	24	25
50	26	27	27
55	28	29	30

Z. Dis. 82°

M	43	44
5	4	4
10	7	7
15	11	11
20	14	15
25	18	18
30	21	22
35	25	26
40	29	29
45	32	33
50	36	37
55	39	40

Zen. Dis. 83°

M	58	59	60
5	5	5	5
10	10	10	10
15	14	15	15
20	19	20	20
25	24	25	25
30	29	29	30
35	34	34	35
40	39	39	40
45	43	44	45
50	48	49	50
55	53	54	55

Z. Dis. 84°

M	80	81
5	7	7
10	13	13
15	20	20
20	27	27
25	33	34
30	40	40
35	47	47
40	53	54
45	60	61
50	67	67
55	73	74

Zen. Dis. 85°

M	112	113
5	9	9
10	19	19
15	28	28
20	37	38
25	47	47
30	56	56
35	65	66
40	75	75
45	84	85
50	93	94
55	103	104

Zen. Dis. 86°

M	161	162
5	13	13
10	27	27
15	40	40
20	54	54
25	67	6[illegible]
30	80	81
35	94	94
40	107	108
45	121	121
50	134	135
55	148	148

TABLE XIX. For computing the Effects of Parallax on the Moon's Distance from the Sun or a Star.

Par. in Alt. or Distance	Apparent Distance. Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.																Par. in Alt. or Distance.
	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	
M	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	M
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	5
8	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	8
10	5	4	4	4	3	3	3	3	3	3	2	2	2	2	2	2	10
11	6	5	5	5	4	4	4	3	3	3	3	3	3	2	2	2	11
12	7	6	6	5	5	5	4	4	4	4	3	3	3	3	3	3	12
13	8	8	7	6	6	6	5	5	5	4	4	4	4	3	3	3	13
14	10	9	8	7	7	6	6	6	5	5	5	4	4	4	4	4	14
15	11	10	9	9	8	7	7	6	6	6	5	5	5	5	4	4	15
16	13	11	11	10	9	8	8	7	7	6	6	6	6	5	5	5	16
17	14	13	12	11	10	9	9	8	8	7	7	7	6	6	6	5	17
18	16	15	13	12	11	11	10	9	9	8	8	7	7	7	6	6	18
19	18	16	15	14	13	12	11	10	10	9	9	8	8	7	7	7	19
20	20	18	16	15	14	13	12	11	11	10	10	9	9	8	8	7	20
21	22	20	18	17	15	14	13	13	12	11	11	10	10	9	9	8	21
22	24	22	20	18	17	16	15	14	13	12	12	11	10	10	9	9	22
23	26	24	22	20	19	17	16	15	14	13	13	12	11	11	10	10	23
24	28	26	24	22	20	19	18	16	15	15	14	13	12	12	11	11	24
25	31	28	26	24	22	20	19	18	17	16	15	14	13	13	12	12	25
26	33	30	28	26	24	22	21	19	18	17	16	15	15	14	13	13	26
27	36	33	30	28	26	24	22	21	20	18	17	17	16	15	14	14	27
28	39	35	32	30	27	26	24	22	21	20	19	18	17	16	15	15	28
29	42	38	35	32	29	27	26	24	23	21	20	19	18	17	16	16	29
30	45	40	37	34	31	29	27	26	24	23	22	20	19	19	18	17	30
31	48	43	39	36	34	31	29	27	26	24	23	22	21	20	19	18	31
32	51	46	42	39	36	33	31	29	27	26	25	23	22	21	20	19	32
33	54	49	45	41	38	35	33	31	29	28	26	25	24	22	21	20	33
34	57	52	47	44	40	38	35	33	31	29	28	26	25	24	23	22	34
35	61	55	50	46	43	40	37	35	33	31	29	28	26	25	24	23	35
36	64	58	53	49	45	42	39	37	35	33	31	29	28	27	25	24	36
37	68	61	56	52	48	45	42	39	37	35	33	31	30	28	27	26	37
38	71	65	59	55	51	47	44	41	39	37	35	33	31	30	28	27	38
39	75	68	62	57	53	50	46	43	41	39	36	35	33	31	30	28	39
40	79	72	66	60	56	52	49	46	43	41	38	36	35	33	31	30	40
41	83	75	69	63	59	55	51	48	45	43	40	38	36	35	33	31	41
42	87	79	72	67	62	57	54	50	47	45	42	40	38	36	35	33	42
43	91	83	76	70	65	60	56	53	50	47	44	42	40	38	36	35	43
44	96	87	79	73	68	63	59	55	52	49	46	44	42	40	38	36	44
45	100	91	83	76	71	66	62	58	54	51	49	46	44	42	40	38	45
46	105	95	87	80	74	69	64	60	57	54	51	48	46	43	41	40	46
47	109	99	91	83	77	72	67	63	59	56	53	50	48	45	43	41	47
48	114	103	94	87	81	75	70	66	62	58	55	52	50	47	45	43	48
49	119	108	98	91	84	78	73	68	64	61	58	55	52	49	47	45	49
50	124	112	103	94	87	81	76	71	67	63	60	57	54	51	49	47	50
51	128	117	107	98	91	85	79	74	70	66	62	59	56	53	51	49	51
52	134	121	111	102	95	88	82	77	73	68	65	61	58	56	53	51	52
53	139	126	115	106	98	91	85	80	75	71	67	64	61	58	55	53	53
54	144	131	120	110	102	95	89	83	78	74	70	66	63	60	57	55	54
55	149	136	124	114	106	98	92	86	81	77	72	69	65	62	59	57	55
56	155	141	129	118	110	102	95	89	84	79	75	71	68	64	61	59	56
57	160	146	133	123	114	106	99	93	87	82	78	74	70	67	64	61	57
58	166	151	138	127	118	109	102	96	90	85	81	76	73	69	66	63	58
59	172	156	143	131	122	113	106	99	93	88	83	79	75	72	68	65	59
60	178	161	148	136	126	117	109	103	97	91	86	82	78	74	71	67	60
61	184	167	152	140	130	121	113	106	100	94	89	85	80	76	73	70	61
62	190	172	158	145	134	125	117	110	103	97	92	87	83	79	75	72	62
M	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	M

TABLE XIX. For computing the effects of Parallax on the Moon's Distance from the Sun or a Star.

Par. in Alt. or Distance	Apparent Distance. Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.													Par. in Alt. or Distance
	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	
M	"	"	"	"	"	"	"	"	"	"	"	"	"	M
5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
8	1	1	1	1	1	1	1	1	1	1	1	1	1	8
10	2	2	2	2	2	1	1	1	1	1	1	1	1	10
11	2	2	2	2	2	2	2	2	2	2	1	1	1	11
12	3	2	2	2	2	2	2	2	2	2	2	2	2	12
13	3	3	3	3	3	2	2	2	2	2	2	2	2	13
14	4	3	3	3	3	3	3	3	3	2	2	2	2	14
15	4	4	4	4	3	3	3	3	3	3	3	3	3	15
16	5	4	4	4	4	4	4	3	3	3	3	3	3	16
17	5	5	5	5	4	4	4	4	4	4	3	3	3	17
18	6	6	5	5	5	5	5	4	4	4	4	4	4	18
19	6	6	6	6	5	5	5	5	5	4	4	4	4	19
20	7	7	7	6	6	6	6	5	5	5	5	5	4	20
21	8	8	7	7	7	6	6	6	6	5	5	5	5	21
22	9	8	8	8	7	7	7	7	6	6	6	6	5	22
23	9	9	9	8	8	8	7	7	7	7	6	6	6	23
24	10	10	9	9	9	8	8	8	7	7	7	7	6	24
25	11	11	10	10	9	9	9	8	8	8	8	7	7	25
26	12	12	11	11	10	10	9	9	9	8	8	8	8	26
27	13	12	12	11	11	11	10	10	9	9	9	8	8	27
28	14	13	13	12	12	11	11	11	10	10	9	9	9	28
29	15	14	14	13	13	12	12	11	11	10	10	10	9	29
30	16	15	15	14	14	13	13	12	12	11	11	10	10	30
31	17	16	16	15	15	14	13	13	12	12	12	11	11	31
32	18	18	17	16	15	15	14	14	13	13	12	12	11	32
33	19	19	18	17	16	16	15	15	14	14	13	13	12	33
34	21	20	19	18	17	17	16	16	15	14	14	13	13	34
35	22	21	20	19	19	18	17	16	16	15	15	14	14	35
36	23	22	21	20	20	19	18	17	17	16	16	15	14	36
37	24	23	22	22	21	20	19	18	18	17	16	16	15	37
38	26	25	24	23	22	21	20	19	19	18	17	17	16	38
39	27	26	25	24	23	22	21	20	20	19	18	18	17	39
40	29	27	26	25	24	23	22	21	21	20	19	19	18	40
41	30	29	28	26	25	24	23	23	22	21	20	19	19	41
42	32	30	29	28	27	26	25	24	23	22	21	20	20	42
43	33	32	30	29	28	27	26	25	24	23	22	21	21	43
44	35	33	32	30	29	28	27	26	25	24	23	22	22	44
45	36	35	33	32	31	29	28	27	26	25	24	23	23	45
46	38	36	35	33	32	31	30	28	27	26	25	25	24	46
47	40	38	36	35	33	32	31	30	29	28	27	26	25	47
48	41	39	38	36	35	33	32	31	30	29	28	27	26	48
49	43	41	39	38	36	35	34	32	31	30	29	28	27	49
50	45	43	41	39	38	36	35	34	32	31	30	29	28	50
51	47	45	43	41	39	38	36	35	34	32	31	30	29	51
52	48	46	44	43	41	39	38	36	35	34	32	31	30	52
53	50	48	46	44	42	41	39	38	36	35	34	33	31	53
54	52	50	48	46	44	42	41	39	38	36	35	34	33	54
55	54	52	50	48	46	44	42	41	39	38	36	35	34	55
56	56	54	51	49	47	46	44	42	41	39	38	36	35	56
57	58	56	53	51	49	47	45	44	42	40	39	38	36	57
58	60	58	55	53	51	49	47	45	44	42	40	39	38	58
59	62	60	57	55	53	51	49	47	45	43	42	40	39	59
60	64	62	59	57	54	52	50	48	47	45	43	42	40	60
61	67	64	61	59	56	54	52	50	48	46	45	43	42	61
62	69	66	63	60	58	56	54	52	50	48	46	45	43	62
M	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	M

Table XIX. For computing the Effects of Parallax on the Moon's Distance from the Sun or a Star.

Par. in Alt. or Distance	Apparent Distance. Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.													Par. in Alt. or Distance
	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	
M	"	"	"	"	"	"	"	"	"	"	"	"	"	M
5	0	0	0	0	0	0	0	0	0	0	0	0	0	5
8	1	1	1	1	1	1	1	1	1	1	0	0	0	8
10	1	1	1	1	1	1	1	1	1	1	1	1	1	10
11	1	1	1	1	1	1	1	1	1	1	1	1	1	11
12	2	1	1	1	1	1	1	1	1	1	1	1	1	12
13	2	2	2	2	2	2	1	1	1	1	1	1	1	13
14	2	2	2	2	2	2	2	2	2	2	1	1	1	14
15	2	2	2	2	2	2	2	2	2	2	2	2	2	15
16	3	3	3	2	2	2	2	2	2	2	2	2	2	16
17	3	3	3	3	3	3	3	2	2	2	2	2	2	17
18	3	3	3	3	3	3	3	3	3	3	2	2	2	18
19	4	4	4	3	3	3	3	3	3	3	3	3	3	19
20	4	4	4	4	4	4	3	3	3	3	3	3	3	20
21	5	5	4	4	4	4	4	4	4	3	3	3	3	21
22	5	5	5	5	5	4	4	4	4	4	4	4	3	22
23	6	6	5	5	5	5	5	4	4	4	4	4	4	23
24	6	6	6	6	5	5	5	5	5	5	4	4	4	24
25	7	6	6	6	6	6	5	5	5	5	5	5	4	25
26	7	7	7	7	6	6	6	6	6	5	5	5	5	26
27	8	8	7	7	7	7	6	6	6	6	6	5	5	27
28	8	8	8	8	7	7	7	7	6	6	6	6	6	28
29	9	9	8	8	8	8	7	7	7	7	6	6	6	29
30	10	9	9	9	8	8	8	8	7	7	7	7	6	30
31	10	10	10	9	9	9	8	8	8	8	7	7	7	31
32	11	11	10	10	10	9	9	9	8	8	8	7	7	32
33	12	11	11	11	10	10	10	9	9	9	8	8	8	33
34	12	12	12	11	11	10	10	10	9	9	9	8	8	34
35	13	13	12	12	11	11	11	10	10	10	9	9	9	35
36	14	13	13	13	12	12	11	11	11	10	10	9	9	36
37	15	14	14	13	13	12	12	12	11	11	10	10	10	37
38	16	15	14	14	14	13	13	12	12	11	11	11	10	38
39	16	16	15	15	14	14	13	13	12	12	12	11	11	39
40	17	17	16	16	15	14	14	13	13	13	12	12	11	40
41	18	17	17	16	16	15	15	14	14	13	13	12	12	41
42	19	18	18	17	17	16	15	15	14	14	13	13	12	42
43	20	19	19	18	17	17	16	16	15	15	14	14	13	43
44	21	20	19	19	18	17	17	16	16	15	15	14	14	44
45	22	21	20	20	19	18	18	17	16	16	15	15	14	45
46	23	22	21	21	20	19	18	18	17	17	16	15	15	46
47	24	23	22	21	21	20	19	19	18	17	17	16	16	47
48	25	24	23	22	22	21	20	19	19	18	17	17	16	48
49	26	25	24	23	22	22	21	20	20	19	18	18	17	49
50	27	26	25	24	23	23	22	21	20	20	19	18	18	50
51	28	27	26	25	24	24	23	22	21	20	20	19	18	51
52	29	28	27	26	25	24	24	23	22	21	21	20	19	52
53	30	29	28	27	26	25	25	24	23	22	21	21	20	53
54	31	30	29	28	27	26	25	25	24	23	22	21	21	54
55	33	31	30	29	28	27	26	25	25	24	23	22	21	55
56	34	33	31	30	29	28	27	26	26	25	24	23	22	56
57	35	34	33	31	30	29	28	27	26	26	25	24	23	57
58	36	35	34	33	31	30	29	28	27	26	26	25	24	58
59	38	36	35	34	33	31	30	29	28	27	26	25	25	59
60	39	37	36	35	34	33	31	30	29	28	27	26	25	60
61	40	39	37	36	35	34	32	31	30	29	28	27	26	61
62	41	40	39	37	36	35	34	32	31	30	29	28	27	62
M	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	M

TABLE XIX. For computing the Effects of Paralax on the Moon's Distance from the Sun or a Star.

Par. in Alt. or Distance.	Apparent Distance. Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.															Par. in Alt. or Distance.
	52°	53°	54°	55°	56°	57°	58°	59°	60° 120	65° 115	70° 110	75° 105	80° 100	85° 95	90° 90	
M	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	M
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
10	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	10
11	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	11
12	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	12
13	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	13
14	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	14
15	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	15
16	2	2	2	2	2	1	1	1	1	1	1	1	0	0	0	16
17	2	2	2	2	2	2	2	2	1	1	1	1	0	0	0	17
18	2	2	2	2	2	2	2	2	2	1	1	1	0	0	0	18
19	2	2	2	2	2	2	2	2	2	1	1	1	1	0	0	19
20	3	3	3	2	2	2	2	2	2	2	1	1	1	0	0	20
21	3	3	3	3	3	2	2	2	2	2	1	1	1	0	0	21
22	3	3	3	3	3	3	3	3	2	2	2	1	1	0	0	22
23	4	3	3	3	3	3	3	3	3	2	2	1	1	0	0	23
24	4	4	4	4	3	3	3	3	3	2	2	1	1	0	0	24
25	4	4	4	4	4	4	3	3	3	3	2	1	1	0	0	25
26	5	4	4	4	4	4	4	4	3	3	2	2	1	1	0	26
27	5	5	5	4	4	4	4	4	4	3	2	2	1	1	0	27
28	5	5	5	5	5	4	4	4	4	3	2	2	1	1	0	28
29	6	6	5	5	5	5	5	4	4	3	3	2	1	1	0	29
30	6	6	6	5	5	5	5	5	5	4	3	2	1	1	0	30
31	7	6	6	6	6	5	5	5	5	4	3	2	1	1	0	31
32	7	7	6	6	6	6	6	5	5	4	3	2	2	1	0	32
33	7	7	7	7	6	6	6	6	5	4	3	3	2	1	0	33
34	8	8	7	7	7	7	6	6	6	5	4	3	2	1	0	34
35	8	8	8	7	7	7	7	6	6	5	4	3	2	1	0	35
36	9	9	8	8	8	7	7	7	7	5	4	3	2	1	0	36
37	9	9	9	8	8	8	7	7	7	6	4	3	2	1	0	37
38	10	9	9	9	8	8	8	8	7	6	5	3	2	1	0	38
39	10	10	10	9	9	9	8	8	8	6	5	4	2	1	0	39
40	11	11	10	10	9	9	9	8	8	7	5	4	2	1	0	40
41	11	11	11	10	10	10	9	9	8	7	5	4	3	1	0	41
42	12	12	11	11	10	10	10	9	9	7	6	4	3	1	0	42
43	13	12	12	11	11	10	10	10	9	8	6	4	3	1	0	43
44	13	13	12	12	11	11	11	10	10	8	6	5	3	1	0	44
45	14	13	13	12	12	11	11	11	10	8	6	5	3	2	0	45
46	14	14	13	13	12	12	12	11	11	9	7	5	3	2	0	46
47	15	15	14	13	13	13	12	12	11	9	7	5	3	2	0	47
48	16	15	15	14	14	13	13	12	12	9	7	5	4	2	0	48
49	16	16	15	15	14	14	13	13	12	10	8	6	4	2	0	49
50	17	16	16	15	15	14	14	13	13	10	8	6	4	2	0	50
51	18	17	16	16	15	15	14	14	13	11	8	6	4	2	0	51
52	18	18	17	17	16	15	15	14	14	11	9	6	4	2	0	52
53	19	18	18	17	17	16	15	15	14	11	9	7	4	2	0	53
54	20	19	18	18	17	17	16	15	15	12	9	7	4	2	0	54
55	21	20	19	18	18	17	16	16	15	12	10	7	5	2	0	55
56	21	21	20	19	18	18	17	16	16	13	10	7	5	2	0	56
57	22	21	21	20	19	18	18	17	16	13	10	8	5	2	0	57
58	23	22	21	21	20	19	18	18	17	14	11	8	5	3	0	58
59	24	23	22	21	20	20	19	18	18	14	11	8	5	3	0	59
60	25	24	23	22	21	20	20	19	18	15	11	8	6	3	0	60
61	25	24	24	23	22	21	20	20	19	15	12	9	6	3	0	61
62	26	25	24	23	23	22	21	20	19	16	12	9	6	3	0	62
M	52°	53°	54°	55°	56°	57°	58°	59°	60° 120	65° 115	70° 110	75° 105	80° 100	85° 95	90° 90	M

TABLE XX. For turning Degrees and Minutes into Time, and the contrary.

D	H M	D	H M	D	H M	D	H M	D	H M	D	H M
M	M S	M	M S	M	M S	M	M S	M	M S	M	M S
1	0. 4	61	4. 4	121	8. 4	181	12. 4	241	16. 4	301	20. 4
2	0. 8	62	4. 8	122	8. 8	182	12. 8	242	16. 8	302	20. 8
3	0.12	63	4.12	123	8.12	183	12.12	243	16.12	303	20.12
4	0.16	64	4.16	124	8.16	184	12.16	244	16.16	304	20.16
5	0.20	65	4.20	125	8.20	185	12.20	245	16.20	305	20.20
6	0.24	66	4.24	126	8.24	186	12.24	246	16.24	306	20.24
7	0.28	67	4.28	127	8.28	187	12.28	247	16.28	307	20.28
8	0.32	68	4.32	128	8.32	188	12.32	248	16.32	308	20.32
9	0.36	69	4.36	129	8.36	189	12.36	249	16.36	309	20.36
10	0.40	70	4.40	130	8.40	190	12.40	250	16.40	310	20.40
11	0.44	71	4.44	131	8.44	191	12.44	251	16.44	311	20.44
12	0.48	72	4.48	132	8.48	192	12.48	252	16.48	312	20.48
13	0.52	73	4.52	133	8.52	193	12.52	253	16.52	313	20.52
14	0.56	74	4.56	134	8.56	194	12.56	254	16.56	314	20.56
15	1. 0	75	5. 0	135	9. 0	195	13. 0	255	17. 0	315	21. 0
16	1. 4	76	5. 4	136	9. 4	196	13. 4	256	17. 4	316	21. 4
17	1. 8	77	5. 8	137	9. 8	197	13. 8	257	17. 8	317	21. 8
18	1.12	78	5.12	138	9.12	198	13.12	258	17.12	318	21.12
19	1.16	79	5.16	139	9.16	199	13.16	259	17.16	319	21.16
20	1.20	80	5.20	140	9.20	200	13.20	260	17.20	320	21.20
21	1.24	81	5.24	141	9.24	201	13.24	261	17.24	321	21.24
22	1.28	82	5.28	142	9.28	202	13.28	262	17.28	322	21.28
23	1.32	83	5.32	143	9.32	203	13.32	263	17.32	323	21.32
24	1.36	84	5.36	144	9.36	204	13.36	264	17.36	324	21.36
25	1.40	85	5.40	145	9.40	205	13.40	265	17.40	325	21.40
26	1.44	86	5.44	146	9.44	206	13.44	266	17.44	326	21.44
27	1.48	87	5.48	147	9.48	207	13.48	267	17.48	327	21.48
28	1.52	88	5.52	148	9.52	208	13.52	268	17.52	328	21.52
29	1.56	89	5.56	149	9.56	209	13.56	269	17.56	329	21.56
30	2. 0	90	6. 0	150	10. 0	210	14. 0	270	18. 0	330	22. 0
31	2. 4	91	6. 4	151	10. 4	211	14. 4	271	18. 4	331	22. 4
32	2. 8	92	6. 8	152	10. 8	212	14. 8	272	18. 8	332	22. 8
33	2.12	93	6.12	153	10.12	213	14.12	273	18.12	333	22.12
34	2.16	94	6.16	154	10.16	214	14.16	274	18.16	334	22.16
35	2.20	95	6.20	155	10.20	215	14.20	275	18.20	335	22.20
36	2.24	96	6.24	156	10.24	216	14.24	276	18.24	336	22.24
37	2.28	97	6.28	157	10.28	217	14.28	277	18.28	337	22.28
38	2.32	98	6.32	158	10.32	218	14.32	278	18.32	338	22.32
39	2.36	99	6.36	159	10.36	219	14.36	279	18.36	339	22.36
40	2.40	100	6.40	160	10.40	220	14.40	280	18.40	340	22.40
41	2.44	101	6.44	161	10.44	221	14.44	281	18.44	341	22.44
42	2.48	102	6.48	162	10.48	222	14.48	282	18.48	342	22.48
43	2.52	103	6.52	163	10.52	223	14.52	283	18.52	343	22.52
44	2.56	104	6.56	164	10.56	224	14.56	284	18.56	344	22.56
45	3. 0	105	7. 0	165	11. 0	225	15. 0	285	19. 0	345	23. 0
46	3. 4	106	7. 4	166	11. 4	226	15. 4	286	19. 4	346	23. 4
47	3. 8	107	7. 8	167	11. 8	227	15. 8	287	19. 8	347	23. 8
48	3.12	108	7.12	168	11.12	228	15.12	288	19.12	348	23.12
49	3.16	109	7.16	169	11.16	229	15.16	289	19.16	349	23.16
50	3.20	110	7.20	170	11.20	230	15.20	290	19.20	350	23.20
51	3.24	111	7.24	171	11.24	231	15.24	291	19.24	351	23.24
52	3.28	112	7.28	172	11.28	232	15.28	292	19.28	352	23.28
53	3.32	113	7.32	173	11.32	233	15.32	293	19.32	353	23.32
54	3.36	114	7.36	174	11.36	234	15.36	294	19.36	354	23.36
55	3.40	115	7.40	175	11.40	235	15.40	295	19.40	355	23.40
56	3.44	116	7.44	176	11.44	236	15.44	296	19.44	356	23.44
57	3.48	117	7.48	177	11.48	237	15.48	297	19.48	357	23.48
58	3.52	118	7.52	178	11.52	238	15.52	298	19.52	358	23.52
59	3.56	119	7.56	179	11.56	239	15.56	299	19.56	359	23.56
60	4. 0	120	8. 0	180	12. 0	240	16. 0	300	20. 0	360	24. 0

0 HOUR.

M.	S.	Log½ela Time.	Log. Mid Time.	Logarith Rising.	M.	S.	Log ½ela Time.	Log Mid Time.	Logarith Rising.
0	0				10	0	1.36032	3.94071	1.97854
	10	3.13833	2.16270	8.42230		10	1.35315	3.94788	1.99289
	20	2.83730	2.46373	9.02436		20	1.34609	3.95494	2.00701
	30	2.66121	2.63982	9.37654		30	1.33915	3.96188	2.02091
	40	2.53627	2.76476	9.62642		40	1.33231	3.96872	2.03458
	50	2.43936	2.86167	9.82024		50	1.32558	3.97545	2.04805
1	0	2.36018	2.94085	9.97860	11	0	1.31896	3.98207	2.06131
	10	2.29324	3.00779	0.11250		10	1.31243	3.98860	2.07437
	20	2.23525	3.06578	0.22848		20	1.30600	3.99503	2.08723
	30	2.18409	3.11694	0.33079		30	1.29967	4.00136	2.09991
	40	2.13834	3.16269	0.42230		40	1.29342	4.00761	2.11240
	50	2.09695	3.20408	0.50509		50	1.28727	4.01376	2.12472
2	0	2.05916	3.24187	0.58066	12	0	1.28120	4.01983	2.13687
	10	2.02440	3.27663	0.65019		10	1.27522	4.02581	2.14885
	20	1.99221	3.30882	0.71455		20	1.26931	4.03172	2.16066
	30	1.96225	3.33878	0.77448		30	1.26349	4.03754	2.17232
	40	1.93422	3.36681	0.83054		40	1.25774	4.04329	2.18382
	50	1.90790	3.39313	0.88319		50	1.25207	4.04896	2.19517
3	0	1.88307	3.41796	0.93284	13	0	1.24647	4.05456	2.20638
	10	1.85959	3.44144	0.97980		10	1.24095	4.06008	2.21744
	20	1.83732	3.46371	1.02435		20	1.23549	4.06554	2.22836
	30	1.81613	3.48490	1.06673		30	1.23010	4.07093	2.23915
	40	1.79593	3.50510	1.10714		40	1.22478	4.07625	2.24980
	50	1.77663	3.52440	1.14575		50	1.21952	4.08151	2.26033
4	0	1.75814	3.54289	1.18271	14	0	1.21432	4.08671	2.27073
	10	1.74042	3.56061	1.21817		10	1.20919	4.09184	2.28100
	20	1.72339	3.57764	1.25224		20	1.20412	4.09691	2.29116
	30	1.70700	3.59403	1.28502		30	1.19910	4.10193	2.30120
	40	1.69121	3.60982	1.31660		40	1.19415	4.10688	2.31112
	50	1.67597	3.62506	1.34708		50	1.18925	4.11178	2.32093
5	0	1.66125	3.63978	1.37653	15	0	1.18440	4.11663	2.33063
	10	1.64701	3.65402	1.40501		10	1.17961	4.12147	2.34023
	20	1.63322	3.66781	1.43258		20	1.17487	4.12616	2.34972
	30	1.61986	3.68117	1.45931		30	1.17018	4.13085	2.35910
	40	1.60690	3.69413	1.48524		40	1.16554	4.13549	2.36839
	50	1.59431	3.70672	1.51041		50	1.16096	4.14007	2.37758
6	0	1.58208	3.71895	1.53488	16	0	1.15642	4.14461	2.38667
	10	1.57018	3.73085	1.55868		10	1.15192	4.14911	2.39567
	20	1.55861	3.74242	1.58184		20	1.14748	4.15355	2.40457
	30	1.54733	3.75370	1.60440		30	1.14307	4.15790	2.41339
	40	1.53634	3.76469	1.62639		40	1.13872	4.16231	2.42211
	50	1.52561	3.77542	1.64784		50	1.13440	4.16663	2.43075
7	0	1.51515	3.78588	1.66877	17	0	1.13013	4.17090	2.43930
	10	1.50494	3.79609	1.68920		10	1.12590	4.17513	2.44777
	20	1.49496	3.80607	1.70917		20	1.12171	4.17932	2.45616
	30	1.48520	3.81583	1.72869		30	1.11757	4.18346	2.46447
	40	1.47566	3.82537	1.74778		40	1.11346	4.18757	2.47270
	50	1.46632	3.83471	1.76646		50	1.10939	4.19164	2.48085
8	0	1.45718	3.84385	1.78474	18	0	1.10536	4.19567	2.48893
	10	1.44823	3.85280	1.80265		10	1.10136	4.19967	2.49693
	20	1.43946	3.86157	1.82019		20	1.09740	4.20363	2.50486
	30	1.43086	3.87017	1.83739		30	1.09348	4.20755	2.51271
	40	1.42243	3.87860	1.85426		40	1.08960	4.21143	2.52050
	50	1.41417	3.88686	1.87080		50	1.08574	4.21529	2.52821
9	0	1.40605	3.89498	1.88703	19	0	1.08193	4.21910	2.53586
	10	1.39809	3.90294	1.90297		10	1.07814	4.22289	2.54344
	20	1.39027	3.91076	1.91862		20	1.07439	4.22664	2.55096
	30	1.38258	3.91845	1.93399		30	1.07067	4.23036	2.55841
	40	1.37503	3.92600	1.94909		40	1.06699	4.23404	2.56580
	50	1.36762	3.93341	1.96394		50	1.06333	4.23770	2.57313

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

M.	S.	Log ½ ela. Time.	Log Mi. Time.	Logarith. Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
				0 HOUR.					
20	0	1.05970	4.24133	2.58039	30	0	0.88430	4.41673	2.93223
	10	1.05611	4.24492	2.58759		10	0.88191	4.41912	2.93703
	20	1.05254	4.24849	2.59474		20	0.87953	4.42150	2.94181
	30	1.04901	4.25202	2.60182		30	0.87717	4.42386	2.94656
	40	1.04550	4.25553	2.60885		40	0.87481	4.42622	2.95129
	50	1.04202	4.25901	2.61582		50	0.87247	4.42856	2.95599
21	0	1.03857	4.26246	2.62274	31	0	0.87015	4.43088	2.96067
	10	1.03515	4.26588	2.62960		10	0.86783	4.43320	2.96532
	20	1.03175	4.26928	2.63641		20	0.86553	4.43550	2.96994
	30	1.02838	4.27265	2.64316		30	0.86324	4.43779	2.97454
	40	1.02504	4.27599	2.64987		40	0.86096	4.44007	2.97912
	50	1.02172	4.27931	2.65652		50	0.85870	4.44233	2.98367
22	0	1.01843	4.28260	2.66312	32	0	0.85644	4.44459	2.98820
	10	1.01516	4.28587	2.66967		10	0.85420	4.44683	2.99270
	20	1.01192	4.28911	2.67617		20	0.85197	4.44906	2.99719
	30	1.00870	4.29233	2.68262		30	0.84976	4.45127	3.00164
	40	1.00550	4.29553	2.68903		40	0.84755	4.45348	3.00608
	50	1.00233	4.29870	2.69538		50	0.84535	4.45568	3.01049
23	0	0.99918	4.30185	2.70170	33	0	0.84317	4.45786	3.01488
	10	0.99606	4.30497	2.70796		10	0.84100	4.46003	3.01925
	20	0.99296	4.30807	2.71418		20	0.83884	4.46219	3.02360
	30	0.98988	4.31115	2.72036		30	0.83669	4.46434	3.02792
	40	0.98682	4.31421	2.72649		40	0.83455	4.46648	3.03222
	50	0.98378	4.31725	2.73258		50	0.83242	4.46861	3.03651
24	0	0.98077	4.32026	2.73863	34	0	0.83030	4.47073	3.04077
	10	0.97777	4.32326	2.74464		10	0.82819	4.47284	3.04501
	20	0.97480	4.32623	2.75060		20	0.82609	4.47494	3.04922
	30	0.97184	4.32919	2.75652		30	0.82401	4.47702	3.05342
	40	0.96891	4.33212	2.76241		40	0.82193	4.47910	3.05760
	50	0.96600	4.33503	2.76825		50	0.81986	4.48117	3.06176
25	0	0.96310	4.33793	2.77405	35	0	0.81780	4.48323	3.06590
	10	0.96023	4.34080	2.77982		10	0.81576	4.48527	3.07001
	20	0.95738	4.34365	2.78555		20	0.81372	4.48731	3.07411
	30	0.95454	4.34649	2.79124		30	0.81169	4.48934	3.07819
	40	0.95172	4.34931	2.79689		40	0.80967	4.49136	3.08225
	50	0.94892	4.35211	2.80251		50	0.80767	4.49336	3.08629
26	0	0.94614	4.35489	2.80809	36	0	0.80567	4.49536	3.09032
	10	0.94338	4.35765	2.81363		10	0.80368	4.49735	3.09432
	20	0.94063	4.36040	2.81914		20	0.80170	4.49933	3.09831
	30	0.93790	4.36313	2.82461		30	0.79973	4.50130	3.10227
	40	0.93519	4.36584	2.83005		40	0.79777	4.50326	3.10622
	50	0.93250	4.36853	2.83546		50	0.79581	4.50522	3.11015
27	0	0.92982	4.37121	2.84083	37	0	0.79387	4.50716	3.11406
	10	0.92716	4.37387	2.84617		10	0.79193	4.50910	3.11796
	20	0.92452	4.37651	2.85148		20	0.79001	4.51102	3.12184
	30	0.92189	4.37914	2.85675		30	0.78809	4.51294	3.12570
	40	0.91928	4.38175	2.86199		40	0.78618	4.51485	3.12954
	50	0.91669	4.38434	2.86720		50	0.78428	4.51675	3.13337
28	0	0.91411	4.38692	2.87238	38	0	0.78239	4.51864	3.13718
	10	0.91154	4.38949	2.87753		10	0.78051	4.52052	3.14097
	20	0.90899	4.39204	2.88265		20	0.77863	4.52240	3.14475
	30	0.90646	4.39457	2.88773		30	0.77677	4.52426	3.14850
	40	0.90394	4.39709	2.89279		40	0.77491	4.52612	3.15225
	50	0.90143	4.39960	2.89782		50	0.77306	4.52797	3.15597
29	0	0.89894	4.40209	2.90282	39	0	0.77122	4.52981	3.15969
	10	0.89647	4.40456	2.90779		10	0.76938	4.53165	3.16338
	20	0.89401	4.40702	2.91273		20	0.76756	4.53347	3.16706
	30	0.89158	4.40947	2.91765		30	0.76574	4.53529	3.17072
	40	0.88913	4.41190	2.92254		40	0.76393	4.53710	3.17437
	50	0.88671	4.41432	2.92739		50	0.76212	4.53891	3.17800

Table XXI. For finding the Latitude by two Altitudes of the Sun.

0 HOUR.									
M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
40	0	0.76033	4.54070	3.18162	50	0	0.66466	4.63637	3.37482
	10	0.75854	4.54249	3.18522		10	0.66324	4.63779	3.37770
	20	0.75676	4.54427	3.18881		20	0.66182	4.63921	3.38057
	30	0.75499	4.54604	3.19238		30	0.66041	4.64062	3.38343
	40	0.75323	4.54780	3.19594		40	0.65900	4.64203	3.38628
	50	0.75147	4.54956	3.19949		50	0.65760	4.64343	3.38912
41	0	0.74972	4.55131	3.20301	51	0	0.65620	4.64483	3.39195
	10	0.74797	4.55306	3.20653		10	0.65481	4.64622	3.39477
	20	0.74624	4.55479	3.21003		20	0.65342	4.64761	3.39759
	30	0.74451	4.55652	3.21351		30	0.65204	4.64899	3.40039
	40	0.74279	4.55824	3.21699		40	0.65066	4.65037	3.40319
	50	0.74107	4.55996	3.22044		50	0.64928	4.65175	3.40597
42	0	0.73937	4.56166	3.22389	52	0	0.64791	4.65312	3.40875
	10	0.73767	4.56336	3.22732		10	0.64655	4.65448	3.41152
	20	0.73597	4.56506	3.23073		20	0.64519	4.65584	3.41427
	30	0.73429	4.56674	3.23414		30	0.64383	4.65720	3.41702
	40	0.73261	4.56842	3.23753		40	0.64248	4.65855	3.41976
	50	0.73093	4.57010	3.24090		50	0.64113	4.65990	3.42250
43	0	0.72927	4.57176	3.24427	53	0	0.63978	4.66125	3.42522
	10	0.72760	4.57343	3.24762		10	0.63845	4.66258	3.42794
	20	0.72595	4.57508	3.25095		20	0.63711	4.66392	3.43064
	30	0.72430	4.57673	3.25428		30	0.63578	4.66525	3.43334
	40	0.72266	4.57837	3.25759		40	0.63445	4.66658	3.43603
	50	0.72103	4.58000	3.26089		50	0.63313	4.66790	3.43871
44	0	0.71940	4.58163	3.26418	54	0	0.63181	4.66922	3.44138
	10	0.71778	4.58325	3.26745		10	0.63050	4.67053	3.44405
	20	0.71616	4.58487	3.27071		20	0.62919	4.67184	3.44670
	30	0.71455	4.58648	3.27396		30	0.62789	4.67314	3.44935
	40	0.71295	4.58808	3.27720		40	0.62659	4.67444	3.45199
	50	0.71136	4.58967	3.28042		50	0.62529	4.67574	3.45462
45	0	0.70976	4.59127	3.28363	55	0	0.62400	4.67703	3.45724
	10	0.70818	4.59285	3.28683		10	0.62271	4.67832	3.45986
	20	0.70660	4.59443	3.29002		20	0.62142	4.67961	3.46247
	30	0.70503	4.59600	3.29320		30	0.62014	4.68089	3.46507
	40	0.70346	4.59757	3.29637		40	0.61887	4.68216	3.46766
	50	0.70190	4.59913	3.29952		50	0.61759	4.68344	3.47024
46	0	0.70034	4.60069	3.30266	56	0	0.61632	4.68471	3.47282
	10	0.69880	4.60223	3.30579		10	0.61506	4.68597	3.47539
	20	0.69725	4.60378	3.30891		20	0.61380	4.68723	3.47795
	30	0.69571	4.60532	3.31202		30	0.61254	4.68849	3.48050
	40	0.69418	4.60685	3.31512		40	0.61129	4.68974	3.48305
	50	0.69265	4.60838	3.31820		50	0.61004	4.69099	3.48558
47	0	0.69113	4.60990	3.32128	57	0	0.60879	4.69224	3.48811
	10	0.68962	4.61141	3.32434		10	0.60755	4.69348	3.49064
	20	0.68811	4.61292	3.32739		20	0.60631	4.69472	3.49315
	30	0.68660	4.61443	3.33044		30	0.60508	4.69595	3.49566
	40	0.68510	4.61593	3.33347		40	0.60385	4.69718	3.49816
	50	0.68361	4.61742	3.33649		50	0.60262	4.69841	3.50066
48	0	0.68212	4.61891	3.33950	58	0	0.60140	4.69963	3.50314
	10	0.68064	4.62039	3.34250		10	0.60018	4.70085	3.50562
	20	0.67916	4.62187	3.34549		20	0.59897	4.70206	3.50809
	30	0.67769	4.62334	3.34847		30	0.59775	4.70328	3.51056
	40	0.67622	4.62481	3.35144		40	0.59654	4.70449	3.51301
	50	0.67476	4.62627	3.35439		50	0.59534	4.70569	3.51547
49	0	0.67330	4.62773	3.35734	59	0	0.59414	4.70689	3.51791
	10	0.67185	4.62918	3.36028		10	0.59294	4.70809	3.52035
	20	0.67040	4.63063	3.36321		20	0.59175	4.70928	3.52278
	30	0.66896	4.63207	3.36613		30	0.59056	4.71047	3.52520
	40	0.66752	4.63351	3.36903		40	0.58937	4.71166	3.52761
	50	0.66609	4.63494	3.37193		50	0.58818	4.71285	3.53002

M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
		1 HOUR.							
0	0	0.58700	4.71403	3.53243	10	0	0.52186	4.77917	3.66542
	10	0.58583	4.71520	3.53482		10	0.52086	4.78017	3.66747
	20	0.58465	4.71638	3.53721		20	0.51986	4.78117	3.66952
	30	0.58348	4.71755	3.53959		30	0.51886	4.78217	3.67156
	40	0.58232	4.71871	3.54197		40	0.51787	4.78316	3.67359
	50	0.58115	4.71988	3.54434		50	0.51688	4.78415	3.67562
1	0	0.57999	4.72104	3.54670	11	0	0.51589	4.78514	3.67765
	10	0.57884	4.72219	3.54905		10	0.51491	4.78612	3.67967
	20	0.57768	4.72335	3.55140		20	0.51393	4.78710	3.68168
	30	0.57653	4.72450	3.55375		30	0.51294	4.78809	3.68369
	40	0.57539	4.72564	3.55608		40	0.51197	4.78906	3.68570
	50	0.57424	4.72679	3.55841		50	0.51099	4.79004	3.68770
2	0	0.57310	4.72793	3.56074	12	0	0.51002	4.79101	3.68969
	10	0.57196	4.72907	3.56306		10	0.50905	4.79198	3.69169
	20	0.57083	4.73020	3.56537		20	0.50808	4.79295	3.69367
	30	0.56970	4.73133	3.56767		30	0.50711	4.79392	3.69566
	40	0.56857	4.73246	3.56997		40	0.50615	4.79488	3.69763
	50	0.56745	4.73358	3.57226		50	0.50519	4.79584	3.69961
3	0	0.56633	4.73470	3.57455	13	0	0.50423	4.79680	3.70158
	10	0.56521	4.73582	3.57683		10	0.50327	4.79776	3.70354
	20	0.56409	4.73694	3.57910		20	0.50232	4.79871	3.70550
	30	0.56298	4.73805	3.58137		30	0.50137	4.79966	3.70745
	40	0.56187	4.73916	3.58363		40	0.50042	4.80061	3.70940
	50	0.56076	4.74027	3.58589		50	0.49947	4.80156	3.71135
4	0	0.55966	4.74137	3.58814	14	0	0.49852	4.80251	3.71329
	10	0.55856	4.74247	3.59038		10	0.49758	4.80345	3.71523
	20	0.55747	4.74356	3.59262		20	0.49664	4.80439	3.71716
	30	0.55637	4.74466	3.59486		30	0.49570	4.80533	3.71909
	40	0.55528	4.74575	3.59708		40	0.49477	4.80626	3.72101
	50	0.55419	4.74684	3.59930		50	0.49383	4.80720	3.72293
5	0	0.55311	4.74792	3.60152	15	0	0.49290	4.80813	3.72485
	10	0.55203	4.74900	3.60373		10	0.49197	4.80906	3.72676
	20	0.55095	4.75008	3.60593		20	0.49104	4.80999	3.72867
	30	0.54987	4.75116	3.60813		30	0.49012	4.81091	3.73057
	40	0.54880	4.75223	3.61032		40	0.48920	4.81183	3.73247
	50	0.54773	4.75330	3.61251		50	0.48828	4.81275	3.73436
6	0	0.54666	4.75437	3.61469	16	0	0.48736	4.81367	3.73625
	10	0.54559	4.75544	3.61686		10	0.48644	4.81459	3.73813
	20	0.54453	4.75650	3.61903		20	0.48553	4.81550	3.74001
	30	0.54347	4.75756	3.62120		30	0.48462	4.81641	3.74189
	40	0.54242	4.75861	3.62336		40	0.48371	4.81732	3.74376
	50	0.54136	4.75967	3.62551		50	0.48280	4.81823	3.74563
7	0	0.54031	4.76072	3.62766	17	0	0.48189	4.81914	3.74750
	10	0.53926	4.76177	3.62980		10	0.48099	4.82004	3.74936
	20	0.53822	4.76281	3.63194		20	0.48009	4.82094	3.75121
	30	0.53718	4.76385	3.63407		30	0.47919	4.82184	3.75307
	40	0.53614	4.76489	3.63620		40	0.47829	4.82274	3.75491
	50	0.53510	4.76593	3.63832		50	0.47740	4.82363	3.75676
8	0	0.53406	4.76697	3.64043	18	0	0.47650	4.82453	3.75860
	10	0.53303	4.76800	3.64254		10	0.47561	4.82542	3.76043
	20	0.53200	4.76903	3.64465		20	0.47473	4.82630	3.76227
	30	0.53098	4.77005	3.64675		30	0.47384	4.82719	3.76409
	40	0.52995	4.77108	3.64885		40	0.47295	4.82808	3.76592
	50	0.52893	4.77210	3.65094		50	0.47207	4.82896	3.76774
9	0	0.52791	4.77312	3.65302	19	0	0.47119	4.82984	3.76955
	10	0.52690	4.77413	3.65510		10	0.47031	4.83072	3.77137
	20	0.52589	4.77514	3.65717		20	0.46944	4.83159	3.77318
	30	0.52487	4.77616	3.65924		30	0.46856	4.83247	3.77498
	40	0.52384	4.77716	3.66131		40	0.46769	4.83334	3.77678
	50	0.52286	4.77817	3.66337		50	0.46682	4.83421	3.77858

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

1 HOUR.

M.	S.	Log ½ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ela Time.	Log Mid Time.	Logarith Rising.
20	0	0.46595	4.83508	3.78037	30	0	0.41716	4.88387	3.88150
	10	0.46508	4.83595	3.78216		10	0.41640	4.88463	3.88309
	20	0.46422	4.83681	3.78395		20	0.41564	4.88539	3.88467
	30	0.46335	4.83768	3.78573		30	0.41488	4.88615	3.88625
	40	0.46249	4.83854	3.78750		40	0.41412	4.88691	3.88783
	50	0.46163	4.83940	3.78928		50	0.41337	4.88766	3.88940
21	0	0.46078	4.84025	3.79105	31	0	0.41261	4.88842	3.89097
	10	0.45992	4.84111	3.79282		10	0.41186	4.88917	3.89254
	20	0.45907	4.84196	3.79458		20	0.41111	4.88992	3.89411
	30	0.45822	4.84281	3.79634		30	0.41036	4.89067	3.89567
	40	0.45737	4.84366	3.79809		40	0.40961	4.89142	3.89723
	50	0.45652	4.84451	3.79985		50	0.40887	4.89216	3.89879
22	0	0.45567	4.84536	3.80159	32	0	0.40812	4.89291	3.90034
	10	0.45483	4.84620	3.80334		10	0.40738	4.89365	3.90189
	20	0.45399	4.84704	3.80508		20	0.40664	4.89439	3.90344
	30	0.45315	4.84788	3.80682		30	0.40590	4.89513	3.90498
	40	0.45231	4.84872	3.80855		40	0.40516	4.89587	3.90653
	50	0.45147	4.84956	3.81028		50	0.40442	4.89661	3.90807
23	0	0.45064	4.85039	3.81201	33	0	0.40368	4.89735	3.90960
	10	0.44981	4.85122	3.81373		10	0.40295	4.89808	3.91114
	20	0.44898	4.85205	3.81545		20	0.40222	4.89881	3.91267
	30	0.44815	4.85288	3.81717		30	0.40149	4.89954	3.91420
	40	0.44732	4.85371	3.81888		40	0.40076	4.90027	3.91572
	50	0.44649	4.85454	3.82059		50	0.40003	4.90100	3.91724
24	0	0.44567	4.85536	3.82230	34	0	0.39930	4.90173	3.91876
	10	0.44485	4.85618	3.82400		10	0.39857	4.90246	3.92028
	20	0.44403	4.85700	3.82570		20	0.39785	4.90318	3.92179
	30	0.44321	4.85782	3.82739		30	0.39713	4.90390	3.92331
	40	0.44239	4.85864	3.82908		40	0.39641	4.90462	3.92482
	50	0.44158	4.85945	3.83077		50	0.39569	4.90534	3.92632
25	0	0.44077	4.86026	3.83246	35	0	0.39497	4.90606	3.92782
	10	0.43995	4.86108	3.83414		10	0.39425	4.90678	3.92933
	20	0.43915	4.86188	3.83582		20	0.39354	4.90749	3.93082
	30	0.43834	4.86269	3.83749		30	0.39282	4.90821	3.93232
	40	0.43753	4.86350	3.83917		40	0.39211	4.90892	3.93381
	50	0.43673	4.86430	3.84083		50	0.39140	4.90963	3.93530
26	0	0.43592	4.86511	3.84250	36	0	0.39069	4.91034	3.93679
	10	0.43512	4.86591	3.84416		10	0.38998	4.91105	3.93827
	20	0.43432	4.86671	3.84582		20	0.38927	4.91176	3.93975
	30	0.43353	4.86750	3.84748		30	0.38856	4.91247	3.94123
	40	0.43273	4.86830	3.84913		40	0.38786	4.91317	3.94271
	50	0.43194	4.86909	3.85078		50	0.38716	4.91387	3.94418
27	0	0.43114	4.86989	3.85242	37	0	0.38646	4.91457	3.94566
	10	0.43035	4.87068	3.85406		10	0.38575	4.91528	3.94712
	20	0.42956	4.87147	3.85570		20	0.38506	4.91597	3.94859
	30	0.42878	4.87225	3.85734		30	0.38436	4.91667	3.95005
	40	0.42799	4.87304	3.85897		40	0.38366	4.91737	3.95152
	50	0.42721	4.87382	3.86060		50	0.38297	4.91806	3.95297
28	0	0.42642	4.87461	3.86223	38	0	0.38227	4.91876	3.95443
	10	0.42564	4.87539	3.86385		10	0.38158	4.91945	3.95588
	20	0.42486	4.87617	3.86547		20	0.38089	4.92014	3.95733
	30	0.42409	4.87694	3.86709		30	0.38020	4.92083	3.95878
	40	0.42331	4.87772	3.86870		40	0.37951	4.92152	3.96023
	50	0.42254	4.87849	3.87031		50	0.37882	4.92221	3.96167
29	0	0.42176	4.87927	3.87192	39	0	0.37814	4.92289	3.96311
	10	0.42099	4.88004	3.87352		10	0.37745	4.92358	3.96455
	20	0.42022	4.88081	3.87513		20	0.37677	4.92426	3.96599
	30	0.41945	4.88158	3.87672		30	0.37609	4.92494	3.96742
	40	0.41869	4.88234	3.87832		40	0.37541	4.92562	3.96885
	50	0.41792	4.88311	3.87991		50	0.37473	4.92630	3.97028

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

1 HOUR.

M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
40	0	0.37405	4.92698	3.97170	50	0	0.33559	4.96544	4.05304
	10	0.37338	4.92765	3.97313		10	0.33499	4.96604	4.05433
	20	0.37270	4.92833	3.97455		20	0.33438	4.96665	4.05561
	30	0.37203	4.92900	3.97597		30	0.33378	4.96725	4.05690
	40	0.37135	4.92968	3.97738		40	0.33318	4.96785	4.05818
	50	0.37068	4.93035	3.97880		50	0.33257	4.96846	4.05946
41	0	0.37001	4.93102	3.98021	51	0	0.33197	4.96906	4.06074
	10	0.36934	4.93169	3.98162		10	0.33137	4.96966	4.06202
	20	0.36867	4.93236	3.98302		20	0.33078	4.97025	4.06330
	30	0.36801	4.93302	3.98443		30	0.33018	4.97085	4.06457
	40	0.36734	4.93369	3.98583		40	0.32958	4.97145	4.06584
	50	0.36668	4.93435	3.98723		50	0.32899	4.97204	4.06711
42	0	0.36602	4.93501	3.98862	52	0	0.32839	4.97264	4.06838
	10	0.36535	4.93568	3.99002		10	0.32780	4.97323	4.06965
	20	0.36469	4.93634	3.99141		20	0.32720	4.97383	4.07091
	30	0.36403	4.93700	3.99280		30	0.32661	4.97442	4.07217
	40	0.36338	4.93765	3.99419		40	0.32602	4.97501	4.07343
	50	0.36272	4.93831	3.99557		50	0.32543	4.97560	4.07469
43	0	0.36206	4.93897	3.99696	53	0	0.32485	4.97618	4.07595
	10	0.36141	4.93962	3.99834		10	0.32426	4.97677	4.07720
	20	0.36076	4.94027	3.99972		20	0.32367	4.97736	4.07845
	30	0.36011	4.94092	4.00109		30	0.32309	4.97794	4.07970
	40	0.35946	4.94157	4.00247		40	0.32250	4.97853	4.08095
	50	0.35881	4.94222	4.00384		50	0.32192	4.97911	4.08220
44	0	0.35816	4.94287	4.00521	54	0	0.32134	4.97969	4.08344
	10	0.35751	4.94352	4.00657		10	0.32076	4.98027	4.08468
	20	0.35687	4.94416	4.00794		20	0.32018	4.98085	4.08592
	30	0.35622	4.94481	4.00930		30	0.31960	4.98143	4.08716
	40	0.35558	4.94545	4.01066		40	0.31902	4.98201	4.08840
	50	0.35494	4.94609	4.01202		50	0.31844	4.98259	4.08964
45	0	0.35429	4.94674	4.01337	55	0	0.31787	4.98316	4.09087
	10	0.35365	4.94738	4.01473		10	0.31729	4.98374	4.09210
	20	0.35302	4.94801	4.01608		20	0.31672	4.98431	4.09333
	30	0.35238	4.94865	4.01743		30	0.31614	4.98489	4.09456
	40	0.35174	4.94929	4.01877		40	0.31557	4.98546	4.09578
	50	0.35111	4.94992	4.02012		50	0.31500	4.98603	4.09701
46	0	0.35047	4.95056	4.02146	56	0	0.31443	4.98660	4.09823
	10	0.34984	4.95119	4.02280		10	0.31386	4.98717	4.09945
	20	0.34921	4.95182	4.02414		20	0.31329	4.98774	4.10067
	30	0.34858	4.95245	4.02547		30	0.31272	4.98831	4.10188
	40	0.34795	4.95308	4.02681		40	0.31216	4.98887	4.10310
	50	0.34732	4.95371	4.02814		50	0.31159	4.98944	4.10431
47	0	0.34669	4.95434	4.02947	57	0	0.31103	4.99000	4.10552
	10	0.34607	4.95496	4.03080		10	0.31046	4.99057	4.10673
	20	0.34544	4.95559	4.03212		20	0.30990	4.99113	4.10794
	30	0.34482	4.95621	4.03344		30	0.30934	4.99169	4.10915
	40	0.34420	4.95683	4.03477		40	0.30878	4.99225	4.11035
	50	0.34357	4.95746	4.03608		50	0.30822	4.99281	4.11155
48	0	0.34295	4.95808	4.03740	58	0	0.30766	4.99337	4.11275
	10	0.34233	4.95870	4.03871		10	0.30710	4.99393	4.11395
	20	0.34172	4.95931	4.04003		20	0.30655	4.99448	4.11515
	30	0.34110	4.95993	4.04134		30	0.30599	4.99504	4.11634
	40	0.34048	4.96055	4.04265		40	0.30544	4.99559	4.11754
	50	0.33987	4.96116	4.04395		50	0.30488	4.99615	4.11873
49	0	0.33925	4.96178	4.04526	59	0	0.30433	4.99670	4.11992
	10	0.33864	4.96239	4.04656		10	0.30378	4.99725	4.12111
	20	0.33803	4.96300	4.04786		20	0.30323	4.99780	4.12229
	30	0.33742	4.96361	4.04916		30	0.30268	4.99835	4.12348
	40	0.33681	4.96422	4.05045		40	0.30213	4.99890	4.12466
	50	0.33620	4.96483	4.05175		50	0.30158	4.99945	4.12584

2 HOURS.									
M.	S.	Log ½ ela Time	Log Mid Time.	Logarith. Rising.	M.	S.	Log ½ ela Time.	Log Mid Time	Logarith Rising.
0	0	0.30103	5.00000	4.12702	10	0	0.26978	5.03125	4.19482
	10	0.30048	5.00055	4.12820		10	0.26929	5.03174	4.19590
	20	0.29994	5.00109	4.12938		20	0.26879	5.03224	4.19698
	30	0.29939	5.00164	4.13055		30	0.26830	5.03273	4.19806
	40	0.29885	5.00218	4.13172		40	0.26781	5.03322	4.19914
	50	0.29831	5.00272	4.13289		50	0.26731	5.03372	4.20022
1	0	0.29776	5.00327	4.13406	11	0	0.26682	5.03421	4.20129
	10	0.29722	5.00381	4.13523		10	0.26633	5.03470	4.20236
	20	0.29668	5.00435	4.13640		20	0.26584	5.03519	4.20344
	30	0.29614	5.00489	4.13756		30	0.26535	5.03568	4.20451
	40	0.29561	5.00542	4.13872		40	0.26487	5.03616	4.20558
	50	0.29507	5.00596	4.13989		50	0.26438	5.03665	4.20665
2	0	0.29453	5.00650	4.14104	12	0	0.26389	5.03714	4.20771
	10	0.29400	5.00703	4.14220		10	0.26341	5.03762	4.20878
	20	0.29346	5.00757	4.14336		20	0.26292	5.03811	4.20984
	30	0.29293	5.00810	4.14451		30	0.26244	5.03859	4.21091
	40	0.29239	5.00864	4.14567		40	0.26195	5.03908	4.21197
	50	0.29186	5.00917	4.14682		50	0.26147	5.03956	4.21303
3	0	0.29133	5.00970	4.14797	13	0	0.26099	5.04004	4.21409
	10	0.29080	5.01023	4.14911		10	0.26051	5.04052	4.21514
	20	0.29027	5.01076	4.15026		20	0.26003	5.04100	4.21620
	30	0.28974	5.01129	4.15140		30	0.25955	5.04148	4.21725
	40	0.28921	5.01182	4.15255		40	0.25907	5.04196	4.21831
	50	0.28869	5.01234	4.15369		50	0.25859	5.04244	4.21936
4	0	0.28816	5.01287	4.15483	14	0	0.25811	5.04292	4.22041
	10	0.28764	5.01339	4.15597		10	0.25763	5.04340	4.22146
	20	0.28711	5.01392	4.15710		20	0.25716	5.04387	4.22250
	30	0.28659	5.01444	4.15824		30	0.25668	5.04435	4.22355
	40	0.28607	5.01496	4.15937		40	0.25621	5.04482	4.22459
	50	0.28554	5.01549	4.16050		50	0.25573	5.04530	4.22564
5	0	0.28502	5.01601	4.16163	15	0	0.25526	5.04577	4.22668
	10	0.28450	5.01653	4.16276		10	0.25479	5.04624	4.22772
	20	0.28398	5.01705	4.16389		20	0.25432	5.04671	4.22876
	30	0.28346	5.01757	4.16501		30	0.25385	5.04718	4.22980
	40	0.28295	5.01808	4.16614		40	0.25338	5.04765	4.23083
	50	0.28243	5.01860	4.16726		50	0.25291	5.04812	4.23187
6	0	0.28191	5.01912	4.16838	16	0	0.25244	5.04859	4.23290
	10	0.28140	5.01963	4.16950		10	0.25197	5.04906	4.23393
	20	0.28089	5.02014	4.17062		20	0.25150	5.04953	4.23496
	30	0.28037	5.02066	4.17173		30	0.25104	5.04999	4.23599
	40	0.27986	5.02117	4.17285		40	0.25057	5.05046	4.23702
	50	0.27935	5.02168	4.17396		50	0.25011	5.05092	4.23805
7	0	0.27884	5.02219	4.17507	17	0	0.24964	5.05139	4.23907
	10	0.27833	5.02270	4.17618		10	0.24918	5.05185	4.24010
	20	0.27782	5.02321	4.17729		20	0.24872	5.05231	4.24112
	30	0.27731	5.02372	4.17840		30	0.24825	5.05278	4.24214
	40	0.27680	5.02423	4.17950		40	0.24779	5.05324	4.24316
	50	0.27630	5.02473	4.18060		50	0.24733	5.05370	4.24418
8	0	0.27579	5.02524	4.18171	18	0	0.24687	5.05416	4.24520
	10	0.27529	5.02574	4.18281		10	0.24641	5.05462	4.24622
	20	0.27478	5.02625	4.18391		20	0.24595	5.05508	4.24723
	30	0.27428	5.02675	4.18500		30	0.24550	5.05553	4.24825
	40	0.27378	5.02725	4.18610		40	0.24504	5.05599	4.24926
	50	0.27327	5.02776	4.18719		50	0.24458	5.05645	4.25027
9	0	0.27277	5.02826	4.18829	19	0	0.24413	5.05690	4.25128
	10	0.27227	5.02876	4.18938		10	0.24367	5.05736	4.25229
	20	0.27177	5.02926	4.19047		20	0.24322	5.05781	4.25330
	30	0.27127	5.02976	4.19156		30	0.24276	5.05827	4.25430
	40	0.27078	5.03025	4.19265		40	0.24231	5.05872	4.25531
	50	0.27028	5.03075	4.19373		50	0.24186	5.05917	4.25631

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

2 HOURS.

M.	S.	Log½ela Time.	Log Mid Time.	ogarith Rising.	M.	S.	Log½ela Time.	Log Mid Time.	Logarith Rising.
20	0	0.24141	5.05962	4.25731	30	0	0.21555	5.08548	4.31523
	10	0.24096	5.06007	4.25831		10	0.21514	5.08589	4.31616
	20	0.24051	5.06052	4.25931		20	0.21473	5.08630	4.31709
	30	0.24006	5.06097	4.26031		30	0.21432	5.08671	4.31801
	40	0.23961	5.06142	4.26131		40	0.21391	5.08712	4.31894
	50	0.23916	5.06187	4.26231		50	0.21350	5.08753	4.31987
21	0	0.23871	5.06232	4.26330	31	0	0.21309	5.08794	4.32079
	10	0.23827	5.06276	4.26429		10	0.21269	5.08834	4.32171
	20	0.23782	5.06321	4.26529		20	0.21228	5.08875	4.32264
	30	0.23738	5.06365	4.26628		30	0.21187	5.08916	4.32356
	40	0.23693	5.06410	4.26727		40	0.21147	5.08956	4.32448
	50	0.23649	5.06454	4.26826		50	0.21106	5.08997	4.32540
22	0	0.23605	5.06498	4.26924	32	0	0.21066	5.09037	4.32631
	10	0.23560	5.06543	4.27023		10	0.21025	5.09078	4.32723
	20	0.23516	5.06587	4.27121		20	0.20985	5.09118	4.32815
	30	0.23472	5.06631	4.27220		30	0.20945	5.09158	4.32906
	40	0.23428	5.06675	4.27318		40	0.20905	5.09198	4.32997
	50	0.23384	5.06719	4.27416		50	0.20864	5.09239	4.33089
23	0	0.23340	5.06763	4.27514	33	0	0.20824	5.09279	4.33180
	10	0.23296	5.06807	4.27612		10	0.20784	5.09319	4.33271
	20	0.23253	5.06850	4.27710		20	0.20744	5.09359	4.33362
	30	0.23209	5.06894	4.27807		30	0.20704	5.09399	4.33453
	40	0.23165	5.06938	4.27905		40	0.20663	5.09438	4.33543
	50	0.23122	5.06981	4.28002		50	0.20625	5.09478	4.33634
24	0	0.23078	5.07025	4.28099	34	0	0.20585	5.09518	4.33724
	10	0.23035	5.07068	4.28197		10	0.20545	5.09558	4.33815
	20	0.22991	5.07112	4.28294		20	0.20506	5.09597	4.33905
	30	0.22948	5.07155	4.28391		30	0.20466	5.09637	4.33995
	40	0.22905	5.07198	4.28487		40	0.20427	5.09676	4.34085
	50	0.22862	5.07241	4.28584		50	0.20387	5.09716	4.34175
25	0	0.22819	5.07284	4.28681	35	0	0.20348	5.09755	4.34265
	10	0.22775	5.07328	4.28777		10	0.20309	5.09794	4.34355
	20	0.22732	5.07371	4.28873		20	0.20269	5.09834	4.34444
	30	0.22690	5.07413	4.28969		30	0.20230	5.09873	4.34534
	40	0.22647	5.07456	4.29066		40	0.20191	5.09912	4.34623
	50	0.22604	5.07499	4.29161		50	0.20152	5.09951	4.34713
26	0	0.22561	5.07542	4.29257	36	0	0.20113	5.09990	4.34802
	10	0.22519	5.07584	4.29353		10	0.20074	5.10029	4.34891
	20	0.22476	5.07627	4.29449		20	0.20035	5.10068	4.34980
	30	0.22433	5.07670	4.29544		30	0.19996	5.10107	4.35069
	40	0.22391	5.07712	4.29639		40	0.19957	5.10146	4.35158
	50	0.22349	5.07754	4.29735		50	0.19919	5.10184	4.35247
27	0	0.22306	5.07797	4.29830	37	0	0.19880	5.10223	4.35335
	10	0.22264	5.07839	4.29925		10	0.19841	5.10262	4.35424
	20	0.22222	5.07881	4.30020		20	0.19803	5.10300	4.35512
	30	0.22180	5.07923	4.30115		30	0.19764	5.10339	4.35601
	40	0.22138	5.07965	4.30209		40	0.19726	5.10377	4.35689
	50	0.22096	5.08007	4.30304		50	0.19687	5.10416	4.35777
28	0	0.22054	5.08049	4.30398	38	0	0.19649	5.10454	4.35865
	10	0.22012	5.08091	4.30493		10	0.19611	5.10492	4.35953
	20	0.21970	5.08133	4.30587		20	0.19572	5.10531	4.36041
	30	0.21928	5.08175	4.30681		30	0.19534	5.10569	4.36128
	40	0.21887	5.08216	4.30775		40	0.19496	5.10607	4.36216
	50	0.21845	5.08258	4.30869		50	0.19458	5.10645	4.36304
29	0	0.21803	5.08300	4.30963	39	0	0.19420	5.10683	4.36391
	10	0.21762	5.08341	4.31056		10	0.19382	5.10721	4.36478
	20	0.21720	5.08383	4.31150		20	0.19344	5.10759	4.36565
	30	0.21679	5.08424	4.31243		30	0.19306	5.10797	4.36653
	40	0.21638	5.08465	4.31337		40	0.19269	5.10834	4.36740
	50	0.21596	5.08507	4.31430		50	0.19231	5.10872	4.36827

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

2 HOURS.

M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
40	0	0.19193	5.10910	4.36913	50	0	0.17032	5.13071	4.41950
	10	0.19156	5.10947	4.37000		10	0.16997	5.13106	4.42031
	20	0.19118	5.10985	4.37087		20	0.16963	5.13140	4.42112
	30	0.19081	5.11022	4.37173		30	0.16928	5.13175	4.42193
	40	0.19043	5.11060	4.37260		40	0.16894	5.13209	4.42274
	50	0.19006	5.11097	4.37346		50	0.16860	5.13243	4.42355
41	0	0.18968	5.11135	4.37432	51	0	0.16826	5.13277	4.42435
	10	0.18931	5.11172	4.37518		10	0.16792	5.13311	4.42516
	20	0.18894	5.11209	4.37604		20	0.16758	5.13345	4.42597
	30	0.18857	5.11246	4.37690		30	0.16723	5.13380	4.42677
	40	0.18820	5.11283	4.37776		40	0.16690	5.13413	4.42758
	50	0.18783	5.11320	4.37862		50	0.16656	5.13447	4.42838
42	0	0.18746	5.11357	4.37948	52	0	0.16622	5.13481	4.42918
	10	0.18709	5.11394	4.38033		10	0.16588	5.13515	4.42998
	20	0.18672	5.11431	4.38119		20	0.16554	5.13549	4.43078
	30	0.18635	5.11468	4.38204		30	0.16520	5.13583	4.43158
	40	0.18598	5.11505	4.38289		40	0.16487	5.13616	4.43238
	50	0.18561	5.11542	4.38374		50	0.16453	5.13650	4.43318
43	0	0.18525	5.11578	4.38460	53	0	0.16419	5.13684	4.43398
	10	0.18488	5.11615	4.38545		10	0.16386	5.13717	4.43477
	20	0.18451	5.11652	4.38629		20	0.16352	5.13751	4.43557
	30	0.18415	5.11688	4.38714		30	0.16319	5.13784	4.43636
	40	0.18378	5.11725	4.38799		40	0.16285	5.13818	4.43716
	50	0.18342	5.11761	4.38884		50	0.16252	5.13851	4.43795
44	0	0.18306	5.11797	4.38968	54	0	0.16219	5.13884	4.43874
	10	0.18269	5.11834	4.39052		10	0.16186	5.13917	4.43953
	20	0.18233	5.11870	4.39137		20	0.16152	5.13951	4.44032
	30	0.18197	5.11906	4.39221		30	0.16119	5.13984	4.44111
	40	0.18161	5.11942	4.39305		40	0.16086	5.14017	4.44190
	50	0.18125	5.11978	4.39389		50	0.16053	5.14050	4.44269
45	0	0.18089	5.12014	4.39473	55	0	0.16020	5.14083	4.44348
	10	0.18053	5.12050	4.39557		10	0.15987	5.14116	4.44426
	20	0.18017	5.12086	4.39641		20	0.15954	5.14149	4.44505
	30	0.17981	5.12122	4.39725		30	0.15921	5.14182	4.44583
	40	0.17945	5.12158	4.39808		40	0.15888	5.14215	4.44662
	50	0.17909	5.12194	4.39892		50	0.15856	5.14247	4.44740
46	0	0.17874	5.12229	4.39975	56	0	0.15823	5.14280	4.44818
	10	0.17838	5.12265	4.40058		10	0.15790	5.14313	4.44896
	20	0.17802	5.12301	4.40142		20	0.15758	5.14345	4.44974
	30	0.17767	5.12336	4.40225		30	0.15725	5.14378	4.45052
	40	0.17731	5.12372	4.40308		40	0.15692	5.14411	4.45130
	50	0.17696	5.12407	4.40391		50	0.15660	5.14443	4.45208
47	0	0.17660	5.12443	4.40474	57	0	0.15627	5.14476	4.45286
	10	0.17625	5.12478	4.40556		10	0.15595	5.14508	4.45363
	20	0.17590	5.12513	4.40639		20	0.15563	5.14540	4.45441
	30	0.17554	5.12549	4.40722		30	0.15530	5.14573	4.45518
	40	0.17519	5.12584	4.40804		40	0.15498	5.14605	4.45596
	50	0.17484	5.12619	4.40887		50	0.15466	5.14637	4.45673
48	0	0.17449	5.12654	4.40969	58	0	0.15434	5.14669	4.45750
	10	0.17414	5.12689	4.41051		10	0.15402	5.14701	4.45827
	20	0.17379	5.12724	4.41133		20	0.15370	5.14733	4.45905
	30	0.17344	5.12759	4.41215		30	0.15338	5.14765	4.45982
	40	0.17309	5.12794	4.41297		40	0.15306	5.14797	4.46058
	50	0.17274	5.12829	4.41379		50	0.15274	5.14829	4.46135
49	0	0.17239	5.12864	4.41461	59	0	0.15242	5.14861	4.46212
	10	0.17205	5.12898	4.41543		10	0.15210	5.14893	4.46289
	20	0.17170	5.12933	4.41624		20	0.15178	5.14925	4.46365
	30	0.17135	5.12968	4.41706		30	0.15146	5.14957	4.46442
	40	0.17101	5.13002	4.41787		40	0.15115	5.14988	4.46518
	50	0.17066	5.13037	4.41868		50	0.15083	5.15020	4.46595

Table XXI. For finding the Latitude by two Altitudes of the Sun.

3 HOURS.

M.	S.	Log½ela Time.	LogMid Time.	Logarith Rising.	M.	S.	Log½ela Time.	LogMid Time.	Logarith Rising.
40	0	0.08664	5.21439	4.62984	50	0	0.07397	5.22706	4.66530
	10	0.08641	5.21462	4.63045		10	0.07377	5.22726	4.66588
	20	0.08619	5.21484	4.63105		20	0.07357	5.22746	4.66645
	30	0.08597	5.21506	4.63166		30	0.07337	5.22766	4.66702
	40	0.08575	5.21528	4.63226		40	0.07317	5.22786	4.66760
	50	0.08553	5.21550	4.63287		50	0.07297	5.22806	4.66817
41	0	0.08531	5.21572	4.63347	51	0	0.07277	5.22826	4.66875
	10	0.08510	5.21593	4.63407		10	0.07257	5.22846	4.66932
	20	0.08488	5.21615	4.63468		20	0.07237	5.22866	4.66989
	30	0.08466	5.21637	4.63528		30	0.07217	5.22886	4.67046
	40	0.08444	5.21659	4.63588		40	0.07197	5.22906	4.67103
	50	0.08422	5.21681	4.63648		50	0.07178	5.22925	4.67160
42	0	0.08401	5.21702	4.63708	52	0	0.07158	5.22945	4.67217
	10	0.08379	5.21724	4.63768		10	0.07138	5.22965	4.67274
	20	0.08357	5.21746	4.63828		20	0.07119	5.22984	4.67331
	30	0.08336	5.21767	4.63888		30	0.07099	5.23004	4.67388
	40	0.08314	5.21789	4.63948		40	0.07079	5.23024	4.67445
	50	0.08293	5.21810	4.64008		50	0.07060	5.23043	4.67502
43	0	0.08271	5.21832	4.64068	53	0	0.07040	5.23063	4.67558
	10	0.08250	5.21853	4.64127		10	0.07021	5.23082	4.67615
	20	0.08228	5.21875	4.64187		20	0.07001	5.23102	4.67672
	30	0.08207	5.21896	4.64246		30	0.06982	5.23121	4.67728
	40	0.08185	5.21918	4.64306		40	0.06962	5.23141	4.67785
	50	0.08164	5.21939	4.64365		50	0.06943	5.23160	4.67841
44	0	0.08143	5.21960	4.64425	54	0	0.06923	5.23180	4.67897
	10	0.08121	5.21982	4.64484		10	0.06904	5.23199	4.67954
	20	0.08100	5.22003	4.64544		20	0.06885	5.23218	4.68010
	30	0.08079	5.22024	4.64603		30	0.06866	5.23237	4.68066
	40	0.08058	5.22045	4.64662		40	0.06846	5.23257	4.68123
	50	0.08036	5.22067	4.64721		50	0.06827	5.23276	4.68179
45	0	0.08015	5.22088	4.64780	55	0	0.06808	5.23295	4.68235
	10	0.07994	5.22109	4.64839		10	0.06789	5.23314	4.68291
	20	0.07973	5.22130	4.64898		20	0.06770	5.23333	4.68347
	30	0.07952	5.22151	4.64957		30	0.06751	5.23352	4.68403
	40	0.07931	5.22172	4.65016		40	0.06731	5.23372	4.68459
	50	0.07910	5.22193	4.65075		50	0.06712	5.23391	4.68515
46	0	0.07889	5.22214	4.65134	56	0	0.06693	5.23410	4.68571
	10	0.07868	5.22235	4.65193		10	0.06674	5.23429	4.68627
	20	0.07848	5.22255	4.65251		20	0.06656	5.23447	4.68682
	30	0.07827	5.22276	4.65310		30	0.06637	5.23466	4.68738
	40	0.07806	5.22297	4.65369		40	0.06618	5.23485	4.68794
	50	0.07785	5.22318	4.65427		50	0.06599	5.23504	4.68849
47	0	0.07765	5.22338	4.65486	57	0	0.06580	5.23523	4.68905
	10	0.07744	5.22359	4.65544		10	0.06561	5.23542	4.68960
	20	0.07723	5.22380	4.65603		20	0.06543	5.23560	4.69016
	30	0.07703	5.22400	4.65661		30	0.06524	5.23579	4.69071
	40	0.07682	5.22421	4.65719		40	0.06505	5.23598	4.69127
	50	0.07661	5.22442	4.65777		50	0.06487	5.23616	4.69182
48	0	0.07641	5.22462	4.65836	58	0	0.06468	5.23635	4.69237
	10	0.07620	5.22483	4.65894		10	0.06449	5.23654	4.69292
	20	0.07600	5.22503	4.65952		20	0.06431	5.23672	4.69348
	30	0.07579	5.22524	4.66010		30	0.06412	5.23691	4.69403
	40	0.07559	5.22544	4.66068		40	0.06394	5.23709	4.69458
	50	0.07539	5.22564	4.66126		50	0.0637[illegible]	5.23728	4.69513
49	0	0.07518	5.22585	4.66184	59	0	0.06357	5.23746	4.69568
	10	0.07498	5.22605	4.66242		10	0.06338	5.23765	4.69623
	20	0.07478	5.22625	4.66299		20	0.06320	5.23783	4.69678
	30	0.07458	5.22645	4.66357		30	0.06302	5.23801	4.69733
	40	0.07437	5.22666	4.66415		40	0.06283	5.23820	4.69788
	50	0.07417	5.22686	4.66472		50	0.06265	5.23838	4.69842

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

4 HOURS.

M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
0	0	0.06247	5.23856	4.69897	10	0	0.05207	5.24896	4.73099
	10	0.06229	5.23874	4.69952		10	0.05191	5.24912	4.73151
	20	0.06211	5.23892	4.70006		20	0.05174	5.24929	4.73203
	30	0.06192	5.23911	4.70061		30	0.05158	5.24945	4.73254
	40	0.06174	5.23929	4.70115		40	0.05142	5.24961	4.73306
	50	0.06156	5.23947	4.70170		50	0.05125	5.24978	4.73358
1	0	0.06138	5.23965	4.70224	11	0	0.05109	5.24994	4.73410
	10	0.06120	5.23983	4.70279		10	0.05093	5.25010	4.73462
	20	0.06102	5.24001	4.70333		20	0.05077	5.25026	4.73514
	30	0.06084	5.24019	4.70387		30	0.05060	5.25043	4.73565
	40	0.06066	5.24037	4.70442		40	0.05044	5.25059	4.73617
	50	0.06048	5.24055	4.70496		50	0.05028	5.25075	4.73668
2	0	0.06030	5.24073	4.70550	12	0	0.05012	5.25091	4.73720
	10	0.06012	5.24091	4.70604		10	0.04996	5.25107	4.73772
	20	0.05995	5.24108	4.70658		20	0.04980	5.25123	4.73823
	30	0.05977	5.24126	4.70712		30	0.04964	5.25139	4.73874
	40	0.05959	5.24144	4.70766		40	0.04948	5.25155	4.73926
	50	0.05941	5.24162	4.70820		50	0.04932	5.25171	4.73977
3	0	0.05924	5.24179	4.70874	13	0	0.04916	5.25187	4.74028
	10	0.05906	5.24197	4.70928		10	0.04900	5.25203	4.74080
	20	0.05888	5.24215	4.70982		20	0.04884	5.25219	4.74131
	30	0.05871	5.24232	4.71036		30	0.04868	5.25235	4.74182
	40	0.05853	5.24250	4.71089		40	0.04852	5.25251	4.74233
	50	0.05836	5.24267	4.71143		50	0.04837	5.25266	4.74284
4	0	0.05818	5.24285	4.71197	14	0	0.04821	5.25282	4.74335
	10	0.05801	5.24302	4.71250		10	0.04805	5.25298	4.74386
	20	0.05783	5.24320	4.71304		20	0.04789	5.25314	4.74437
	30	0.05766	5.24337	4.71357		30	0.04774	5.25329	4.74488
	40	0.05748	5.24355	4.71411		40	0.04758	5.25345	4.74539
	50	0.05731	5.24372	4.71464		50	0.04743	5.25360	4.74590
5	0	0.05714	5.24389	4.71518	15	0	0.04727	5.25376	4.74641
	10	0.05696	5.24407	4.71571		10	0.04711	5.25392	4.74692
	20	0.05679	5.24424	4.71624		20	0.04696	5.25407	4.74742
	30	0.05662	5.24441	4.71678		30	0.04680	5.25423	4.74793
	40	0.05645	5.24458	4.71731		40	0.04665	5.25438	4.74844
	50	0.05627	5.24476	4.71784		50	0.04649	5.25454	4.74894
6	0	0.05610	5.24493	4.71837	16	0	0.04634	5.25469	4.74945
	10	0.05593	5.24510	4.71890		10	0.04619	5.25484	4.74995
	20	0.05576	5.24527	4.71943		20	0.04603	5.25500	4.75046
	30	0.05559	5.24544	4.71996		30	0.04588	5.25515	4.75096
	40	0.05542	5.24561	4.72049		40	0.04573	5.25530	4.75147
	50	0.05525	5.24578	4.72102		50	0.04557	5.25546	4.75197
7	0	0.05508	5.24595	4.72155	17	0	0.04542	5.25561	4.75247
	10	0.05491	5.24612	4.72208		10	0.04527	5.25576	4.75298
	20	0.05474	5.24629	4.72260		20	0.04512	5.25591	4.75348
	30	0.05457	5.24646	4.72313		30	0.04496	5.25607	4.75398
	40	0.05440	5.24663	4.72366		40	0.04481	5.25622	4.75448
	50	0.05423	5.24680	4.72418		50	0.04466	5.25637	4.75498
8	0	0.05407	5.24696	4.72471	18	0	0.04451	5.25652	4.75549
	10	0.05390	5.24713	4.72523		10	0.04436	5.25667	4.75599
	20	0.05373	5.24730	4.72576		20	0.04421	5.25682	4.75649
	30	0.05356	5.24747	4.72628		30	0.04406	5.25697	4.75699
	40	0.05340	5.24763	4.72681		40	0.04391	5.25712	4.75748
	50	0.05323	5.24780	4.72733		50	0.04376	5.25727	4.75798
9	0	0.05306	5.24797	4.72785	19	0	0.04361	5.25742	4.75848
	10	0.05290	5.24813	4.72838		10	0.04346	5.25757	4.75898
	20	0.05273	5.24830	4.72890		20	0.04332	5.25771	4.75948
	30	0.05257	5.24846	4.72942		30	0.04317	5.25786	4.75997
	40	0.05240	5.2486	4.72994		40	0.04302	5.25801	4.76047
	50	0.05224	5.24879	4.73046		50	0.04287	5.25816	4.76097

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

4 HOURS.

M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
20	0	0.04272	5.25831	4.76146	30	0	0.03438	5.26665	4.79051
	10	0.04258	5.25845	4.76196		10	0.03425	5.26678	4.79098
	20	0.04243	5.25860	4.76245		20	0.03412	5.26691	4.79145
	30	0.04228	5.25875	4.76295		30	0.03399	5.26704	4.79192
	40	0.04214	5.25889	4.76344		40	0.03386	5.26717	4.79240
	50	0.04199	5.25904	4.76394		50	0.03373	5.26730	4.79287
21	0	0.04185	5.25918	4.76443	31	0	0.03360	5.26743	4.79334
	10	0.04170	5.25933	4.76492		10	0.03348	5.26755	4.79381
	20	0.04156	5.25947	4.76542		20	0.03335	5.26768	4.79428
	30	0.04141	5.25962	4.76591		30	0.03322	5.26781	4.79475
	40	0.04127	5.25976	4.76640		40	0.03309	5.26794	4.79522
	50	0.04112	5.25991	4.76689		50	0.03296	5.26807	4.79568
22	0	0.04098	5.26005	4.76738	32	0	0.03283	5.26820	4.79615
	10	0.04083	5.26020	4.76787		10	0.03271	5.26832	4.79662
	20	0.04069	5.26034	4.76836		20	0.03258	5.26845	4.79709
	30	0.04055	5.26048	4.76885		30	0.03245	5.26858	4.79756
	40	0.04040	5.26063	4.76934		40	0.03233	5.26870	4.79802
	50	0.04026	5.26077	4.76983		50	0.03220	5.26883	4.79849
23	0	0.04012	5.26091	4.77032	33	0	0.03207	5.26896	4.79896
	10	0.03998	5.26105	4.77081		10	0.03195	5.26908	4.79942
	20	0.03983	5.26120	4.77130		20	0.03182	5.26921	4.79989
	30	0.03969	5.26134	4.77179		30	0.03170	5.26933	4.80035
	40	0.03955	5.26148	4.77227		40	0.03157	5.26946	4.80082
	50	0.03941	5.26162	4.77276		50	0.03145	5.26958	4.80128
24	0	0.03927	5.26176	4.77325	34	0	0.03132	5.26971	4.80175
	10	0.03913	5.26190	4.77373		10	0.03120	5.26983	4.80221
	20	0.03899	5.26204	4.77422		20	0.03107	5.26996	4.80267
	30	0.03885	5.26218	4.77470		30	0.03095	5.27008	4.80314
	40	0.03871	5.26232	4.77519		40	0.03083	5.27020	4.80360
	50	0.03857	5.26246	4.77567		50	0.03070	5.27033	4.80406
25	0	0.03843	5.26260	4.77616	35	0	0.03058	5.27045	4.80452
	10	0.03829	5.26274	4.77664		10	0.03046	5.27057	4.80498
	20	0.03815	5.26288	4.77713		20	0.03034	5.27069	4.80545
	30	0.03802	5.26301	4.77761		30	0.03021	5.27082	4.80591
	40	0.03788	5.26315	4.77809		40	0.03009	5.27094	4.80637
	50	0.03774	5.26329	4.77857		50	0.02997	5.27106	4.80683
26	0	0.03760	5.26343	4.77906	36	0	0.02985	5.27118	4.80729
	10	0.03747	5.26356	4.77954		10	0.02973	5.27130	4.80775
	20	0.03733	5.26370	4.78002		20	0.02961	5.27142	4.80820
	30	0.03719	5.26384	4.78050		30	0.02949	5.27154	4.80866
	40	0.03706	5.26397	4.78098		40	0.02937	5.27166	4.80912
	50	0.03692	5.26411	4.78146		50	0.02925	5.27178	4.80958
27	0	0.03678	5.26425	4.78194	37	0	0.02913	5.27190	4.81004
	10	0.03665	5.26438	4.78242		10	0.02901	5.27202	4.81049
	20	0.03651	5.26452	4.78290		20	0.02889	5.27214	4.81095
	30	0.03638	5.26465	4.78338		30	0.02877	5.27226	4.81141
	40	0.03624	5.26479	4.78385		40	0.02865	5.27238	4.81186
	50	0.03611	5.26492	4.78433		50	0.02853	5.27250	4.81232
28	0	0.03597	5.26506	4.78481	38	0	0.02841	5.27262	4.81277
	10	0.03584	5.26519	4.78529		10	0.02829	5.27274	4.81323
	20	0.03571	5.26532	4.78576		20	0.02818	5.27285	4.81368
	30	0.03557	5.26546	4.78624		30	0.02806	5.27297	4.81414
	40	0.03544	5.26559	4.78671		40	0.02794	5.27309	4.81459
	50	0.03531	5.26572	4.78719		50	0.02783	5.27320	4.81505
29	0	0.03517	5.26586	4.78767	39	0	0.02771	5.27332	4.81550
	10	0.03504	5.26599	4.78814		10	0.02759	5.27344	4.81595
	20	0.03491	5.26612	4.78861		20	0.02748	5.27355	4.81641
	30	0.03478	5.26625	4.78909		30	0.02736	5.27367	4.81686
	40	0.03465	5.26638	4.78956		40	0.02724	5.27379	4.81731
	50	0.03452	5.26651	4.79004		50	0.02713	5.27390	4.81776

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

4 HOURS.									
M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
40	0	0.02701	5.27402	4.81821	50	0	0.02058	5.28045	4.84466
	10	0.02690	5.27413	4.81866		10	0.02048	5.28055	4.84509
	20	0.02678	5.27425	4.81911		20	0.02038	5.28065	4.84552
	30	0.02667	5.27436	4.81956		30	0.02028	5.28075	4.84595
	40	0.02656	5.27447	4.82001		40	0.02018	5.28085	4.84638
	50	0.02644	5.27459	4.82046		50	0.02009	5.28094	4.84681
41	0	0.02633	5.27470	4.82091	51	0	0.01999	5.28104	4.84724
	10	0.02622	5.27481	4.82136		10	0.01989	5.28114	4.84767
	20	0.02610	5.27493	4.82181		20	0.01979	5.28124	4.84810
	30	0.02599	5.27504	4.82226		30	0.01969	5.28134	4.84852
	40	0.02588	5.27515	4.82271		40	0.01960	5.28143	4.84895
	50	0.02577	5.27526	4.82315		50	0.01950	5.28153	4.84938
42	0	0.02565	5.27538	4.82360	52	0	0.01940	5.28163	4.84981
	10	0.02554	5.27549	4.82405		10	0.01931	5.28172	4.85023
	20	0.02543	5.27560	4.82449		20	0.01921	5.28182	4.85066
	30	0.02532	5.27571	4.82494		30	0.01912	5.28191	4.85108
	40	0.02521	5.27582	4.82538		40	0.01902	5.28201	4.85151
	50	0.02510	5.27593	4.82583		50	0.01892	5.28211	4.85194
43	0	0.02499	5.27604	4.82628	53	0	0.01883	5.28220	4.85236
	10	0.02488	5.27615	4.82672		10	0.01873	5.28230	4.85278
	20	0.02477	5.27626	4.82716		20	0.01864	5.28239	4.85321
	30	0.02466	5.27637	4.82761		30	0.01854	5.28249	4.85363
	40	0.02455	5.27648	4.82805		40	0.01845	5.28258	4.85406
	50	0.02444	5.27659	4.82850		50	0.01836	5.28267	4.85448
44	0	0.02433	5.27670	4.82894	54	0	0.01826	5.28277	4.85490
	10	0.02422	5.27681	4.82938		10	0.01817	5.28286	4.85533
	20	0.02411	5.27692	4.82982		20	0.01808	5.28295	4.85575
	30	0.02400	5.27703	4.83026		30	0.01798	5.28305	4.85617
	40	0.02390	5.27713	4.83071		40	0.01789	5.28314	4.85659
	50	0.02379	5.27724	4.83115		50	0.01780	5.28323	4.85701
45	0	0.02368	5.27735	4.83159	55	0	0.01771	5.28332	4.85744
	10	0.02357	5.27746	4.83203		10	0.01761	5.28342	4.85786
	20	0.02347	5.27756	4.83247		20	0.01752	5.28351	4.85828
	30	0.02336	5.27767	4.83291		30	0.01743	5.28360	4.85870
	40	0.02326	5.27777	4.83335		40	0.01734	5.28369	4.85912
	50	0.02315	5.27788	4.83379		50	0.01725	5.28378	4.85954
46	0	0.02304	5.27799	4.83423	56	0	0.01716	5.28387	4.85996
	10	0.02294	5.27809	4.83467		10	0.01707	5.28396	4.86038
	20	0.02283	5.27820	4.83510		20	0.01698	5.28405	4.86079
	30	0.02273	5.27830	4.83554		30	0.01689	5.28414	4.86121
	40	0.02262	5.27841	4.83598		40	0.01680	5.28423	4.86163
	50	0.02252	5.27851	4.83642		50	0.01671	5.28432	4.86205
47	0	0.02241	5.27862	4.83685	57	0	0.01662	5.28441	4.86247
	10	0.02231	5.27872	4.83729		10	0.01653	5.28450	4.86288
	20	0.02221	5.27882	4.83773		20	0.01644	5.28459	4.86330
	30	0.02210	5.27893	4.83816		30	0.01635	5.28468	4.86372
	40	0.02200	5.27903	4.83860		40	0.01627	5.28476	4.86413
	50	0.02190	5.27913	4.83903		50	0.01618	5.28485	4.86455
48	0	0.02179	5.27924	4.83947	58	0	0.01609	5.28494	4.86496
	10	0.02169	5.27934	4.83990		10	0.01600	5.28503	4.86538
	20	0.02159	5.27944	4.84034		20	0.01591	5.28512	4.86579
	30	0.02149	5.27954	4.84077		30	0.01583	5.28520	4.86621
	40	0.02139	5.27964	4.84120		40	0.01574	5.28529	4.86662
	50	0.02128	5.27975	4.84164		50	0.01565	5.28538	4.86704
49	0	0.02118	5.27985	4.84207	59	0	0.01557	5.28546	4.86745
	10	0.02108	5.27995	4.84250		10	0.01548	5.28555	4.86786
	20	0.02098	5.28005	4.84293		20	0.01540	5.28563	4.86828
	30	0.02088	5.28015	4.84337		30	0.01531	5.28572	4.86869
	40	0.02078	5.28025	4.84380		40	0.01523	5.28580	4.86910
	50	0.02068	5.28035	4.84423		50	0.01514	5.28589	4.86951

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

5 HOURS.

M.	S.	Log ½ ela. Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela. Time.	Log Mid Time.	Logarith Rising.
0	0	0.01506	5.28597	4.86992	10	0	0.01042	5.29061	4.89407
	10	0.01497	5.28606	4.87034		10	0.01035	5.29068	4.89447
	20	0.01489	5.28614	4.87075		20	0.01028	5.29075	4.89486
	30	0.01480	5.28623	4.87116		30	0.01021	5.29082	4.89525
	40	0.01472	5.28631	4.87157		40	0.01014	5.29089	4.89564
	50	0.01464	5.28639	4.87198		50	0.01007	5.29096	4.89604
1	0	0.01455	5.28648	4.87239	11	0	0.01000	5.29103	4.89643
	10	0.01447	5.28656	4.87280		10	0.00993	5.29110	4.89682
	20	0.01439	5.28664	4.87321		20	0.00987	5.29116	4.89721
	30	0.01430	5.28673	4.87362		30	0.00980	5.29123	4.89760
	40	0.01422	5.28681	4.87402		40	0.00973	5.29130	4.89799
	50	0.01414	5.28689	4.87443		50	0.00966	5.29137	4.89838
2	0	0.01406	5.28697	4.87484	12	0	0.00960	5.29143	4.89877
	10	0.01398	5.28705	4.87525		10	0.00953	5.29150	4.89916
	20	0.01390	5.28713	4.87566		20	0.00946	5.29157	4.89955
	30	0.01381	5.28722	4.87606		30	0.00940	5.29163	4.89994
	40	0.01373	5.28730	4.87647		40	0.00933	5.29170	4.90033
	50	0.01365	5.28738	4.87688		50	0.00926	5.29177	4.90072
3	0	0.01357	5.28746	4.87728	13	0	0.00920	5.29183	4.90111
	10	0.01349	5.28754	4.87769		10	0.00913	5.29190	4.90150
	20	0.01341	5.28762	4.87809		20	0.00907	5.29196	4.90188
	30	0.01333	5.28770	4.87850		30	0.00900	5.29203	4.90227
	40	0.01325	5.28778	4.87890		40	0.00894	5.29209	4.90266
	50	0.01317	5.28786	4.87931		50	0.00887	5.29216	4.90305
4	0	0.01310	5.28793	4.87971	14	0	0.00881	5.29222	4.90343
	10	0.01302	5.28801	4.88012		10	0.00874	5.29229	4.90382
	20	0.01294	5.28809	4.88052		20	0.00868	5.29235	4.90421
	30	0.01286	5.28817	4.88093		30	0.00862	5.29241	4.90459
	40	0.01278	5.28825	4.88133		40	0.00855	5.29248	4.90498
	50	0.01271	5.28832	4.88173		50	0.00849	5.29254	4.90536
5	0	0.01263	5.28840	4.88213	15	0	0.00843	5.29260	4.90575
	10	0.01255	5.28848	4.88254		10	0.00836	5.29267	4.90613
	20	0.01247	5.28856	4.88294		20	0.00830	5.29273	4.90652
	30	0.01240	5.28863	4.88334		30	0.00824	5.29279	4.90690
	40	0.01232	5.28871	4.88374		40	0.00818	5.29285	4.90728
	50	0.01224	5.28879	4.88414		50	0.00811	5.29292	4.90767
6	0	0.01217	5.28886	4.88454	16	0	0.00805	5.29298	4.90805
	10	0.01209	5.28894	4.88494		10	0.00799	5.29304	4.90843
	20	0.01202	5.28901	4.88534		20	0.00793	5.29310	4.90882
	30	0.01194	5.28909	4.88574		30	0.00787	5.29316	4.90920
	40	0.01187	5.28916	4.88614		40	0.00781	5.29322	4.90958
	50	0.01179	5.28924	4.88654		50	0.00775	5.29328	4.90996
7	0	0.01172	5.28931	4.88694	17	0	0.00769	5.29334	4.91034
	10	0.01164	5.28939	4.88734		10	0.00763	5.29340	4.91073
	20	0.01157	5.28946	4.88774		20	0.00757	5.29346	4.91111
	30	0.01150	5.28953	4.88814		30	0.00751	5.29352	4.91149
	40	0.01142	5.28961	4.88853		40	0.00745	5.29358	4.91187
	50	0.01135	5.28968	4.88893		50	0.00739	5.29364	4.91225
8	0	0.01128	5.28975	4.88933	18	0	0.00733	5.29370	4.91263
	10	0.01120	5.28983	4.88973		10	0.00728	5.29375	4.91301
	20	0.01113	5.28990	4.89012		20	0.00722	5.29381	4.91339
	30	0.01106	5.28997	4.89052		30	0.00716	5.29387	4.91377
	40	0.01099	5.29004	4.89091		40	0.00710	5.29393	4.91414
	50	0.01091	5.29012	4.89131		50	0.00704	5.29399	4.91452
9	0	0.01084	5.29019	4.89171	19	0	0.00699	5.29404	4.91490
	10	0.01077	5.29026	4.89210		10	0.00693	5.29410	4.91528
	20	0.01070	5.29033	4.89250		20	0.00687	5.29416	4.91566
	30	0.01063	5.29040	4.89289		30	0.00682	5.29421	4.91603
	40	0.01056	5.29047	4.89328		40	0.00676	5.29427	4.91641
	50	0.01049	5.29054	4.89368		50	0.00670	5.29433	4.91679

5 HOURS.

M.	S.	Log ½ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ela Time.	Log Mid Time.	Logarith Rising.
20	0	0.00665	5.29438	4.91716	30	0	0.00373	5.29730	4.93926
	10	0.00659	5.29444	4.91754		10	0.00369	5.29734	4.93962
	20	0.00654	5.29449	4.91792		20	0.00365	5.29738	4.93998
	30	0.00648	5.29455	4.91829		30	0.00361	5.29742	4.94034
	40	0.00643	5.29460	4.91867		40	0.00357	5.29746	4.94069
	50	0.00637	5.29466	4.91904		50	0.00353	5.29750	4.94105
21	0	0.00632	5.29471	4.91942	31	0	0.00349	5.29754	4.94141
	10	0.00626	5.29477	4.91979		10	0.00345	5.29758	4.94177
	20	0.00621	5.29482	4.92017		20	0.00341	5.29762	4.94213
	30	0.00616	5.29487	4.92054		30	0.00337	5.29766	4.94249
	40	0.00610	5.29493	4.92092		40	0.00333	5.29770	4.94284
	50	0.00605	5.29498	4.92129		50	0.00329	5.29774	4.94320
22	0	0.00600	5.29503	4.92166	32	0	0.00325	5.29778	4.94356
	10	0.00594	5.29509	4.92203		10	0.00321	5.29782	4.94392
	20	0.00589	5.29514	4.92241		20	0.00317	5.29786	4.94427
	30	0.00584	5.29519	4.92278		30	0.00313	5.29790	4.94463
	40	0.00579	5.29524	4.92315		40	0.00310	5.29793	4.94498
	50	0.00574	5.29529	4.92352		50	0.00306	5.29797	4.94534
23	0	0.00568	5.29535	4.92390	33	0	0.00302	5.29801	4.94570
	10	0.00563	5.29540	4.92427		10	0.00298	5.29805	4.94605
	20	0.00558	5.29545	4.92464		20	0.00295	5.29808	4.94641
	30	0.00553	5.29550	4.92501		30	0.00291	5.29812	4.94676
	40	0.00548	5.29555	4.92538		40	0.00287	5.29816	4.94712
	50	0.00543	5.29560	4.92575		50	0.00284	5.29819	4.94747
24	0	0.00538	5.29565	4.92612	34	0	0.00280	5.29823	4.94782
	10	0.00533	5.29570	4.92649		10	0.00276	5.29827	4.94818
	20	0.00528	5.29575	4.92686		20	0.00273	5.29830	4.94853
	30	0.00523	5.29580	4.92723		30	0.00269	5.29834	4.94888
	40	0.00518	5.29585	4.92760		40	0.00266	5.29837	4.94924
	50	0.00513	5.29590	4.92796		50	0.00262	5.29841	4.94959
25	0	0.00508	5.29595	4.92833	35	0	0.00259	5.29844	4.94994
	10	0.00504	5.29599	4.92870		10	0.00255	5.29848	4.95029
	20	0.00499	5.29604	4.92907		20	0.00252	5.29851	4.95065
	30	0.00494	5.29609	4.92944		30	0.00249	5.29854	4.95100
	40	0.00489	5.29614	4.92980		40	0.00245	5.29858	4.95135
	50	0.00484	5.29619	4.93017		50	0.00242	5.29861	4.95170
26	0	0.00480	5.29623	4.93054	36	0	0.00239	5.29864	4.95205
	10	0.00475	5.29628	4.93090		10	0.00235	5.29868	4.95240
	20	0.00470	5.29633	4.93127		20	0.00232	5.29871	4.95275
	30	0.00466	5.29637	4.93164		30	0.00229	5.29874	4.95310
	40	0.00461	5.29642	4.93200		40	0.00225	5.29878	4.95345
	50	0.00456	5.29647	4.93237		50	0.00222	5.29881	4.95380
27	0	0.00452	5.29651	4.93273	37	0	0.00219	5.29884	4.95415
	10	0.00447	5.29656	4.93310		10	0.00216	5.29887	4.95450
	20	0.00443	5.29660	4.93346		20	0.00213	5.29890	4.95485
	30	0.00438	5.29665	4.93382		30	0.00210	5.29893	4.95520
	40	0.00434	5.29669	4.93419		40	0.00207	5.29896	4.95555
	50	0.00429	5.29674	4.93455		50	0.00203	5.29900	4.95589
28	0	0.00425	5.29678	4.93492	38	0	0.00200	5.29903	4.95624
	10	0.00420	5.29683	4.93528		10	0.00197	5.29906	4.95659
	20	0.00416	5.29687	4.93564		20	0.00194	5.29909	4.95694
	30	0.00412	5.29691	4.93600		30	0.00191	5.29912	4.95728
	40	0.00407	5.29696	4.93637		40	0.00188	5.29915	4.95763
	50	0.00403	5.29700	4.93673		50	0.00185	5.29918	4.95798
29	0	0.00399	5.29704	4.93709	39	0	0.00183	5.29920	4.95832
	10	0.00394	5.29709	4.93745		10	0.00180	5.29923	4.95867
	20	0.00390	5.29713	4.93781		20	0.00177	5.29926	4.95902
	30	0.00386	5.29717	4.93817		30	0.00174	5.29929	4.95936
	40	0.00382	5.29721	4.93854		40	0.00171	5.29932	4.95971
	50	0.00377	5.29726	4.93890		50	0.00168	5.29935	4.96005

Table XXI. For finding the Latitude by two Altitudes of the Sun.

5 HOURS.

M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ ela Time.	Log Mid Time.	Logarith Rising.
40	0	0.00166	5.29937	4.96040	50	0	0.00041	5.30062	4.98063
	10	0.00163	5.29940	4.96074		10	0.00040	5.30063	4.98096
	20	0.00160	5.29943	4.96109		20	0.00039	5.30064	4.98129
	30	0.00157	5.29946	4.96143		30	0.00037	5.30066	4.98162
	40	0.00155	5.29948	4.96177		40	0.00036	5.30067	4.98195
	50	0.00152	5.29951	4.96212		50	0.00035	5.30068	4.98228
41	0	0.00149	5.29954	4.96246	51	0	0.00033	5.30070	4.98261
	10	0.00147	5.29956	4.96280		10	0.00032	5.30071	4.98293
	20	0.00144	5.29959	4.96315		20	0.00031	5.30072	4.98326
	30	0.00142	5.29961	4.96349		30	0.00030	5.30073	4.98359
	40	0.00139	5.29964	4.96383		40	0.00029	5.30074	4.98392
	50	0.00137	5.29966	4.96417		50	0.00028	5.30075	4.98425
42	0	0.00134	5.29969	4.96451	52	0	0.00026	5.30077	4.98457
	10	0.00132	5.29971	4.96486		10	0.00025	5.30078	4.98490
	20	0.00129	5.29974	4.96520		20	0.00024	5.30079	4.98523
	30	0.00127	5.29976	4.96554		30	0.00023	5.30080	4.98555
	40	0.00124	5.29979	4.96588		40	0.00022	5.30081	4.98588
	50	0.00122	5.29981	4.96622		50	0.00021	5.30082	4.98620
43	0	0.00120	5.29983	4.96656	53	0	0.00020	5.30083	4.98653
	10	0.00117	5.29986	4.96690		10	0.00019	5.30084	4.98686
	20	0.00115	5.29988	4.96724		20	0.00018	5.30085	4.98718
	30	0.00113	5.29990	4.96758		30	0.00017	5.30086	4.98751
	40	0.00110	5.29993	4.96792		40	0.00017	5.30086	4.98783
	50	0.00108	5.29995	4.96826		50	0.00016	5.30087	4.98816
44	0	0.00106	5.29997	4.96860	54	0	0.00015	5.30088	4.98848
	10	0.00104	5.29999	4.96894		10	0.00014	5.30089	4.98880
	20	0.00102	5.30001	4.96927		20	0.00013	5.30090	4.98913
	30	0.00099	5.30004	4.96961		30	0.00013	5.30090	4.98945
	40	0.00097	5.30006	4.96995		40	0.00012	5.30091	4.98977
	50	0.00095	5.30008	4.97029		50	0.00011	5.30092	4.99010
45	0	0.00093	5.30010	4.97062	55	0	0.00010	5.30093	4.99042
	10	0.00091	5.30012	4.97096		10	0.00010	5.30093	4.99074
	20	0.00089	5.30014	4.97130		20	0.00009	5.30094	4.99107
	30	0.00087	5.30016	4.97163		30	0.00008	5.30095	4.99139
	40	0.00085	5.30018	4.97197		40	0.00008	5.30095	4.99171
	50	0.00083	5.30020	4.97231		50	0.00007	5.30096	4.99203
46	0	0.00081	5.30022	4.97264	56	0	0.00007	5.30096	4.99235
	10	0.00079	5.30024	4.97298		10	0.00006	5.30097	4.99267
	20	0.00077	5.30026	4.97331		20	0.00006	5.30097	4.99300
	30	0.00075	5.30028	4.97365		30	0.00005	5.30098	4.99332
	40	0.00074	5.30029	4.97398		40	0.00005	5.30098	4.99364
	50	0.00072	5.30031	4.97432		50	0.00004	5.30099	4.99396
47	0	0.00070	5.30033	4.97465	57	0	0.00004	5.30099	4.99428
	10	0.00068	5.30035	4.97499		10	0.00003	5.30100	4.99460
	20	0.00066	5.30037	4.97532		20	0.00003	5.30100	4.99492
	30	0.00065	5.30038	4.97565		30	0.00003	5.30100	4.99524
	40	0.00063	5.30040	4.97599		40	0.00002	5.30101	4.99556
	50	0.00061	5.30042	4.97632		50	0.00002	5.30101	4.99587
48	0	0.00060	5.30043	4.97665		0	0.00002	5.30101	4.99619
	10	0.00058	5.30045	4.97699	58	10	0.00001	5.30102	4.99651
	20	0.00056	5.30047	4.97732		20	0.00001	5.30102	4.99683
	30	0.00055	5.30048	4.97765		30	0.00001	5.30102	4.99715
	40	0.00053	5.30050	4.97798		40	0.00001	5.30102	4.99747
	50	0.00052	5.30051	4.97832		50	0.00001	5.30102	4.99778
49	0	0.00050	5.30053	4.97865	59	0	0.00000	5.30103	4.99810
	10	0.00049	5.30054	4.97898		10	0.00000	5.30103	4.99842
	20	0.00047	5.30056	4.97931		20	0.00000	5.30103	4.99873
	30	0.00046	5.30057	4.97964		30	0.00000	5.30103	4.99905
	40	0.00044	5.30059	4.97997		40	0.00000	5.30103	4.99937
	50	0.00043	5.30060	4.98030		50	0.00000	5.30103	4.99968

Table XXI. For finding the Latitude by two Altitudes of the Sun.

6 HOURS.											
M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.
0	0	5.00000	10	0	5.01854	20	0	5.03629	30	0	5.05328
	10	5.00032		10	5.01884		10	5.03658		10	5.05356
	20	5.00063		20	5.01915		20	5.03687		20	5.05383
	30	5.00095		30	5.01945		30	5.03716		30	5.05411
	40	5.00126		40	5.01975		40	5.03745		40	5.05439
	50	5.00158		50	5.02005		50	5.03774		50	5.05466
1	0	5.00189	11	0	5.02035	21	0	5.03802	31	0	5.05494
	10	5.00221		10	5.02065		10	5.03831		10	5.05521
	20	5.00252		20	5.02095		20	5.03860		20	5.05549
	30	5.00283		30	5.02125		30	5.03889		30	5.05577
	40	5.00315		40	5.02155		40	5.03918		40	5.05604
	50	5.00346		50	5.02185		50	5.03946		50	5.05632
2	0	5.00377	12	0	5.02215	22	0	5.03975	32	0	5.05659
	10	5.00409		10	5.02245		10	5.04004		10	5.05686
	20	5.00440		20	5.02275		20	5.04032		20	5.05714
	30	5.00471		30	5.02305		30	5.04061		30	5.05741
	40	5.00502		40	5.02335		40	5.04090		40	5.05769
	50	5.00534		50	5.02365		50	5.04118		50	5.05796
3	0	5.00565	13	0	5.02395	23	0	5.04147	33	0	5.05823
	10	5.00596		10	5.02425		10	5.04175		10	5.05851
	20	5.00627		20	5.02455		20	5.04204		20	5.05878
	30	5.00658		30	5.02484		30	5.04232		30	5.05905
	40	5.00689		40	5.02514		40	5.04261		40	5.05933
	50	5.00720		50	5.02544		50	5.04289		50	5.05960
4	0	5.00751	14	0	5.02574	24	0	5.04318	34	0	5.05987
	10	5.00782		10	5.02603		10	5.04346		10	5.06014
	20	5.00813		20	5.02633		20	5.04375		20	5.06041
	30	5.00844		30	5.02663		30	5.04403		30	5.06069
	40	5.00875		40	5.02692		40	5.04431		40	5.06096
	50	5.00906		50	5.02722		50	5.04460		50	5.06123
5	0	5.00937	15	0	5.02751	25	0	5.04488	35	0	5.06150
	10	5.00968		10	5.02781		10	5.04516		10	5.06177
	20	5.00999		20	5.02811		20	5.04545		20	5.06204
	30	5.01030		30	5.02840		30	5.04573		30	5.06231
	40	5.01061		40	5.02870		40	5.04601		40	5.06258
	50	5.01091		50	5.02899		50	5.04629		50	5.06285
6	0	5.01122	16	0	5.02928	26	0	5.04657	36	0	5.06312
	10	5.01153		10	5.02958		10	5.04686		10	5.06339
	20	5.01184		20	5.02987		20	5.04714		20	5.06366
	30	5.01214		30	5.03017		30	5.04742		30	5.06393
	40	5.01245		40	5.03046		40	5.04770		40	5.06420
	50	5.01276		50	5.03075		50	5.04798		50	5.06447
7	0	5.01306	17	0	5.03105	27	0	5.04826	37	0	5.06474
	10	5.01337		10	5.03134		10	5.04854		10	5.06500
	20	5.01368		20	5.03163		20	5.04882		20	5.06527
	30	5.01398		30	5.03193		30	5.04910		30	5.06554
	40	5.01429		40	5.03222		40	5.04938		40	5.06581
	50	5.01459		50	5.03251		50	5.04966		50	5.06608
8	0	5.01490	18	0	5.03280	28	0	5.04994	38	0	5.06634
	10	5.01520		10	5.03310		10	5.05022		10	5.06661
	20	5.01551		20	5.03339		20	5.05050		20	5.06688
	30	5.01581		30	5.03368		30	5.05078		30	5.06714
	40	5.01612		40	5.03397		40	5.05106		40	5.06741
	50	5.01642		50	5.03426		50	5.05134		50	5.06768
9	0	5.01672	19	0	5.03455	29	0	5.05162	39	0	5.06794
	10	5.01703		10	5.03484		10	5.05189		10	5.06821
	20	5.01733		20	5.03513		20	5.05217		20	5.06848
	30	5.01763		30	5.03542		30	5.05245		30	5.06874
	40	5.01794		40	5.03571		40	5.05273		40	5.06901
	50	5.01824		50	5.03600		50	5.05300		50	5.06927

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

6 HOURS.						7 HOURS.					
M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.
40	0	5.06954	50	0	5.08509	0	0	5.09996	10	0	5.11418
	10	5.06980		10	5.08534		10	5.10021		10	5.11441
	20	5.07007		20	5.08560		20	5.10045		20	5.11464
	30	5.07033		30	5.08585		30	5.10069		30	5.11487
	40	5.07060		40	5.08610		40	5.10093		40	5.11510
	50	5.07086		50	5.08636		50	5.10117		50	5.11533
41	0	5.07112	51	0	5.08661	1	0	5.10141	11	0	5.11557
	10	5.07139		10	5.08686		10	5.10166		10	5.11580
	20	5.07165		20	5.08711		20	5.10190		20	5.11603
	30	5.07192		30	5.08736		30	5.10214		30	5.11626
	40	5.07218		40	5.08762		40	5.10238		40	5.11649
	50	5.07244		50	5.08787		50	5.10262		50	5.11672
42	0	5.07270	52	0	5.08812	2	0	5.10286	12	0	5.11695
	10	5.07297		10	5.08837		10	5.10310		10	5.11717
	20	5.07323		20	5.08862		20	5.10334		20	5.11740
	30	5.07349		30	5.08887		30	5.10358		30	5.11763
	40	5.07375		40	5.08912		40	5.10382		40	5.11786
	50	5.07401		50	5.08937		50	5.10406		50	5.11809
43	0	5.07428	53	0	5.08962	3	0	5.10430	13	0	5.11832
	10	5.07454		10	5.08987		10	5.10454		10	5.11855
	20	5.07480		20	5.09012		20	5.10477		20	5.11878
	30	5.07506		30	5.09037		30	5.10501		30	5.11900
	40	5.07532		40	5.09062		40	5.10525		40	5.11923
	50	5.07558		50	5.09087		50	5.10549		50	5.11946
44	0	5.07584	54	0	5.09112	4	0	5.10573	14	0	5.11969
	10	5.07610		10	5.09137		10	5.10597		10	5.11991
	20	5.07636		20	5.09162		20	5.10620		20	5.12014
	30	5.07662		30	5.09187		30	5.10644		30	5.12037
	40	5.07688		40	5.09211		40	5.10668		40	5.12059
	50	5.07714		50	5.09236		50	5.10691		50	5.12082
45	0	5.07740	55	0	5.09261	5	0	5.10715	15	0	5.12105
	10	5.07766		10	5.09286		10	5.10739		10	5.12127
	20	5.07792		20	5.09311		20	5.10763		20	5.12150
	30	5.07818		30	5.09335		30	5.10786		30	5.12173
	40	5.07844		40	5.09360		40	5.10810		40	5.12195
	50	5.07869		50	5.09385		50	5.10833		50	5.12218
46	0	5.07895	56	0	5.09409	6	0	5.10857	16	0	5.12240
	10	5.07921		10	5.09434		10	5.10881		10	5.12263
	20	5.07947		20	5.09459		20	5.10904		20	5.12285
	30	5.07973		30	5.09483		30	5.10928		30	5.12308
	40	5.07998		40	5.09508		40	5.10951		40	5.12330
	50	5.08024		50	5.09533		50	5.10975		50	5.12353
47	0	5.08050	57	0	5.09557	7	0	5.10998	17	0	5.12375
	10	5.08075		10	5.09582		10	5.11022		10	5.12397
	20	5.08101		20	5.09606		20	5.11045		20	5.12420
	30	5.08127		30	5.09631		30	5.11069		30	5.12442
	40	5.08152		40	5.09655		40	5.11092		40	5.12465
	50	5.08178		50	5.09680		50	5.11115		50	5.12487
48	0	5.08204	58	0	5.09704	8	0	5.11139	18	0	5.12509
	10	5.08229		10	5.09729		10	5.11162		10	5.12532
	20	5.08255		20	5.09753		20	5.11185		20	5.12554
	30	5.08280		30	5.09777		30	5.11209		30	5.12576
	40	5.08306		40	5.09802		40	5.11232		40	5.12598
	50	5.08331		50	5.09826		50	5.11255		50	5.12621
49	0	5.08357	59	0	5.09851	9	0	5.11279	19	0	5.12643
	10	5.08382		10	5.09875		10	5.11302		10	5.12665
	20	5.08408		20	5.09899		20	5.11325		20	5.12687
	30	5.08433		30	5.09924		30	5.11348		30	5.12709
	40	5.08458		40	5.09948		40	5.11372		40	5.12732
	50	5.08484		50	5.09972		50	5.11395		50	5.12754

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

7 HOURS.

M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.
20	0	5.12776	30	0	5.14072	40	0	5.15309	50	0	5.16487
	10	5.12798		10	5.14093		10	5.15329		10	5.16506
	20	5.12820		20	5.14114		20	5.15349		20	5.16526
	30	5.12842		30	5.14136		30	5.15369		30	5.16545
	40	5.12864		40	5.14157		40	5.15389		40	5.16564
	50	5.12886		50	5.14178		50	5.15409		50	5.16583
21	0	5.12908	31	0	5.14199	41	0	5.15429	51	0	5.16602
	10	5.12930		10	5.14220		10	5.15449		10	5.16621
	20	5.12952		20	5.14241		20	5.15469		20	5.16640
	30	5.12974		30	5.14262		30	5.15489		30	5.16659
	40	5.12996		40	5.14282		40	5.15509		40	5.16678
	50	5.13018		50	5.14303		50	5.15529		50	5.16697
22	0	5.13040	32	0	5.14324	42	0	5.15549	52	0	5.16716
	10	5.13062		10	5.14345		10	5.15569		10	5.16735
	20	5.13084		20	5.14366		20	5.15589		20	5.16754
	30	5.13106		30	5.14387		30	5.15609		30	5.16773
	40	5.13128		40	5.14408		40	5.15629		40	5.16792
	50	5.13149		50	5.14429		50	5.15649		50	5.16811
23	0	5.13171	33	0	5.14449	43	0	5.15668	53	0	5.16830
	10	5.13193		10	5.14470		10	5.15688		10	5.16849
	20	5.13215		20	5.14491		20	5.15708		20	5.16867
	30	5.13237		30	5.14512		30	5.15728		30	5.16886
	40	5.13258		40	5.14533		40	5.15748		40	5.16905
	50	5.13280		50	5.14553		50	5.15767		50	5.16924
24	0	5.13302	34	0	5.14574	44	0	5.15787	54	0	5.16943
	10	5.13323		10	5.14595		10	5.15807		10	5.16961
	20	5.13345		20	5.14615		20	5.15827		20	5.16980
	30	5.13367		30	5.14636		30	5.15846		30	5.16999
	40	5.13388		40	5.14657		40	5.15866		40	5.17018
	50	5.13410		50	5.14677		50	5.15886		50	5.17036
25	0	5.13432	35	0	5.14698	45	0	5.15905	55	0	5.17055
	10	5.13453		10	5.14719		10	5.15925		10	5.17074
	20	5.13475		20	5.14739		20	5.15944		20	5.17093
	30	5.13496		30	5.14760		30	5.15964		30	5.17111
	40	5.13518		40	5.14780		40	5.15984		40	5.17130
	50	5.13539		50	5.14801		50	5.16003		50	5.17148
26	0	5.13561	36	0	5.14821	46	0	5.16023	56	0	5.17167
	10	5.13582		10	5.14842		10	5.16042		10	5.17186
	20	5.13604		20	5.14862		20	5.16062		20	5.17204
	30	5.13625		30	5.14883		30	5.16081		30	5.17223
	40	5.13647		40	5.14903		40	5.16101		40	5.17241
	50	5.13668		50	5.14924		50	5.16120		50	5.17260
27	0	5.13690	37	0	5.14944	47	0	5.16140	57	0	5.17278
	10	5.13711		10	5.14964		10	5.16159		10	5.17297
	20	5.13732		20	5.14985		20	5.16179		20	5.17315
	30	5.13754		30	5.15005		30	5.16198		30	5.17334
	40	5.13775		40	5.15026		40	5.16217		40	5.17352
	50	5.13797		50	5.15046		50	5.16237		50	5.17371
28	0	5.13818	38	0	5.15066	48	0	5.16256	58	0	5.17389
	10	5.13839		10	5.15087		10	5.16276		10	5.17408
	20	5.13860		20	5.15107		20	5.16295		20	5.17426
	30	5.13882		30	5.15127		30	5.16314		30	5.17444
	40	5.13903		40	5.15147		40	5.16333		40	5.17463
	50	5.13924		50	5.15168		50	5.16353		50	5.17481
29	0	5.13945	39	0	5.15188	49	0	5.16372	59	0	5.17499
	10	5.13967		10	5.15208		10	5.16391		10	5.17518
	20	5.13988		20	5.15228		20	5.16410		20	5.17536
	30	5.14009		30	5.15248		30	5.16430		30	5.17554
	40	5.14030		40	5.15269		40	5.16449		40	5.17573
	50	5.14051		50	5.15289		50	5.16468		50	5.17591

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

8 HOURS.								
M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.
0	0	5.17609	10	0	5.18676	20	0	5.19689
	10	5.17627		10	5.18693		10	5.19705
	20	5.17646		20	5.18710		20	5.19722
	30	5.17664		30	5.18728		30	5.19738
	40	5.17682		40	5.18745		40	5.19754
	50	5.17700		50	5.18762		50	5.19771
1	0	5.17718	11	0	5.18780	21	0	5.19787
	10	5.17736		10	5.18797		10	5.19804
	20	5.17755		20	5.18814		20	5.19820
	30	5.17773		30	5.18831		30	5.19836
	40	5.17791		40	5.18848		40	5.19852
	50	5.17809		50	5.18866		50	5.19869
2	0	5.17827	12	0	5.18883	22	0	5.19885
	10	5.17845		10	5.18900		10	5.19901
	20	5.17863		20	5.18917		20	5.19918
	30	5.17881		30	5.18934		30	5.19934
	40	5.17899		40	5.18951		40	5.19950
	50	5.17917		50	5.18968		50	5.19966
3	0	5.17935	13	0	5.18985	23	0	5.19982
	10	5.17953		10	5.19002		10	5.19999
	20	5.17971		20	5.19019		20	5.20015
	30	5.17989		30	5.19036		30	5.20031
	40	5.18007		40	5.19053		40	5.20047
	50	5.18024		50	5.19070		50	5.20063
4	0	5.18042	14	0	5.19087	24	0	5.20079
	10	5.18060		10	5.19104		10	5.20095
	20	5.18078		20	5.19121		20	5.20111
	30	5.18096		30	5.19138		30	5.20127
	40	5.18114		40	5.19155		40	5.20143
	50	5.18132		50	5.19172		50	5.20159
5	0	5.18149	15	0	5.19189	25	0	5.20175
	10	5.18167		10	5.19206		10	5.20191
	20	5.18185		20	5.19223		20	5.20207
	30	5.18203		30	5.19240		30	5.20223
	40	5.18220		40	5.19256		40	5.20239
	50	5.18238		50	5.19273		50	5.20255
6	0	5.18256	16	0	5.19290	26	0	5.20271
	10	5.18273		10	5.19307		10	5.20287
	20	5.18291		20	5.19324		20	5.20303
	30	5.18309		30	5.19340		30	5.20319
	40	5.18326		40	5.19357		40	5.20335
	50	5.18344		50	5.19374		50	5.20351
7	0	5.18362	17	0	5.19390	27	0	5.20366
	10	5.18379		10	5.19407		10	5.20382
	20	5.18397		20	5.19424		20	5.20398
	30	5.18414		30	5.19441		30	5.20414
	40	5.18432		40	5.19457		40	5.20430
	50	5.18449		50	5.19474		50	5.20445
8	0	5.18467	18	0	5.19490	28	0	5.20461
	10	5.18484		10	5.19507		10	5.20477
	20	5.18502		20	5.19524		20	5.20493
	30	5.18519		30	5.19540		30	5.20508
	40	5.18537		40	5.19557		40	5.20524
	50	5.18554		50	5.19573		50	5.20540
9	0	5.18572	19	0	5.19590	29	0	5.20555
	10	5.18589		10	5.19606		10	5.20571
	20	5.18606		20	5.19623		20	5.20587
	30	5.18624		30	5.19639		30	5.20602
	40	5.18641		40	5.19656		40	5.20618
	50	5.18659		50	5.19672		50	5.20634

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

8 HOURS.

M.	S.	Logarith Rising.	M.	S.	Logarith Rising.	M.	S.	Logarith Rising.
30	0	5.20649	40	0	5.21558	50	0	5.22417
	10	5.20665		10	5.21573		10	5.22431
	20	5.20680		20	5.21588		20	5.22445
	30	5.20696		30	5.21602		30	5.22458
	40	5.20711		40	5.21617		40	5.22472
	50	5.20727		50	5.21632		50	5.22486
31	0	5.20742	41	0	5.21646	51	0	5.22500
	10	5.20758		10	5.21661		10	5.22514
	20	5.20773		20	5.21676		20	5.22528
	30	5.20789		30	5.21690		30	5.22541
	40	5.20804		40	5.21705		40	5.22555
	50	5.20820		50	5.21719		50	5.22569
32	0	5.20835	42	0	5.21734	52	0	5.22583
	10	5.20850		10	5.21748		10	5.22596
	20	5.20866		20	5.21763		20	5.22610
	30	5.20881		30	5.21777		30	5.22624
	40	5.20897		40	5.21792		40	5.22637
	50	5.20912		50	5.21806		50	5.22651
33	0	5.20927	43	0	5.21821	53	0	5.22665
	10	5.20943		10	5.21835		10	5.22678
	20	5.20958		20	5.21850		20	5.22692
	30	5.20973		30	5.21864		30	5.22706
	40	5.20988		40	5.21879		40	5.22719
	50	5.21004		50	5.21893		50	5.22733
34	0	5.21019	44	0	5.21908	54	0	5.22746
	10	5.21034		10	5.21922		10	5.22760
	20	5.21049		20	5.21936		20	5.22773
	30	5.21065		30	5.21951		30	5.22787
	40	5.21080		40	5.21965		40	5.22801
	50	5.21095		50	5.21979		50	5.22814
35	0	5.21110	45	0	5.21994	55	0	5.22828
	10	5.21125		10	5.22008		10	5.22841
	20	5.21140		20	5.22022		20	5.22854
	30	5.21155		30	5.22037		30	5.22868
	40	5.21170		40	5.22051		40	5.22881
	50	5.21186		50	5.22065		50	5.22895
36	0	5.21201	46	0	5.22079	56	0	5.22908
	10	5.21216		10	5.22094		10	5.22922
	20	5.21231		20	5.22108		20	5.22935
	30	5.21246		30	5.22122		30	5.22948
	40	5.21261		40	5.22136		40	5.22962
	50	5.21276		50	5.22150		50	5.22975
37	0	5.21291	47	0	5.22164	57	0	5.22988
	10	5.21306		10	5.22179		10	5.23002
	20	5.21321		20	5.22193		20	5.23015
	30	5.21336		30	5.22207		30	5.23028
	40	5.21351		40	5.22221		40	5.23042
	50	5.21366		50	5.22235		50	5.23055
38	0	5.21380	48	0	5.22249	58	0	5.23068
	10	5.21395		10	5.22263		10	5.23081
	20	5.21410		20	5.22277		20	5.23095
	30	5.21425		30	5.22291		30	5.23108
	40	5.21440		40	5.22305		40	5.23121
	50	5.21455		50	5.22319		50	5.23134
39	0	5.21470	49	0	5.22333	59	0	5.23147
	10	5.21484		10	5.22347		10	5.23160
	20	5.21499		20	5.22361		20	5.23174
	30	5.21514		30	5.22375		30	5.23187
	40	5.21529		40	5.22389		40	5.23200
	50	5.21543		50	5.22403		50	5.23213

Table XXII. Of Natural Sines.

	0°		1°		2°		3°		4°		
M.	N. sine	N. cos.	N. sine.	N. cos.	N. sine	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	
0	00000	100000	01745	99985	03490	99939	05234	99863	06976	99756	60
1	00029	100000	01774	99984	03519	99938	05263	99861	07005	99754	59
2	00058	100000	01803	99984	03548	99937	05292	99860	07034	99752	58
3	00087	100000	01832	99983	03577	99936	05321	99858	07063	99750	57
4	00116	100000	01862	99983	03606	99935	05350	99857	07092	99748	56
5	00145	100000	01891	99982	03635	99934	05379	99855	07121	99746	55
6	00175	100000	01920	99982	03664	99933	05408	99854	07150	99744	54
7	00204	100000	01949	99981	03693	99932	05437	99852	07179	99742	53
8	00233	100000	01978	99980	03723	99931	05466	99851	07208	99740	52
9	00262	100000	02007	99980	03752	99930	05495	99849	07237	99738	51
10	00291	100000	02036	99979	03781	99929	05524	99847	07266	99736	50
11	00320	99999	02065	99979	03810	99927	05553	99846	07295	99734	49
12	00349	99999	02094	99978	03839	99926	05582	99844	07324	99731	48
13	00378	99999	02123	99977	03868	99925	05611	99842	07353	99729	47
14	00407	99999	02152	99977	03897	99924	05640	99841	07382	99727	46
15	00436	99999	02181	99976	03926	99923	05669	99839	07411	99725	45
16	00465	99999	02211	99976	03955	99922	05698	99838	07440	99723	44
17	00495	99999	02240	99975	03984	99921	05727	99836	07469	99721	43
18	00524	99999	02269	99974	04013	99919	05756	99834	07498	99719	42
19	00553	99998	02298	99974	04042	99918	05785	99833	07527	99716	41
20	00582	99998	02327	99973	04071	99917	05814	99831	07556	99714	40
21	00611	99998	02356	99972	04100	99916	05844	99829	07585	99712	39
22	00640	99998	02385	99972	04129	99915	05873	99827	07614	99710	38
23	00669	99998	02414	99971	04159	99913	05902	99826	07643	99708	37
24	00698	99998	02443	99970	04188	99912	05931	99824	07672	99705	36
25	00727	99997	02472	99969	04217	99911	05960	99822	07701	99703	35
26	00756	99997	02501	99969	04246	99910	05989	99821	07730	99701	34
27	00785	99997	02530	99968	04275	99909	06018	99819	07759	99699	33
28	00814	99997	02560	99967	04304	99907	06047	99817	07788	99696	32
29	00844	99996	02589	99966	04333	99906	06076	99815	07817	99694	31
30	00873	99996	02618	99966	04362	99905	06105	99813	07846	99692	30
31	00902	99996	02647	99965	04391	99904	06134	99812	07875	99689	29
32	00931	99996	02676	99964	04420	99902	06163	99810	07904	99687	28
33	00960	99995	02705	99963	04449	99901	06192	99808	07933	99685	27
34	00989	99995	02734	99963	04478	99900	06221	99806	07962	99683	26
35	01018	99995	02763	99962	04507	99898	06250	99804	07991	99680	25
36	01047	99995	02792	99961	04536	99897	06279	99803	08020	99678	24
37	01076	99994	02821	99960	04565	99896	06308	99801	08049	99676	23
38	01105	99994	02850	99959	04594	99894	06337	99799	08078	99673	22
39	01134	99994	02879	99959	04623	99893	06366	99797	08107	99671	21
40	01164	99993	02908	99958	04653	99892	06395	99795	08136	99668	20
41	01193	99993	02938	99957	04682	99890	06424	99793	08165	99666	19
42	01222	99993	02967	99956	04711	99889	06453	99792	08194	99664	18
43	01251	99992	02996	99955	04740	99888	06482	99790	08223	99661	17
44	01280	99992	03025	99954	04769	99886	06511	99788	08252	99659	16
45	01309	99991	03054	99953	04798	99885	06540	99786	08281	99657	15
46	01338	99991	03083	99952	04827	99883	06569	99784	08310	99654	14
47	01367	99991	03112	99952	04856	99882	06598	99782	08339	99652	13
48	01396	99990	03141	99951	04885	99881	06627	99780	08368	99649	12
49	01425	99990	03170	99950	04914	99879	06656	99778	08397	99647	11
50	01454	99989	03199	99949	04943	99878	06685	99776	08426	99644	10
51	01483	99989	03228	99948	04972	99876	06714	99774	08455	99642	9
52	01513	99989	03257	99947	05001	99875	06743	99772	08484	99639	8
53	01542	99988	03286	99946	05030	99873	06773	99770	08513	99637	7
54	01571	99988	03316	99945	05059	99872	06802	99768	08542	99635	6
55	01600	99987	03345	99944	05088	99870	06831	99766	08571	99632	5
56	01629	99987	03374	99943	05117	99869	06860	99764	08600	99630	4
57	01658	99986	03403	99942	05146	99867	06889	99762	08629	99627	3
58	01687	99986	03432	99941	05175	99866	06918	99760	08658	99625	2
59	01716	99985	03461	99940	05205	99864	06947	99758	08687	99622	1
60	01745	99985	03490	99939	05234	99863	06976	99756	08716	99619	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M
	89°		88°		87°		86°		85°		

Table XXII. Of Natural Sines.

M	5° N. sine	5° N. cos.	6° N. sine	6° N. cos.	7° N. sine	7° N. cos.	8° N. sine	8° N. cos.	9° N. sine	9° N. cos.	
0	08716	99619	10453	99452	12187	99255	13917	99027	15643	98769	60
1	08745	99617	10482	99449	12216	99251	13946	99023	15672	98764	59
2	08774	99614	10511	99446	12245	99248	13975	99019	15701	98760	58
3	08803	99612	10540	99443	12274	99244	14004	99015	15730	98755	57
4	08831	99609	10569	99440	12302	99240	14033	99011	15758	98751	56
5	08860	99607	10597	99437	12331	99237	14061	99006	15787	98746	55
6	08889	99604	10626	99434	12360	99233	14090	99002	15816	98741	54
7	08918	99602	10655	99431	12389	99230	14119	98998	15845	98737	53
8	08947	99599	10684	99428	12418	99226	14148	98994	15873	98732	52
9	08976	99596	10713	99424	12447	99222	14177	98990	15902	98728	51
10	09005	99594	10742	99421	12476	99219	14205	98986	15931	98723	50
11	09034	99591	10771	99418	12504	99215	14234	98982	15959	98718	49
12	09063	99588	10800	99415	12533	99211	14263	98978	15988	98714	48
13	09092	99586	10829	99412	12562	99208	14292	98973	16017	98709	47
14	09121	99583	10858	99409	12591	99204	14320	98969	16046	98704	46
15	09150	99580	10887	99406	12620	99200	14349	98965	16074	98700	45
16	09179	99578	10916	99402	12649	99197	14378	98961	16103	98695	44
17	09208	99575	10945	99399	12678	99193	14407	98957	16132	98690	43
18	09237	99572	10973	99396	12706	99189	14436	98953	16160	98686	42
19	09266	99570	11002	99393	12735	99186	14464	98948	16189	98681	41
20	09295	99567	11031	99390	12764	99182	14493	98944	16218	98676	40
21	09324	99564	11060	99386	12793	99178	14522	98940	16246	98671	39
22	09353	99562	11089	99383	12822	99175	14551	98936	16275	98667	38
23	09382	99559	11118	99380	12851	99171	14580	98931	16304	98662	37
24	09411	99556	11147	99377	12880	99167	14608	98927	16333	98657	36
25	09440	99553	11176	99374	12908	99163	14637	98923	16361	98652	35
26	09469	99551	11205	99370	12937	99160	14666	98919	16390	98648	34
27	09498	99548	11234	99367	12966	99156	14695	98914	16419	98643	33
28	09527	99545	11263	99364	12995	99152	14723	98910	16447	98638	32
29	09556	99542	11291	99360	13024	99148	14752	98906	16476	98633	31
30	09585	99540	11320	99357	13053	99144	14781	98902	16505	98629	30
31	09614	99537	11349	99354	13081	99141	14810	98897	16533	98624	29
32	09642	99534	11378	99351	13110	99137	14838	98893	16562	98619	28
33	09671	99531	11407	99347	13139	99133	14867	98889	16591	98614	27
34	09700	99528	11436	99344	13168	99129	14896	98884	16620	98609	26
35	09729	99526	11465	99341	13197	99125	14925	98880	16648	98604	25
36	09758	99523	11494	99337	13226	99122	14954	98876	16677	98600	24
37	09787	99520	11523	99334	13254	99118	14982	98871	16706	98595	23
38	09816	99517	11552	99331	13283	99114	15011	98867	16734	98590	22
39	09845	99514	11580	99327	13312	99110	15040	98863	16763	98585	21
40	09874	99511	11609	99324	13341	99106	15069	98858	16792	98580	20
41	09903	99508	11638	99320	13370	99102	15097	98854	16820	98575	19
42	09932	99506	11667	99317	13399	99098	15126	98849	16849	98570	18
43	09961	99503	11696	99314	13427	99094	15155	98845	16878	98565	17
44	09990	99500	11725	99310	13456	99091	15184	98841	16906	98561	16
45	10019	99497	11754	99307	13485	99087	15212	98836	16935	98556	15
46	10048	99494	11783	99303	13514	99083	15241	98832	16964	98551	14
47	10077	99491	11812	99300	13543	99079	15270	98827	16992	98546	13
48	10106	99488	11840	99297	13572	99075	15299	98823	17021	98541	12
49	10135	99485	11869	99293	13600	99071	15327	98818	17050	98536	11
50	10164	99482	11898	99290	13629	99067	15356	98814	17078	98531	10
51	10192	99479	11927	99286	13658	99063	15385	98809	17107	98526	9
52	10221	99476	11956	99283	13687	99059	15414	98805	17136	98521	8
53	10250	99473	11985	99279	13716	99055	15442	98800	17164	98516	7
54	10279	99470	12014	99276	13744	99051	15471	98796	17193	98511	6
55	10308	99467	12043	99272	13773	99047	15500	98791	17222	98506	5
56	10337	99464	12071	99269	13802	99043	15529	98787	17250	98501	4
57	10366	99461	12100	99265	13831	99039	15557	98782	17279	98496	3
58	10395	99458	12129	99262	13860	99035	15586	98778	17308	98491	2
59	10424	99455	12158	99258	13889	99031	15615	98773	17336	98486	1
60	10453	99452	12187	99255	13917	99027	15643	98769	17365	98481	0
	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	
	84°		83°		82°		81°		80°		M

	10°		11°		12°		13°		14°		
M.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	
0	17365	98481	19081	98163	20791	97815	22495	97437	24192	97030	60
1	17393	98476	19109	98157	20820	97809	22523	97430	24220	97023	59
2	17422	98471	19138	98152	20848	97803	22552	97424	24249	97015	58
3	17451	98466	19167	98146	20877	97797	22580	97417	24277	97008	57
4	17479	98461	19195	98140	20905	97791	22608	97411	24305	97001	56
5	17508	98455	19224	98135	20933	97784	22637	97404	24333	96994	55
6	17537	98450	19252	98129	20962	97778	22665	97398	24362	96987	54
7	17565	98445	19281	98124	20990	97772	22693	97391	24390	96980	53
8	17594	98440	19309	98118	21019	97765	22722	97384	24418	96973	52
9	17623	98435	19338	98112	21047	97760	22750	97378	24446	96966	51
10	17651	98430	19366	98107	21076	97754	22778	97371	24474	96959	50
11	17680	98425	19395	98101	21104	97748	22807	97365	24503	96952	49
12	17708	98420	19423	98096	21132	97742	22835	97358	24531	96945	48
13	17737	98414	19452	98090	21161	97735	22863	97351	24559	96937	47
14	17766	98409	19481	98084	21189	97729	22892	97345	24587	96930	46
15	17794	98404	19509	98079	21218	97723	22920	97338	24615	96923	45
16	17823	98399	19538	98073	21246	97717	22948	97331	24644	96916	44
17	17852	98394	19566	98067	21275	97711	22977	97325	24672	96909	43
18	17880	98389	19595	98061	21303	97705	23005	97318	24700	96902	42
19	17909	98383	19623	98056	21331	97698	23033	97311	24728	96894	41
20	17937	98378	19652	98050	21360	97692	23062	97304	24756	96887	40
21	17966	98373	19680	98044	21388	97686	23090	97298	24784	96880	39
22	17995	98368	19709	98039	21417	97680	23118	97291	24813	96873	38
23	18023	98362	19737	98033	21445	97673	23146	97284	24841	96866	37
24	18052	98357	19766	98027	21474	97667	23175	97278	24869	96858	36
25	18081	98352	19794	98021	21502	97661	23203	97271	24897	96851	35
26	18109	98347	19823	98016	21530	97655	23231	97264	24925	96844	34
27	18138	98341	19851	98010	21559	97648	23260	97257	24954	96837	33
28	18166	98336	19880	98004	21587	97642	23288	97251	24982	96829	32
29	18195	98331	19908	97998	21616	97636	23316	97244	25010	96822	31
30	18224	98325	19937	97992	21644	97630	23345	97237	25038	96815	30
31	18252	98320	19965	97987	21672	97623	23373	97230	25066	96807	29
32	18281	98315	19994	97981	21701	97617	23401	97223	25094	96800	28
33	18309	98310	20022	97975	21729	97611	23429	97217	25122	96793	27
34	18338	98304	20051	97969	21758	97604	23458	97210	25151	96786	26
35	18367	98299	20079	97963	21786	97598	23486	97203	25179	96778	25
36	18395	98294	20108	97958	21814	97592	23514	97196	25207	96771	24
37	18424	98288	20136	97952	21843	97585	23542	97189	25235	96764	23
38	18452	98283	20165	97946	21871	97579	23571	97182	25263	96756	22
39	18481	98277	20193	97940	21899	97573	23599	97176	25291	96749	21
40	18509	98272	20222	97934	21928	97566	23627	97169	25320	96742	20
41	18538	98267	20250	97928	21956	97560	23656	97162	25348	96734	19
42	18567	98261	20279	97922	21985	97553	23684	97155	25376	96727	18
43	18595	98256	20307	97916	22013	97547	23712	97148	25404	96719	17
44	18624	98250	20336	97910	22041	97541	23740	97141	25432	96712	16
45	18652	98245	20364	97905	22070	97534	23769	97134	25460	96705	15
46	18681	98240	20393	97899	22098	97528	23797	97127	25488	96697	14
47	18710	98234	20421	97893	22126	97521	23825	97120	25516	96690	13
48	18738	98229	20450	97887	22155	97515	23853	97113	25545	96682	12
49	18767	98223	20478	97881	22183	97508	23882	97106	25573	96675	11
50	18795	98218	20507	97875	22212	97502	23910	97100	25601	96667	10
51	18824	98212	20535	97869	22240	97496	23938	97093	25629	96660	9
52	18852	98207	20563	97863	22268	97489	23966	97086	25657	96653	8
53	18881	98201	20592	97857	22297	97483	23995	97079	25685	96645	7
54	18910	98196	20620	97851	22325	97476	24023	97072	25713	96638	6
55	18938	98190	20649	97845	22353	97470	24051	97065	25741	96630	5
56	18967	98185	20677	97839	22382	97463	24079	97058	25769	96623	4
57	18995	98179	20706	97833	22410	97457	24108	97051	25798	96615	3
58	19024	98174	20734	97827	22438	97450	24136	97044	25826	96608	2
59	19052	98168	20763	97821	22467	97444	24164	97037	25854	96600	1
60	19081	98163	20791	97815	22495	97437	24192	97030	25882	96593	0
	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	M
	79°		78°		77°		76°		75°		

M	15° N. sine.	15° N. cos.	16° N. sine.	16° N. cos.	17° N. sine.	17° N. cos.	18° N. sine.	18° N. cos.	19° N. sine.	19° N. cos.	
0	25882	96593	27564	96126	29237	95630	30902	95106	32557	94552	60
1	25910	96585	27592	96118	29265	95622	30929	95097	32584	94542	59
2	25938	96578	27620	96110	29293	95613	30957	95088	32612	94533	58
3	25966	96570	27648	96102	29321	95605	30985	95079	32639	94523	57
4	25994	96562	27676	96094	29348	95596	31012	95070	32667	94514	56
5	26022	96555	27704	96086	29376	95588	31040	95061	32694	94504	55
6	26050	96547	27731	96078	29404	95579	31068	95052	32722	94495	54
7	26079	96540	27759	96070	29432	95571	31095	95043	32749	94485	53
8	26107	96532	27787	96062	29460	95562	31123	95033	32777	94476	52
9	26135	96524	27815	96054	29487	95554	31151	95024	32804	94466	51
10	26163	96517	27843	96046	29515	95545	31178	95015	32832	94457	50
11	26191	96509	27871	96037	29543	95536	31206	95006	32859	94447	49
12	26219	96502	27899	96029	29571	95528	31233	94997	32887	94438	48
13	26247	96494	27927	96021	29599	95519	31261	94988	32914	94428	47
14	26275	96486	27955	96013	29626	95511	31289	94979	32942	94418	46
15	26303	96479	27983	96005	29654	95502	31316	94970	32969	94409	45
16	26331	96471	28011	95997	29682	95493	31344	94961	32997	94399	44
17	26359	96463	28039	95989	29710	95485	31372	94952	33024	94390	43
18	26387	96456	28067	95981	29737	95476	31399	94943	33051	94380	42
19	26415	96448	28095	95972	29765	95467	31427	94933	33079	94370	41
20	26443	96440	28123	95964	29793	95459	31454	94924	33106	94361	40
21	26471	96433	28150	95956	29821	95450	31482	94915	33134	94351	39
22	26500	96425	28178	95948	29849	95441	31510	94906	33161	94342	38
23	26528	96417	28206	95940	29876	95433	31537	94897	33189	94332	37
24	26556	96410	28234	95931	29904	95424	31565	94888	33216	94322	36
25	26584	96402	28262	95923	29932	95415	31593	94878	33244	94313	35
26	26612	96394	28290	95915	29960	95407	31620	94869	33271	94303	34
27	26640	96386	28318	95907	29987	95398	31648	94860	33298	94293	33
28	26668	96379	28346	95898	30015	95389	31675	94851	33326	94284	32
29	26696	96371	28374	95890	30043	95380	31703	94842	33353	94274	31
30	26724	96363	28402	95882	30071	95372	31730	94832	33381	94264	30
31	26752	96355	28429	95874	30098	95363	31758	94823	33408	94254	29
32	26780	96347	28457	95865	30126	95354	31786	94814	33436	94245	28
33	26808	96340	28485	95857	30154	95345	31813	94805	33463	94235	27
34	26836	96332	28513	95849	30182	95337	31841	94795	33490	94225	26
35	26864	96324	28541	95841	30209	95328	31868	94786	33518	94215	25
36	26892	96316	28569	95832	30237	95319	31896	94777	33545	94206	24
37	26920	96308	28597	95824	30265	95310	31923	94768	33573	94196	23
38	26948	96301	28625	95816	30292	95301	31951	94758	33600	94186	22
39	26976	96293	28652	95807	30320	95293	31979	94749	33627	94176	21
40	27004	96285	28680	95799	30348	95284	32006	94740	33655	94167	20
41	27032	96277	28708	95791	30376	95275	32034	94730	33682	94157	19
42	27060	96269	28736	95782	30403	95266	32061	94721	33710	94147	18
43	27088	96261	28764	95774	30431	95257	32089	94712	33737	94137	17
44	27116	96253	28792	95766	30459	95248	32116	94702	33764	94127	16
45	27144	96246	28820	95757	30486	95240	32144	94693	33792	94118	15
46	27172	96238	28847	95749	30514	95231	32171	94684	33819	94108	14
47	27200	96230	28875	95740	30542	95222	32199	94674	33846	94098	13
48	27228	96222	28903	95732	30570	95213	32227	94665	33874	94088	12
49	27256	96214	28931	95724	30597	95204	32254	94656	33901	94078	11
50	27284	96206	28959	95715	30625	95195	32282	94646	33929	94068	10
51	27312	96198	28987	95707	30653	95186	32309	94637	33956	94058	9
52	27340	96190	29015	95698	30680	95177	32337	94627	33983	94049	8
53	27368	96182	29042	95690	30708	95168	32364	94618	34011	94039	7
54	27396	96174	29070	95681	30736	95159	32392	94609	34038	94029	6
55	27424	96166	29098	95673	30763	95150	32419	94599	34065	94019	5
56	27452	96158	29126	95664	30791	95142	32447	94590	34093	94009	4
57	27480	96150	29154	95656	30819	95133	32474	94580	34120	93999	3
58	27508	96142	29182	95647	30846	95124	32502	94571	34147	93989	2
59	27536	96134	29209	95639	30874	95115	32529	94561	34175	93979	1
60	27564	96126	29237	95630	30902	95106	32557	94552	34202	93969	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M
	74°		73°		72°		71°		70°		

TABLE XXII. Of Natural Sines.

M	20° N. fine.	20° N. cof.	21° N. fine.	21° N. cof.	22° N. fine.	22° N. cof.	23° N. fine.	23° N. cof.	24° N. fine.	24° N. cof.	
0	34202	93969	35837	93358	37461	92718	39073	92050	40674	91355	60
1	34229	93959	35864	93348	37488	92707	39100	92039	40700	91343	59
2	34257	93949	35891	93337	37515	92697	39127	92028	40727	91331	58
3	34284	93939	35918	93327	37542	92686	39153	92016	40753	91319	57
4	34311	93929	35945	93316	37569	92675	39180	92005	40780	91307	56
5	34339	93919	35973	93306	37595	92664	39207	91994	40806	91295	55
6	34366	93909	36000	93295	37622	92653	39234	91982	40833	91283	54
7	34393	93899	36027	93285	37649	92642	39260	91971	40860	91272	53
8	34421	93889	36054	93274	37676	92631	39287	91959	40886	91260	52
9	34448	93879	36081	93264	37703	92620	39314	91948	40913	91248	51
10	34475	93869	36108	93253	37730	92609	39341	91936	40939	91236	50
11	34503	93859	36135	93243	37757	92598	39367	91925	40966	91224	49
12	34530	93849	36162	93232	37784	92587	39394	91914	40992	91212	48
13	34557	93839	36190	93222	37811	92576	39421	91902	41019	91200	47
14	34584	93829	36217	93211	37838	92565	39448	91891	41045	91188	46
15	34612	93819	36244	93201	37865	92554	39474	91879	41072	91176	45
16	34639	93809	36271	93190	37892	92543	39501	91868	41098	91164	44
17	34666	93799	36298	93180	37919	92532	39528	91856	41125	91152	43
18	34694	93789	36325	93169	37946	92521	39555	91845	41151	91140	42
19	34721	93779	36352	93159	37973	92510	39581	91833	41178	91128	41
20	34748	93769	36379	93148	37999	92499	39608	91822	41204	91116	40
21	34775	93759	36406	93137	38026	92488	39635	91810	41231	91104	39
22	34803	93748	36434	93127	38053	92477	39661	91799	41257	91092	38
23	34830	93738	36461	93116	38080	92466	39688	91787	41284	91080	37
24	34857	93728	36488	93106	38107	92455	39715	91775	41310	91068	36
25	34884	93718	36515	93095	38134	92444	39741	91764	41337	91056	35
26	34912	93708	36542	93084	38161	92432	39768	91752	41363	91044	34
27	34939	93698	36569	93074	38188	92421	39795	91741	41390	91032	33
28	34966	93688	36596	93063	38215	92410	39822	91729	41416	91020	32
29	34993	93677	36623	93052	38241	92399	39848	91718	41443	91008	31
30	35021	93667	36650	93042	38268	92388	39875	91706	41469	90996	30
31	35048	93657	36677	93031	38295	92377	39902	91694	41496	90984	29
32	35075	93647	36704	93020	38322	92366	39928	91683	41522	90972	28
33	35102	93637	36731	93010	38349	92355	39955	91671	41549	90960	27
34	35130	93626	36758	92999	38376	92343	39982	91660	41575	90948	26
35	35157	93616	36785	92988	38403	92332	40008	91648	41602	90936	25
36	35184	93606	36812	92978	38430	92321	40035	91636	41628	90924	24
37	35211	93596	36839	92967	38456	92310	40062	91625	41655	90911	23
38	35239	93585	36867	92956	38483	92299	40088	91613	41681	90899	22
39	35266	93575	36894	92945	38510	92287	40115	91601	41707	90887	21
40	35293	93565	36921	92935	38537	92276	40141	91590	41734	90875	20
41	35320	93555	36948	92924	38564	92265	40168	91578	41760	90863	19
42	35347	93544	36975	92913	38591	92254	40195	91566	41787	90851	18
43	35375	93534	37002	92902	38617	92243	40221	91555	41813	90839	17
44	35402	93524	37029	92892	38644	92231	40248	91543	41840	90826	16
45	35429	93514	37056	92881	38671	92220	40275	91531	41866	90814	15
46	35456	93503	37083	92870	38698	92209	40301	91519	41892	90802	14
47	35484	93493	37110	92859	38725	92198	40328	91508	41919	90790	13
48	35511	93483	37137	92849	38752	92186	40355	91496	41945	90778	12
49	35538	93472	37164	92838	38778	92175	40381	91484	41972	90766	11
50	35565	93462	37191	92827	38805	92164	40408	91472	41998	90753	10
51	35592	93452	37218	92816	38832	92152	40434	91461	42024	90741	9
52	35619	93441	37245	92805	38859	92141	40461	91449	42051	90729	8
53	35647	93431	37272	92794	38886	92130	40488	91437	42077	90717	7
54	35674	93420	37299	92784	38912	92119	40514	91425	42104	90704	6
55	35701	93410	37326	92773	38939	92107	40541	91414	42130	90692	5
56	35728	93400	37353	92762	38966	92096	40567	91402	42156	90680	4
57	35755	93389	37380	92751	38993	92085	40594	91390	42183	90668	3
58	35782	93379	37407	92740	39020	92073	40621	91378	42209	90655	2
59	35810	93368	37434	92729	39046	92062	40647	91366	42235	90643	1
60	35837	93358	37461	92718	39073	92050	40674	91355	42262	90631	0
	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	M
	69°		68°		67°		66°		65°		

M	25° N. sine	N. cos.	26° N. sine	N. cos.	27° N. sine	N. cos.	28° N. sine	N. cos.	29° N. sine	N. cos.	
0	42262	90631	43837	89879	45399	89101	46947	88295	48481	87462	60
1	42288	90618	43863	89867	45425	89087	46973	88281	48506	87448	59
2	42315	90606	43889	89854	45451	89074	46999	88267	48532	87434	58
3	42341	90594	43916	89841	45477	89061	47024	88254	48557	87420	57
4	42367	90582	43942	89828	45503	89048	47050	88240	48583	87406	56
5	42394	90569	43968	89816	45529	89035	47076	88226	48608	87391	55
6	42420	90557	43994	89803	45554	89021	47101	88213	48634	87377	54
7	42446	90545	44020	89790	45580	89008	47127	88199	48659	87363	53
8	42473	90532	44046	89777	45606	88995	47153	88185	48684	87349	52
9	42499	90520	44072	89764	45632	88981	47178	88172	48710	87335	51
10	42525	90507	44098	89752	45658	88968	47204	88158	48735	87321	50
11	42552	90495	44124	89739	45684	88955	47229	88144	48761	87306	49
12	42578	90483	44151	89726	45710	88942	47255	88130	48786	87292	48
13	42604	90470	44177	89713	45736	88928	47281	88117	48811	87278	47
14	42631	90458	44203	89700	45762	88915	47306	88103	48837	87264	46
15	42657	90446	44229	89687	45787	88902	47332	88089	48862	87250	45
16	42683	90433	44255	89674	45813	88888	47358	88075	48888	87235	44
17	42709	90421	44281	89662	45839	88875	47383	88062	48913	87221	43
18	42736	90408	44307	89649	45865	88862	47409	88048	48938	87207	42
19	42762	90396	44333	89636	45891	88848	47434	88034	48964	87193	41
20	42788	90383	44359	89623	45917	88835	47460	88020	48989	87178	40
21	42815	90371	44385	89610	45942	88822	47486	88006	49014	87164	39
22	42841	90358	44411	89597	45968	88808	47511	87993	49040	87150	38
23	42867	90346	44437	89584	45994	88795	47537	87979	49065	87136	37
24	42894	90334	44464	89571	46020	88782	47562	87965	49090	87121	36
25	42920	90321	44490	89558	46046	88768	47588	87951	49116	87107	35
26	42946	90309	44516	89545	46072	88755	47614	87937	49141	87093	34
27	42972	90296	44542	89532	46097	88741	47639	87923	49166	87079	33
28	42999	90284	44568	89519	46123	88728	47665	87909	49192	87064	32
29	43025	90271	44594	89506	46149	88715	47690	87896	49217	87050	31
30	43051	90259	44620	89493	46175	88701	47716	87882	49242	87036	30
31	43077	90246	44646	89480	46201	88688	47741	87868	49268	87021	29
32	43104	90233	44672	89467	46226	88674	47767	87854	49293	87007	28
33	43130	90221	44698	89454	46252	88661	47793	87840	49318	86993	27
34	43156	90208	44724	89441	46278	88647	47818	87826	49344	86978	26
35	43182	90196	44750	89428	46304	88634	47844	87812	49369	86964	25
36	43209	90183	44776	89415	46330	88620	47869	87798	49394	86949	24
37	43235	90171	44802	89402	46355	88607	47895	87784	49419	86935	23
38	43261	90158	44828	89389	46381	88593	47920	87770	49445	86921	22
39	43287	90146	44854	89376	46407	88580	47946	87756	49470	86906	21
40	43313	90133	44880	89363	46433	88566	47971	87743	49495	86892	20
41	43340	90120	44906	89350	46458	88553	47997	87729	49521	86878	19
42	43366	90108	44932	89337	46484	88539	48022	87715	49546	86863	18
43	43392	90095	44958	89324	46510	88526	48048	87701	49571	86849	17
44	43418	90082	44984	89311	46536	88512	48073	87687	49596	86834	16
45	43445	90070	45010	89298	46561	88499	48099	87673	49622	86820	15
46	43471	90057	45036	89285	46587	88485	48124	87659	49647	86805	14
47	43497	90045	45062	89272	46613	88472	48150	87645	49672	86791	13
48	43523	90032	45088	89259	46639	88458	48175	87631	49697	86777	12
49	43549	90019	45114	89245	46664	88445	48201	87617	49723	86762	11
50	43575	90007	45140	89232	46690	88431	48226	87603	49748	86748	10
51	43602	89994	45166	89219	46716	88417	48252	87589	49773	86733	9
52	43628	89981	45192	89206	46742	88404	48277	87575	49798	86719	8
53	43654	89968	45218	89193	46767	88390	48303	87561	49824	86704	7
54	43680	89956	45243	89180	46793	88377	48328	87546	49849	86690	6
55	43706	89943	45269	89167	46819	88363	48354	87532	49874	86675	5
56	43733	89930	45295	89153	46844	88349	48379	87518	49899	86661	4
57	43759	89918	45321	89140	46870	88336	48405	87504	49924	86646	3
58	43785	89905	45347	89127	46896	88322	48430	87490	49950	86632	2
59	43811	89892	45373	89114	46921	88308	48456	87476	49975	86617	1
60	43837	89879	45399	89101	46947	88295	48481	87462	50000	86603	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M
	64°		63°		62°		61°		60°		

	30°		31°		32°		33°		34°		
M	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	
0	50000	86603	51504	85717	52992	84805	54464	83867	55919	82904	60
1	50025	86588	51529	85702	53017	84789	54488	83851	55943	82887	59
2	50050	86573	51554	85687	53041	84774	54513	83835	55968	82871	58
3	50076	86559	51579	85672	53066	84759	54537	83819	55992	82855	57
4	50101	86544	51604	85657	53091	84743	54561	83804	56016	82839	56
5	50126	86530	51628	85642	53115	84728	54586	83788	56040	82822	55
6	50151	86515	51653	85627	53140	84712	54610	83772	56064	82806	54
7	50176	86501	51678	85612	53164	84697	54635	83756	56088	82790	53
8	50201	86486	51703	85597	53189	84681	54659	83740	56112	82773	52
9	50227	86471	51728	85582	53214	84666	54683	83724	56136	82757	51
10	50252	86457	51753	85567	53238	84650	54708	83708	56160	82741	50
11	50277	86442	51778	85551	53263	84635	54732	83692	56184	82724	49
12	50302	86427	51803	85536	53288	84619	54756	83676	56208	82708	48
13	50327	86413	51828	85521	53312	84604	54781	83660	56232	82692	47
14	50352	86398	51852	85506	53337	84588	54805	83645	56256	82675	46
15	50377	86384	51877	85491	53361	84573	54829	83629	56280	82659	45
16	50403	86369	51902	85476	53386	84557	54854	83613	56305	82643	44
17	50428	86354	51927	85461	53411	84542	54878	83597	56329	82626	43
18	50453	86340	51952	85446	53435	84526	54902	83581	56353	82610	42
19	50478	86325	51977	85431	53460	84511	54927	83565	56377	82593	41
20	50503	86310	52002	85416	53484	84495	54951	83549	56401	82577	40
21	50528	86295	52026	85401	53509	84480	54975	83533	56425	82561	39
22	50553	86281	52051	85385	53534	84464	54999	83517	56449	82544	38
23	50578	86266	52076	85370	53558	84448	55024	83501	56473	82528	37
24	50603	86251	52101	85355	53583	84433	55048	83485	56497	82511	36
25	50628	86237	52126	85340	53607	84417	55072	83469	56521	82495	35
26	50654	86222	52151	85325	53632	84402	55097	83453	56545	82478	34
27	50679	86207	52175	85310	53656	84386	55121	83437	56569	82462	33
28	50704	86192	52200	85294	53681	84370	55145	83421	56593	82446	32
29	50729	86178	52225	85279	53705	84355	55169	83405	56617	82429	31
30	50754	86163	52250	85264	53730	84339	55194	83389	56641	82413	30
31	50779	86148	52275	85249	53754	84324	55218	83373	56665	82396	29
32	50804	86133	52299	85234	53779	84308	55242	83356	56689	82380	28
33	50829	86119	52324	85218	53804	84292	55266	83340	56713	82363	27
34	50854	86104	52349	85203	53828	84277	55291	83324	56736	82347	26
35	50879	86089	52374	85188	53853	84261	55315	83308	56760	82330	25
36	50904	86074	52399	85173	53877	84245	55339	83292	56784	82314	24
37	50929	86059	52423	85157	53902	84230	55363	83276	56808	82297	23
38	50954	86045	52448	85142	53926	84214	55388	83260	56832	82281	22
39	50979	86030	52473	85127	53951	84198	55412	83244	56856	82264	21
40	51004	86015	52498	85112	53975	84182	55436	83228	56880	82248	20
41	51029	86000	52522	85096	54000	84167	55460	83212	56904	82231	19
42	51054	85985	52547	85081	54024	84151	55484	83195	56928	82214	18
43	51079	85970	52572	85066	54049	84135	55509	83179	56952	82198	17
44	51104	85956	52597	85051	54073	84120	55533	83163	56976	82181	16
45	51129	85941	52621	85035	54097	84104	55557	83147	57000	82165	15
46	51154	85926	52646	85020	54122	84088	55581	83131	57024	82148	14
47	51179	85911	52671	85005	54146	84072	55605	83115	57047	82132	13
48	51204	85896	52696	84989	54171	84057	55630	83098	57071	82115	12
49	51229	85881	52720	84974	54195	84041	55654	83082	57095	82098	11
50	51254	85866	52745	84959	54220	84025	55678	83066	57119	82082	10
51	51279	85851	52770	84943	54244	84009	55702	83050	57143	82065	9
52	51304	85836	52794	84928	54269	83994	55726	83034	57167	82048	8
53	51329	85821	52819	84913	54293	83978	55750	83017	57191	82032	7
54	51354	85806	52844	84897	54317	83962	55775	83001	57215	82015	6
55	51379	85792	52869	84882	54342	83946	55799	82985	57238	81999	5
56	51404	85777	52893	84866	54366	83930	55823	82969	57262	81982	4
57	51429	85762	52918	84851	54391	83915	55847	82953	57286	81965	3
58	51454	85747	52943	84836	54415	83899	55871	82936	57310	81949	2
59	51479	85732	52967	84820	54440	83883	55895	82920	57334	81932	1
60	51504	85717	52992	84805	54464	83867	55919	82904	57358	81915	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M
	59°		58°		57°		56°		55°		

M	35°		36°		37°		38°		39°		
	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	
0	57358	81915	58779	80902	60182	79864	61566	78801	62932	77715	60
1	57381	81899	58802	80885	60205	79846	61589	78783	62955	77696	59
2	57405	81882	58826	80867	60228	79829	61612	78765	62977	77678	58
3	57429	81865	58849	80850	60251	79811	61635	78747	63000	77660	57
4	57453	81848	58873	80833	60274	79793	61658	78729	63022	77641	56
5	57477	81832	58896	80816	60298	79776	61681	78711	63045	77623	55
6	57501	81815	58920	80799	60321	79758	61704	78694	63068	77605	54
7	57524	81798	58943	80782	60344	79741	61726	78676	63090	77586	53
8	57548	81782	58967	80765	60367	79723	61749	78658	63113	77568	52
9	57572	81765	58990	80748	60390	79706	61772	78640	63135	77550	51
10	57596	81748	59014	80730	60414	79688	61795	78622	63158	77531	50
11	57619	81731	59037	80713	60437	79671	61818	78604	63180	77513	49
12	57643	81714	59061	80696	60460	79653	61841	78586	63203	77494	48
13	57667	81698	59084	80679	60483	79635	61864	78568	63225	77476	47
14	57691	81681	59108	80662	60506	79618	61887	78550	63248	77458	46
15	57715	81664	59131	80644	60529	79600	61909	78532	63271	77439	45
16	57738	81647	59154	80627	60553	79583	61932	78514	63293	77421	44
17	57762	81631	59178	80610	60576	79565	61955	78496	63316	77402	43
18	57786	81614	59201	80593	60599	79547	61978	78478	63338	77384	42
19	57810	81597	59225	80576	60622	79530	62001	78460	63361	77366	41
20	57833	81580	59248	80558	60645	79512	62024	78442	63383	77347	40
21	57857	81563	59272	80541	60668	79494	62046	78424	63406	77329	39
22	57881	81546	59295	80524	60691	79477	62069	78405	63428	77310	38
23	57904	81530	59318	80507	60714	79459	62092	78387	63451	77292	37
24	57928	81513	59342	80489	60738	79441	62115	78369	63473	77273	36
25	57952	81496	59365	80472	60761	79424	62138	78351	63496	77255	35
26	57976	81479	59389	80455	60784	79406	62160	78333	63518	77236	34
27	57999	81462	59412	80438	60807	79388	62183	78315	63540	77218	33
28	58023	81445	59436	80420	60830	79371	62206	78297	63563	77199	32
29	58047	81428	59459	80403	60853	79353	62229	78279	63585	77181	31
30	58070	81412	59482	80386	60876	79335	62251	78261	63608	77162	30
31	58094	81395	59506	80368	60899	79318	62274	78243	63630	77144	29
32	58118	81378	59529	80351	60922	79300	62297	78225	63653	77125	28
33	58141	81361	59552	80334	60945	79282	62320	78206	63675	77107	27
34	58165	81344	59576	80316	60968	79264	62342	78188	63698	77088	26
35	58189	81327	59599	80299	60991	79247	62365	78170	63720	77070	25
36	58212	81310	59622	80282	61015	79229	62388	78152	63742	77051	24
37	58236	81293	59646	80264	61038	79211	62411	78134	63765	77033	23
38	58260	81276	59669	80247	61061	79193	62433	78116	63787	77014	22
39	58283	81259	59693	80230	61084	79176	62456	78098	63810	76996	21
40	58307	81242	59716	80212	61107	79158	62479	78079	63832	76977	20
41	58330	81225	59739	80195	61130	79140	62502	78061	63854	76959	19
42	58354	81208	59763	80178	61153	79122	62524	78043	63877	76940	18
43	58378	81191	59786	80160	61176	79105	62547	78025	63899	76921	17
44	58401	81174	59809	80143	61199	79087	62570	78007	63922	76903	16
45	58425	81157	59832	80125	61222	79069	62592	77988	63944	76884	15
46	58449	81140	59856	80108	61245	79051	62615	77970	63966	76866	14
47	58472	81123	59879	80091	61268	79033	62638	77952	63989	76847	13
48	58496	81106	59902	80073	61291	79016	62660	77934	64011	76828	12
49	58519	81089	59926	80056	61314	78998	62683	77916	64033	76810	11
50	58543	81072	59949	80038	61337	78980	62706	77897	64056	76791	10
51	58567	81055	59972	80021	61360	78962	62728	77879	64078	76772	9
52	58590	81038	59995	80003	61383	78944	62751	77861	64100	76754	8
53	58614	81021	60019	79986	61406	78926	62774	77843	64123	76735	7
54	58637	81004	60042	79968	61429	78908	62796	77824	64145	76717	6
55	58661	80987	60065	79951	61451	78891	62819	77806	64167	76698	5
56	58684	80970	60089	79934	61474	78873	62842	77788	64190	76679	4
57	58708	80953	60112	79916	61497	78855	62864	77769	64212	76661	3
58	58731	80936	60135	79899	61520	78837	62887	77751	64234	76642	2
59	58755	80919	60158	79881	61543	78819	62909	77733	64256	76623	1
60	58779	80902	60182	79864	61566	78801	62932	77715	64279	76604	0
	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	N. cof.	N. fine.	M
	54°		53°		52°		51°		50°		

Table XXII. Of Natural Sines.

	40°		41°		42°		43°		44°		
M	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	N. sine	N. cos.	
0	64279	76604	65606	75471	66913	74314	68200	73135	69466	71934	60
1	64301	76586	65628	75452	66935	74295	68221	73116	69487	71914	59
2	64323	76567	65650	75433	66956	74276	68242	73096	69508	71894	58
3	64346	76548	65672	75414	66978	74256	68264	73076	69529	71873	57
4	64368	76530	65694	75395	66999	74237	68285	73056	69549	71853	56
5	64390	76511	65716	75375	67021	74217	68306	73036	69570	71833	55
6	64412	76492	65738	75356	67043	74198	68327	73016	69591	71813	54
7	64435	76473	65759	75337	67064	74178	68349	72996	69612	71792	53
8	64457	76455	65781	75318	67086	74159	68370	72976	69633	71772	52
9	64479	76436	65803	75299	67107	74139	68391	72957	69654	71752	51
10	64501	76417	65825	75280	67129	74120	68412	72937	69675	71732	50
11	64524	76398	65847	75261	67151	74100	68434	72917	69696	71711	49
12	64546	76380	65869	75241	67172	74080	68455	72897	69717	71691	48
13	64568	76361	65891	75222	67194	74061	68476	72877	69737	71671	47
14	64590	76342	65913	75203	67215	74041	68497	72857	69758	71650	46
15	64612	76323	65935	75184	67237	74022	68518	72837	69779	71630	45
16	64635	76304	65956	75165	67258	74002	68539	72817	69800	71610	44
17	64657	76286	65978	75146	67280	73983	68561	72797	69821	71590	43
18	64679	76267	66000	75126	67301	73963	68582	72777	69842	71569	42
19	64701	76248	66022	75107	67323	73944	68603	72757	69862	71549	41
20	64723	76229	66044	75088	67344	73924	68624	72737	69883	71529	40
21	64746	76210	66066	75069	67366	73904	68645	72717	69904	71508	39
22	64768	76192	66088	75050	67387	73885	68666	72697	69925	71488	38
23	64790	76173	66109	75030	67409	73865	68688	72677	69946	71468	37
24	64812	76154	66131	75011	67430	73846	68709	72657	69966	71447	36
25	64834	76135	66153	74992	67451	73826	68730	72637	69987	71427	35
26	64856	76116	66175	74973	67473	73806	68751	72617	70008	71407	34
27	64878	76097	66197	74953	67495	73787	68772	72597	70029	71386	33
28	64901	76078	66218	74934	67516	73767	68793	72577	70049	71366	32
29	64923	76059	66240	74915	67538	73747	68814	72557	70070	71345	31
30	64945	76041	66262	74896	67559	73728	68835	72537	70091	71325	30
31	64967	76022	66284	74876	67580	73708	68857	72517	70112	71305	29
32	64989	76003	66306	74857	67602	73688	68878	72497	70132	71284	28
33	65011	75984	66327	74838	67623	73669	68899	72477	70153	71264	27
34	65033	75965	66349	74818	67645	73649	68920	72457	70174	71243	26
35	65055	75946	66371	74799	67666	73629	68941	72437	70195	71223	25
36	65077	75927	66393	74780	67688	73610	68962	72417	70215	71203	24
37	65100	75908	66414	74760	67709	73590	68983	72397	70236	71182	23
38	65122	75889	66436	74741	67730	73570	69004	72377	70257	71162	22
39	65144	75870	66458	74722	67752	73551	69025	72357	70277	71141	21
40	65166	75851	66480	74703	67773	73531	69046	72337	70298	71121	20
41	65188	75832	66501	74683	67795	73511	69067	72317	70319	71100	19
42	65210	75813	66523	74664	67816	73491	69088	72297	70339	71080	18
43	65232	75794	66545	74644	67837	73472	69109	72277	70360	71059	17
44	65254	75775	66566	74625	67859	73452	69130	72257	70381	71039	16
45	65276	75756	66588	74606	67880	73432	69151	72236	70401	71019	15
46	65298	75738	66610	74586	67901	73413	69172	72216	70422	70998	14
47	65320	75719	66632	74567	67923	73393	69193	72196	70443	70978	13
48	65342	75700	66653	74548	67944	73373	69214	72176	70463	70957	12
49	65364	75680	66675	74528	67965	73353	69235	72156	70484	70937	11
50	65386	75661	66697	74509	67987	73333	69256	72136	70505	70916	10
51	65408	75642	66718	74489	68008	73314	69277	72116	70525	70896	9
52	65430	75623	66740	74470	68029	73294	69298	72095	70546	70875	8
53	65452	75604	66762	74451	68051	73274	69319	72075	70567	70855	7
54	65474	75585	66783	74431	68072	73254	69340	72055	70587	70834	6
55	65496	75566	66805	74412	68093	73234	69361	72035	70608	70813	5
56	65518	75547	66827	74392	68115	73215	69382	72015	70628	70793	4
57	65540	75528	66848	74373	68136	73195	69403	71995	70649	70772	3
58	65562	75509	66870	74353	68157	73175	69424	71974	70670	70752	2
59	65584	75490	66891	74334	68179	73155	69445	71954	70690	70731	1
60	65606	75471	66913	74314	68200	73135	69466	71934	70711	70711	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M
	49°		48°		47°		46°		45°		

TABLE XXIII. Proportional Logarithms.

S.	h m 0° 0'	h m 0° 1'	h m 0° 2'	h m 0° 3'	h m 0° 4'	h m 0° 5'	h m 0° 6'	h m 0° 7'	h m 0° 8'	S.
0		2.2553	1.9542	1.7782	1.6532	1.5563	1.4771	1.4102	1.3522	0
1	4.0334	2.2481	1.9506	1.7757	1.6514	1.5549	1.4759	1.4091	1.3513	1
2	3.7324	2.2410	1.9471	1.7734	1.6496	1.5534	1.4747	1.4081	1.3504	2
3	3.5563	2.2341	1.9435	1.7710	1.6478	1.5520	1.4735	1.4071	1.3495	3
4	3.4314	2.2272	1.9400	1.7686	1.6460	1.5506	1.4723	1.4061	1.3486	4
5	3.3345	2.2205	1.9365	1.7663	1.6443	1.5491	1.4711	1.4050	1.3477	5
6	3.2553	2.2139	1.9331	1.7639	1.6425	1.5477	1.4699	1.4040	1.3468	6
7	3.1883	2.2073	1.9296	1.7616	1.6407	1.5463	1.4688	1.4030	1.3459	7
8	3.1303	2.2009	1.9262	1.7593	1.6390	1.5449	1.4676	1.4020	1.3450	8
9	3.0792	2.1946	1.9228	1.7570	1.6372	1.5435	1.4664	1.4010	1.3441	9
10	3.0334	2.1883	1.9195	1.7547	1.6355	1.5421	1.4652	1.4000	1.3432	10
11	2.9920	2.1822	1.9162	1.7524	1.6338	1.5407	1.4640	1.3989	1.3423	11
12	2.9542	2.1761	1.9128	1.7501	1.6320	1.5393	1.4629	1.3979	1.3415	12
13	2.9195	2.1701	1.9096	1.7479	1.6303	1.5379	1.4617	1.3969	1.3406	13
14	2.8873	2.1642	1.9063	1.7456	1.6286	1.5365	1.4606	1.3959	1.3397	14
15	2.8573	2.1584	1.9031	1.7434	1.6269	1.5351	1.4594	1.3949	1.3388	15
16	2.8293	2.1526	1.8999	1.7412	1.6252	1.5337	1.4582	1.3939	1.3379	16
17	2.8030	2.1469	1.8967	1.7390	1.6235	1.5324	1.4571	1.3929	1.3371	17
18	2.7782	2.1413	1.8935	1.7368	1.6218	1.5310	1.4559	1.3919	1.3362	18
19	2.7547	2.1358	1.8904	1.7346	1.6201	1.5296	1.4548	1.3910	1.3353	19
20	2.7324	2.1303	1.8873	1.7324	1.6185	1.5283	1.4536	1.3900	1.3345	20
21	2.7112	2.1249	1.8842	1.7302	1.6168	1.5269	1.4525	1.3890	1.3336	21
22	2.6910	2.1196	1.8811	1.7281	1.6151	1.5256	1.4514	1.3880	1.3327	22
23	2.6717	2.1143	1.8781	1.7259	1.6135	1.5242	1.4502	1.3870	1.3319	23
24	2.6532	2.1091	1.8751	1.7238	1.6118	1.5229	1.4491	1.3860	1.3310	24
25	2.6355	2.1040	1.8721	1.7217	1.6102	1.5215	1.4480	1.3851	1.3301	25
26	2.6185	2.0989	1.8691	1.7196	1.6085	1.5202	1.4468	1.3841	1.3293	26
27	2.6021	2.0939	1.8661	1.7175	1.6069	1.5189	1.4457	1.3831	1.3284	27
28	2.5863	2.0889	1.8632	1.7154	1.6053	1.5175	1.4446	1.3821	1.3276	28
29	2.5710	2.0840	1.8602	1.7133	1.6037	1.5162	1.4435	1.3812	1.3267	29
30	2.5563	2.0792	1.8573	1.7112	1.6021	1.5149	1.4424	1.3802	1.3259	30
31	2.5421	2.0744	1.8544	1.7091	1.6005	1.5136	1.4412	1.3792	1.3250	31
32	2.5283	2.0696	1.8516	1.7071	1.5989	1.5123	1.4401	1.3783	1.3242	32
33	2.5149	2.0649	1.8487	1.7050	1.5973	1.5110	1.4390	1.3773	1.3233	33
34	2.5019	2.0603	1.8459	1.7030	1.5957	1.5097	1.4379	1.3764	1.3225	34
35	2.4894	2.0557	1.8431	1.7010	1.5941	1.5084	1.4368	1.3754	1.3216	35
36	2.4771	2.0512	1.8403	1.6990	1.5925	1.5071	1.4357	1.3745	1.3208	36
37	2.4652	2.0467	1.8375	1.6970	1.5909	1.5058	1.4346	1.3735	1.3199	37
38	2.4536	2.0422	1.8348	1.6950	1.5894	1.5045	1.4335	1.3726	1.3191	38
39	2.4424	2.0378	1.8320	1.6930	1.5878	1.5032	1.4325	1.3716	1.3183	39
40	2.4314	2.0334	1.8293	1.6910	1.5863	1.5019	1.4314	1.3707	1.3174	40
41	2.4206	2.0291	1.8266	1.6890	1.5847	1.5007	1.4303	1.3697	1.3166	41
42	2.4102	2.0248	1.8239	1.6871	1.5832	1.4994	1.4292	1.3688	1.3158	42
43	2.4000	2.0206	1.8212	1.6851	1.5816	1.4981	1.4281	1.3678	1.3149	43
44	2.3900	2.0164	1.8186	1.6832	1.5801	1.4969	1.4270	1.3669	1.3141	44
45	2.3802	2.0122	1.8159	1.6812	1.5786	1.4956	1.4260	1.3660	1.3133	45
46	2.3707	2.0081	1.8133	1.6793	1.5771	1.4943	1.4249	1.3650	1.3124	46
47	2.3613	2.0040	1.8107	1.6774	1.5755	1.4931	1.4238	1.3641	1.3116	47
48	2.3522	2.0000	1.8081	1.6755	1.5740	1.4918	1.4228	1.3632	1.3108	48
49	2.3432	1.9960	1.8055	1.6736	1.5725	1.4906	1.4217	1.3623	1.3100	49
50	2.3345	1.9920	1.8030	1.6717	1.5710	1.4894	1.4206	1.3613	1.3091	50
51	2.3259	1.9881	1.8004	1.6698	1.5695	1.4881	1.4196	1.3604	1.3083	51
52	2.3174	1.9842	1.7979	1.6679	1.5680	1.4869	1.4185	1.3595	1.3075	52
53	2.3091	1.9803	1.7954	1.6661	1.5666	1.4856	1.4175	1.3586	1.3067	53
54	2.3010	1.9765	1.7929	1.6642	1.5651	1.4844	1.4164	1.3576	1.3059	54
55	2.2931	1.9727	1.7904	1.6624	1.5636	1.4832	1.4154	1.3567	1.3051	55
56	2.2852	1.9690	1.7879	1.6605	1.5621	1.4820	1.4143	1.3558	1.3043	56
57	2.2775	1.9652	1.7855	1.6587	1.5607	1.4808	1.4133	1.3549	1.3034	57
58	2.2700	1.9615	1.7830	1.6568	1.5592	1.4795	1.4122	1.3540	1.3026	58
59	2.2626	1.9579	1.7806	1.6550	1.5578	1.4783	1.4112	1.3531	1.3018	59
S.	0° 0'	0° 1'	0° 2'	0° 3'	0° 4'	0° 5'	0° 6'	0° 7'	0° 8'	S.

TABLE XXIII. Proportional Logarithms.

S.	h m 0° 9'	h m 0° 10'	h m 0° 11'	h m 0° 12'	h m 0° 13'	h m 0° 14'	h m 0° 15'	h m 0° 16'	h m 0° 17'	S.
0	1.3010	1.2553	1.2139	1.1761	1.1413	1.1091	1.0792	1.0512	1.0248	0
1	1.3002	1.2545	1.2132	1.1755	1.1408	1.1086	1.0787	1.0507	1.0244	1
2	1.2994	1.2538	1.2126	1.1749	1.1402	1.1081	1.0782	1.0502	1.0240	2
3	1.2986	1.2531	1.2119	1.1743	1.1397	1.1076	1.0777	1.0498	1.0235	3
4	1.2978	1.2524	1.2113	1.1737	1.1391	1.1071	1.0773	1.0493	1.0231	4
5	1.2970	1.2517	1.2106	1.1731	1.1386	1.1066	1.0768	1.0489	1.0227	5
6	1.2962	1.2510	1.2099	1.1725	1.1380	1.1061	1.0763	1.0484	1.0223	6
7	1.2954	1.2502	1.2093	1.1719	1.1374	1.1055	1.0758	1.0480	1.0219	7
8	1.2946	1.2495	1.2086	1.1713	1.1369	1.1050	1.0753	1.0475	1.0214	8
9	1.2939	1.2488	1.2080	1.1707	1.1363	1.1045	1.0749	1.0471	1.0210	9
10	1.2931	1.2481	1.2073	1.1701	1.1358	1.1040	1.0744	1.0467	1.0206	10
11	1.2923	1.2474	1.2067	1.1695	1.1352	1.1035	1.0739	1.0462	1.0202	11
12	1.2915	1.2467	1.2061	1.1689	1.1347	1.1030	1.0734	1.0458	1.0197	12
13	1.2907	1.2460	1.2054	1.1683	1.1342	1.1025	1.0730	1.0453	1.0193	13
14	1.2899	1.2453	1.2048	1.1677	1.1336	1.1020	1.0725	1.0449	1.0189	14
15	1.2891	1.2445	1.2041	1.1671	1.1331	1.1015	1.0720	1.0444	1.0185	15
16	1.2883	1.2438	1.2035	1.1665	1.1325	1.1009	1.0715	1.0440	1.0181	16
17	1.2876	1.2431	1.2028	1.1660	1.1320	1.1004	1.0711	1.0435	1.0176	17
18	1.2868	1.2424	1.2022	1.1654	1.1314	1.0999	1.0706	1.0431	1.0172	18
19	1.2860	1.2417	1.2016	1.1648	1.1309	1.0994	1.0701	1.0426	1.0168	19
20	1.2852	1.2410	1.2009	1.1642	1.1303	1.0989	1.0696	1.0422	1.0164	20
21	1.2845	1.2403	1.2003	1.1636	1.1298	1.0984	1.0692	1.0418	1.0160	21
22	1.2837	1.2396	1.1996	1.1630	1.1292	1.0979	1.0687	1.0413	1.0156	22
23	1.2829	1.2389	1.1990	1.1624	1.1287	1.0974	1.0682	1.0409	1.0151	23
24	1.2821	1.2382	1.1984	1.1619	1.1282	1.0969	1.0678	1.0404	1.0147	24
25	1.2814	1.2375	1.1977	1.1613	1.1276	1.0964	1.0673	1.0400	1.0143	25
26	1.2806	1.2368	1.1971	1.1607	1.1271	1.0959	1.0668	1.0395	1.0139	26
27	1.2798	1.2362	1.1965	1.1601	1.1266	1.0954	1.0663	1.0391	1.0135	27
28	1.2791	1.2355	1.1958	1.1595	1.1260	1.0949	1.0659	1.0387	1.0131	28
29	1.2783	1.2348	1.1952	1.1589	1.1255	1.0944	1.0654	1.0382	1.0126	29
30	1.2775	1.2341	1.1946	1.1584	1.1249	1.0939	1.0649	1.0378	1.0122	30
31	1.2768	1.2334	1.1939	1.1578	1.1244	1.0934	1.0645	1.0374	1.0118	31
32	1.2760	1.2327	1.1933	1.1572	1.1239	1.0929	1.0640	1.0369	1.0114	32
33	1.2753	1.2320	1.1927	1.1566	1.1233	1.0924	1.0635	1.0365	1.0110	33
34	1.2745	1.2313	1.1921	1.1561	1.1228	1.0919	1.0631	1.0360	1.0106	34
35	1.2738	1.2307	1.1914	1.1555	1.1223	1.0914	1.0626	1.0356	1.0102	35
36	1.2730	1.2300	1.1908	1.1549	1.1217	1.0909	1.0621	1.0352	1.0098	36
37	1.2722	1.2293	1.1902	1.1543	1.1212	1.0904	1.0617	1.0347	1.0093	37
38	1.2715	1.2286	1.1896	1.1538	1.1207	1.0899	1.0612	1.0343	1.0089	38
39	1.2707	1.2279	1.1889	1.1532	1.1201	1.0894	1.0608	1.0339	1.0085	39
40	1.2700	1.2272	1.1883	1.1526	1.1196	1.0889	1.0603	1.0334	1.0081	40
41	1.2692	1.2266	1.1877	1.1520	1.1191	1.0884	1.0598	1.0330	1.0077	41
42	1.2685	1.2259	1.1871	1.1515	1.1186	1.0880	1.0594	1.0326	1.0073	42
43	1.2678	1.2252	1.1865	1.1509	1.1180	1.0875	1.0589	1.0321	1.0069	43
44	1.2670	1.2245	1.1859	1.1503	1.1175	1.0870	1.0585	1.0317	1.0065	44
45	1.2663	1.2239	1.1852	1.1498	1.1170	1.0865	1.0580	1.0313	1.0061	45
46	1.2655	1.2232	1.1846	1.1492	1.1164	1.0860	1.0575	1.0308	1.0057	46
47	1.2648	1.2225	1.1840	1.1486	1.1159	1.0855	1.0571	1.0304	1.0053	47
48	1.2640	1.2218	1.1834	1.1481	1.1154	1.0850	1.0566	1.0300	1.0049	48
49	1.2633	1.2212	1.1828	1.1475	1.1149	1.0845	1.0562	1.0295	1.0044	49
50	1.2626	1.2205	1.1822	1.1469	1.1143	1.0840	1.0557	1.0291	1.0040	50
51	1.2618	1.2198	1.1816	1.1464	1.1138	1.0835	1.0552	1.0287	1.0036	51
52	1.2611	1.2192	1.1809	1.1458	1.1133	1.0831	1.0548	1.0282	1.0032	52
53	1.2604	1.2185	1.1803	1.1452	1.1128	1.0826	1.0543	1.0278	1.0028	53
54	1.2596	1.2178	1.1797	1.1447	1.1123	1.0821	1.0539	1.0274	1.0024	54
55	1.2589	1.2172	1.1791	1.1441	1.1117	1.0816	1.0534	1.0270	1.0020	55
56	1.2582	1.2165	1.1785	1.1436	1.1112	1.0811	1.0530	1.0265	1.0016	56
57	1.2574	1.2159	1.1779	1.1430	1.1107	1.0806	1.0525	1.0261	1.0012	57
58	1.2567	1.2152	1.1773	1.1424	1.1102	1.0801	1.0521	1.0257	1.0008	58
59	1.2560	1.2145	1.1767	1.1419	1.1097	1.0797	1.0516	1.0252	1.0004	59
S.	0° 9'	0° 10'	0° 11'	0° 12'	0° 13'	0° 14'	0° 15'	0° 16'	0° 17'	S.

S.	h m 0° 18'	h m 0° 19'	h m 0° 20'	h m 0° 21'	h m 0° 22'	h m 0° 23'	h m 0° 24'	h m 0° 25'	h m 0° 26'	h m 0° 27'	h m 0° 28'	h m 0° 29'	S.
0	10000	9765	9542	9331	9128	8935	8751	8573	8403	8239	8081	7929	0
1	9996	9761	9539	9327	9125	8932	8748	8570	8400	8236	8079	7926	1
2	9992	9758	9535	9324	9122	8929	8745	8568	8397	8234	8076	7924	2
3	9988	9754	9532	9320	9119	8926	8742	8565	8395	8231	8073	7921	3
4	9984	9750	9528	9317	9115	8923	8739	8562	8392	8228	8071	7919	4
5	9980	9746	9524	9313	9112	8920	8736	8559	8389	8226	8068	7916	5
6	9976	9742	9521	9310	9109	8917	8733	8556	8386	8223	8066	7914	6
7	9972	9739	9517	9306	9106	8913	8730	8553	8384	8220	8063	7911	7
8	9968	9735	9514	9303	9102	8910	8727	8550	8381	8218	8061	7909	8
9	9964	9731	9510	9300	9099	8907	8724	8547	8378	8215	8058	7906	9
10	9960	9727	9506	9296	9096	8904	8721	8544	8375	8212	8055	7904	10
11	9956	9723	9503	9293	9092	8901	8718	8542	8372	8210	8053	7901	11
12	9952	9720	9499	9289	9089	8898	8715	8539	8370	8207	8050	7899	12
13	9948	9716	9496	9286	9086	8895	8712	8536	8367	8204	8048	7896	13
14	9944	9712	9492	9283	9083	8892	8709	8533	8364	8202	8045	7894	14
15	9940	9708	9488	9279	9079	8888	8706	8530	8361	8199	8043	7891	15
16	9936	9705	9485	9276	9076	8885	8703	8527	8359	8196	8040	7889	16
17	9932	9701	9481	9272	9073	8882	8700	8524	8356	8194	8037	7887	17
18	9928	9697	9478	9269	9070	8879	8697	8522	8353	8191	8035	7884	18
19	9924	9693	9474	9266	9066	8876	8694	8519	8350	8188	8032	7882	19
20	9920	9690	9471	9262	9063	8873	8691	8516	8348	8186	8030	7879	20
21	9916	9686	9467	9259	9060	8870	8688	8513	8345	8183	8027	7877	21
22	9912	9682	9464	9255	9057	8867	8685	8510	8342	8181	8025	7874	22
23	9908	9678	9460	9252	9053	8864	8682	8507	8339	8178	8022	7872	23
24	9905	9675	9456	9249	9050	8861	8679	8504	8337	8175	8020	7869	24
25	9901	9671	9453	9245	9047	8857	8676	8502	8334	8173	8017	7867	25
26	9897	9667	9449	9242	9044	8854	8673	8499	8331	8170	8014	7864	26
27	9893	9664	9446	9238	9041	8851	8670	8496	8328	8167	8012	7862	27
28	9889	9660	9442	9235	9037	8848	8667	8493	8326	8165	8009	7859	28
29	9885	9656	9439	9232	9034	8845	8664	8490	8323	8162	8007	7857	29
30	9881	9652	9435	9228	9031	8842	8661	8487	8320	8159	8004	7855	30
31	9877	9649	9432	9225	9028	8839	8658	8484	8318	8157	8002	7852	31
32	9873	9645	9428	9222	9024	8836	8655	8482	8315	8154	7999	7850	32
33	9869	9641	9425	9218	9021	8833	8652	8479	8312	8152	7997	7847	33
34	9865	9638	9421	9215	9018	8830	8649	8476	8309	8149	7994	7845	34
35	9861	9634	9418	9212	9015	8827	8646	8473	8307	8146	7992	7842	35
36	9858	9630	9414	9208	9012	8824	8643	8470	8304	8144	7989	7840	36
37	9854	9626	9411	9205	9008	8821	8640	8467	8301	8141	7987	7837	37
38	9850	9623	9407	9201	9005	8817	8637	8465	8298	8138	7984	7835	38
39	9846	9619	9404	9198	9002	8814	8635	8462	8296	8136	7981	7832	39
40	9842	9615	9400	9195	8999	8811	8632	8459	8293	8133	7979	7830	40
41	9838	9612	9397	9191	8996	8808	8629	8456	8290	8131	7976	7828	41
42	9834	9608	9393	9188	8992	8805	8626	8453	8288	8128	7974	7825	42
43	9830	9604	9390	9185	8989	8802	8623	8451	8285	8125	7971	7823	43
44	9827	9601	9386	9181	8986	8799	8620	8448	8282	8123	7969	7820	44
45	9823	9597	9383	9178	8983	8796	8617	8445	8279	8120	7966	7818	45
46	9819	9593	9379	9175	8980	8793	8614	8442	8277	8117	7964	7815	46
47	9815	9590	9376	9171	8977	8790	8611	8439	8274	8115	7961	7813	47
48	9811	9586	9372	9168	8973	8787	8608	8437	8271	8112	7959	7811	48
49	9807	9582	9369	9165	8970	8784	8605	8434	8269	8110	7956	7808	49
50	9803	9579	9365	9162	8967	8781	8602	8431	8266	8107	7954	7806	50
51	9800	9575	9362	9158	8964	8778	8599	8428	8263	8104	7951	7803	51
52	9796	9571	9358	9155	8961	8775	8597	8425	8261	8102	7949	7801	52
53	9792	9568	9355	9152	8958	8772	8594	8423	8258	8099	7946	7798	53
54	9788	9564	9351	9148	8954	8769	8591	8420	8255	8097	7944	7796	54
55	9784	9561	9348	9145	8951	8766	8588	8417	8253	8094	7941	7794	55
56	9780	9557	9344	9142	8948	8763	8585	8414	8250	8091	7939	7791	56
57	9777	9553	9341	9138	8945	8760	8582	8411	8247	8089	7936	7789	57
58	9773	9550	9337	9135	8942	8757	8579	8409	8244	8086	7934	7786	58
59	9769	9546	9334	9132	8939	8754	8576	8406	8242	8084	7931	7784	59
S.	0° 18'	0° 19'	0° 20'	0° 21'	0° 22'	0° 23'	0° 24'	0° 25'	0° 26'	0° 27'	0° 28'	0° 29'	S.

S.	h m 0° 30'	h m 0° 31'	h m 0° 32'	h m 0° 33'	h m 0° 34'	h m 0° 35'	h m 0° 36'	h m 0° 37'	h m 0° 38'	h m 0° 39'	h m 0° 40'	h m 0° 41'	S.
0	7782	7639	7501	7368	7238	7112	6990	6871	6755	6642	6532	6425	0
1	7779	7637	7499	7365	7236	7110	6988	6869	6753	6640	6530	6423	1
2	7777	7634	7497	7363	7234	7108	6986	6867	6751	6638	6529	6421	2
3	7774	7632	7494	7361	7232	7106	6984	6865	6749	6637	6527	6420	3
4	7772	7630	7492	7359	7229	7104	6982	6863	6747	6635	6525	6418	4
5	7769	7627	7490	7357	7227	7102	6980	6861	6745	6633	6523	6416	5
6	7767	7625	7488	7354	7225	7100	6978	6859	6743	6631	6521	6414	6
7	7765	7623	7485	7352	7223	7098	6976	6857	6742	6629	6519	6413	7
8	7762	7620	7483	7350	7221	7096	6974	6855	6740	6627	6518	6411	8
9	7760	7618	7481	7348	7219	7093	6972	6853	6738	6625	6516	6409	9
10	7757	7616	7479	7346	7217	7091	6970	6851	6736	6624	6514	6407	10
11	7755	7613	7476	7344	7215	7089	6968	6849	6734	6622	6512	6406	11
12	7753	7611	7474	7341	7212	7087	6966	6847	6732	6620	6510	6404	12
13	7750	7609	7472	7339	7210	7085	6964	6845	6730	6618	6509	6402	13
14	7748	7607	7470	7337	7208	7083	6962	6843	6728	6616	6507	6400	14
15	7745	7604	7467	7335	7206	7081	6960	6841	6726	6614	6505	6398	15
16	7743	7602	7465	7333	7204	7079	6958	6840	6725	6612	6503	6397	16
17	7741	7600	7463	7330	7202	7077	6956	6838	6723	6611	6501	6395	17
18	7738	7597	7461	7328	7200	7075	6954	6836	6721	6609	6500	6393	18
19	7736	7595	7458	7326	7198	7073	6952	6834	6719	6607	6498	6391	19
20	7734	7593	7456	7324	7196	7071	6950	6832	6717	6605	6496	6390	20
21	7731	7590	7454	7322	7193	7069	6948	6830	6715	6603	6494	6388	21
22	7729	7588	7452	7320	7191	7067	6946	6828	6713	6601	6492	6386	22
23	7726	7586	7450	7317	7189	7065	6944	6826	6711	6600	6491	6384	23
24	7724	7583	7447	7315	7187	7063	6942	6824	6709	6598	6489	6383	24
25	7722	7581	7445	7313	7185	7061	6940	6822	6708	6596	6487	6381	25
26	7719	7579	7443	7311	7183	7059	6938	6820	6706	6594	6485	6379	26
27	7717	7577	7441	7309	7181	7057	6936	6818	6704	6592	6484	6377	27
28	7714	7574	7438	7307	7179	7055	6934	6816	6702	6590	6482	6376	28
29	7712	7572	7436	7304	7177	7052	6932	6814	6700	6589	6480	6374	29
30	7710	7570	7434	7302	7175	7050	6930	6812	6698	6587	6478	6372	30
31	7707	7567	7432	7300	7172	7048	6928	6810	6696	6585	6476	6371	31
32	7705	7565	7429	7298	7170	7046	6926	6809	6694	6583	6475	6369	32
33	7703	7563	7427	7296	7168	7044	6924	6807	6692	6581	6473	6367	33
34	7700	7560	7425	7294	7166	7042	6922	6805	6691	6579	6471	6365	34
35	7698	7558	7423	7291	7164	7040	6920	6803	6689	6578	6469	6364	35
36	7696	7556	7421	7289	7162	7038	6918	6801	6687	6576	6467	6362	36
37	7693	7554	7418	7287	7160	7036	6916	6799	6685	6574	6466	6360	37
38	7691	7551	7416	7285	7158	7034	6914	6797	6683	6572	6464	6358	38
39	7688	7549	7414	7283	7156	7032	6912	6795	6681	6570	6462	6357	39
40	7686	7547	7412	7281	7154	7030	6910	6793	6679	6568	6460	6355	40
41	7684	7544	7409	7279	7152	7028	6908	6791	6677	6567	6459	6353	41
42	7681	7542	7407	7276	7149	7026	6906	6789	6676	6565	6457	6351	42
43	7679	7540	7405	7274	7147	7024	6904	6787	6674	6563	6455	6350	43
44	7677	7538	7403	7272	7145	7022	6902	6785	6672	6561	6453	6348	44
45	7674	7535	7401	7270	7143	7020	6900	6784	6670	6559	6451	6346	45
46	7672	7533	7398	7268	7141	7018	6898	6782	6668	6558	6450	6344	46
47	7670	7531	7396	7266	7139	7016	6896	6780	6666	6556	6448	6343	47
48	7667	7528	7394	7264	7137	7014	6894	6778	6664	6554	6446	6341	48
49	7665	7526	7392	7261	7135	7012	6892	6776	6663	6552	6444	6339	49
50	7663	7524	7390	7259	7133	7010	6890	6774	6661	6550	6443	6338	50
51	7660	7522	7387	7257	7131	7008	6888	6772	6659	6548	6441	6336	51
52	7658	7519	7385	7255	7129	7006	6886	6770	6657	6547	6439	6334	52
53	7655	7517	7383	7253	7127	7004	6884	6768	6655	6545	6437	6332	53
54	7653	7515	7381	7251	7124	7002	6882	6766	6653	6543	6435	6331	54
55	7651	7513	7379	7249	7122	7000	6881	6764	6651	6541	6434	6329	55
56	7648	7510	7376	7246	7120	6998	6879	6763	6650	6539	6432	6327	56
57	7646	7508	7374	7244	7118	6996	6877	6761	6648	6538	6430	6325	57
58	7644	7506	7372	7242	7116	6994	6875	6759	6646	6536	6428	6324	58
59	7641	7503	7370	7240	7114	6992	6873	6757	6644	6534	6427	6322	59
S.	0° 30'	0° 31'	0° 32'	0° 33'	0° 34'	0° 35'	0° 36'	0° 37'	0° 38'	0° 39'	0° 40'	0° 41'	S.

S.	h m 0° 42'	h m 0° 43'	h m 0° 44'	h m 0° 45'	h m 0° 46'	h m 0° 47'	h m 0° 48'	h m 0° 49'	h m 0° 50'	h m 0° 51'	h m 0° 52'	h m 0° 53'	S.
0	6320	6218	6118	6021	5925	5832	5740	5651	5563	5477	5393	5310	0
1	6319	6216	6117	6019	5924	5830	5739	5649	5562	5476	5391	5309	1
2	6317	6215	6115	6017	5922	5829	5737	5648	5560	5474	5390	5307	2
3	6315	6213	6113	6016	5920	5827	5736	5646	5559	5473	5388	5306	3
4	6313	6211	6112	6014	5919	5826	5734	5645	5557	5471	5387	5305	4
5	6312	6210	6110	6013	5917	5824	5733	5643	5556	5470	5386	5303	5
6	6310	6208	6108	6011	5916	5823	5731	5642	5554	5469	5384	5302	6
7	6308	6206	6107	6009	5914	5821	5730	5640	5553	5467	5383	5300	7
8	6306	6205	6105	6008	5913	5819	5728	5639	5551	5466	5382	5299	8
9	6305	6203	6103	6006	5911	5818	5727	5637	5550	5464	5380	5298	9
10	6303	6201	6102	6005	5909	5816	5725	5636	5549	5463	5379	5296	10
11	6301	6200	6100	6003	5908	5815	5724	5635	5547	5461	5377	5295	11
12	6300	6198	6099	6001	5906	5813	5722	5633	5546	5460	5376	5294	12
13	6298	6196	6097	6000	5905	5812	5721	5632	5544	5459	5375	5292	13
14	6296	6195	6095	5998	5903	5810	5719	5630	5543	5457	5373	5291	14
15	6294	6193	6094	5997	5902	5809	5718	5629	5541	5456	5372	5290	15
16	6293	6191	6092	5995	5900	5807	5716	5627	5540	5454	5370	5288	16
17	6291	6190	6090	5993	5898	5806	5715	5626	5538	5453	5369	5287	17
18	6289	6188	6089	5992	5897	5804	5713	5624	5537	5452	5368	5285	18
19	6288	6186	6087	5990	5895	5803	5712	5623	5536	5450	5366	5284	19
20	6286	6185	6085	5989	5894	5801	5710	5621	5534	5449	5365	5283	20
21	6284	6183	6084	5987	5892	5800	5709	5620	5533	5447	5364	5281	21
22	6282	6181	6082	5985	5891	5798	5707	5618	5531	5446	5362	5280	22
23	6281	6179	6081	5984	5889	5796	5706	5617	5530	5445	5361	5279	23
24	6279	6178	6079	5982	5888	5795	5704	5615	5528	5443	5359	5277	24
25	6277	6176	6077	5981	5886	5793	5703	5614	5527	5442	5358	5276	25
26	6276	6174	6076	5979	5884	5792	5701	5613	5526	5440	5357	5275	26
27	6274	6173	6074	5977	5883	5790	5700	5611	5524	5439	5355	5273	27
28	6272	6171	6072	5976	5881	5789	5698	5610	5523	5437	5354	5272	28
29	6271	6169	6071	5974	5880	5787	5697	5608	5521	5436	5353	5271	29
30	6269	6168	6069	5973	5878	5786	5695	5607	5520	5435	5351	5269	30
31	6267	6166	6067	5971	5877	5784	5694	5605	5518	5433	5350	5268	31
32	6265	6165	6066	5969	5875	5783	5692	5604	5517	5432	5348	5266	32
33	6264	6163	6064	5968	5874	5781	5691	5602	5516	5430	5347	5265	33
34	6262	6161	6063	5966	5872	5780	5689	5601	5514	5429	5346	5264	34
35	6260	6160	6061	5965	5870	5778	5688	5599	5513	5428	5344	5262	35
36	6259	6158	6059	5963	5869	5777	5686	5598	5511	5426	5343	5261	36
37	6257	6156	6058	5961	5867	5775	5685	5596	5510	5425	5341	5260	37
38	6255	6155	6056	5960	5866	5774	5683	5595	5508	5423	5340	5258	38
39	6254	6153	6055	5958	5864	5772	5682	5594	5507	5422	5339	5257	39
40	6252	6151	6053	5957	5863	5771	5680	5592	5506	5421	5337	5256	40
41	6250	6150	6051	5955	5861	5769	5679	5591	5504	5419	5336	5254	41
42	6248	6148	6050	5954	5860	5768	5677	5589	5503	5418	5335	5253	42
43	6247	6146	6048	5952	5858	5766	5676	5588	5501	5416	5333	5252	43
44	6245	6145	6046	5950	5856	5765	5674	5586	5500	5415	5332	5250	44
45	6243	6143	6045	5949	5855	5763	5673	5585	5498	5414	5331	5249	45
46	6242	6141	6043	5947	5853	5761	5671	5583	5497	5412	5329	5248	46
47	6240	6140	6042	5946	5852	5760	5670	5582	5496	5411	5328	5246	47
48	6238	6138	6040	5944	5850	5758	5669	5580	5494	5409	5326	5245	48
49	6237	6136	6038	5942	5849	5757	5667	5579	5493	5408	5325	5244	49
50	6235	6135	6037	5941	5847	5755	5666	5578	5491	5407	5324	5242	50
51	6233	6133	6035	5939	5846	5754	5664	5576	5490	5405	5322	5241	51
52	6232	6131	6033	5938	5844	5752	5663	5575	5488	5404	5321	5240	52
53	6230	6130	6032	5936	5843	5751	5661	5573	5487	5402	5320	5238	53
54	6228	6128	6030	5935	5841	5749	5660	5572	5486	5401	5318	5237	54
55	6226	6126	6029	5933	5839	5748	5658	5570	5484	5400	5317	5235	55
56	6225	6125	6027	5931	5838	5746	5657	5569	5483	5398	5315	5234	56
57	6223	6123	6025	5930	5836	5745	5655	5567	5481	5397	5314	5233	57
58	6221	6121	6024	5928	5835	5743	5654	5566	5480	5395	5313	5231	58
59	6220	6120	6022	5927	5833	5742	5652	5564	5478	5394	5311	5230	59
S.	0° 42'	0° 43'	0° 44'	0° 45'	0° 46'	0° 47'	0° 48'	0° 49'	0° 50'	0° 51'	0° 52'	0° 53'	S.

S.	h m 0°54'	h m 0°55'	h m 0°56'	h m 0°57'	h m 0°58'	h m 0°59'	h m 1° 0'	h m 1° 1'	h m 1° 2'	h m 1° 3'	h m 1° 4'	h m 1° 5'	S.
0	5229	5149	5071	4994	4918	4844	4771	4699	4629	4559	4491	4424	0
1	5227	5148	5070	4993	4917	4843	4770	4698	4628	4558	4490	4422	1
2	5226	5146	5068	4991	4916	4842	4769	4697	4626	4557	4489	4421	2
3	5225	5145	5067	4990	4915	4841	4768	4696	4625	4556	4488	4420	3
4	5223	5144	5066	4989	4913	4839	4766	4695	4624	4555	4486	4419	4
5	5222	5143	5064	4988	4912	4838	4765	4693	4623	4554	4485	4418	5
6	5221	5141	5063	4986	4911	4837	4764	4692	4622	4552	4484	4417	6
7	5219	5140	5062	4985	4910	4836	4763	4691	4621	4551	4483	4416	7
8	5218	5139	5061	4984	4908	4834	4762	4690	4619	4550	4482	4415	8
9	5217	5137	5059	4983	4907	4833	4760	4689	4618	4549	4481	4414	9
10	5215	5136	5058	4981	4906	4832	4759	4688	4617	4548	4480	4412	10
11	5214	5135	5057	4980	4905	4831	4758	4686	4616	4547	4479	4411	11
12	5213	5133	5055	4979	4903	4830	4757	4685	4615	4546	4477	4410	12
13	5211	5132	5054	4977	4902	4828	4756	4684	4614	4544	4476	4409	13
14	5210	5131	5053	4976	4901	4827	4754	4683	4612	4543	4475	4408	14
15	5209	5129	5051	4975	4900	4826	4753	4682	4611	4542	4474	4407	15
16	5207	5128	5050	4974	4899	4825	4752	4680	4610	4541	4473	4406	16
17	5206	5127	5049	4972	4897	4823	4751	4679	4609	4540	4472	4405	17
18	5205	5125	5048	4971	4896	4822	4750	4678	4608	4539	4471	4404	18
19	5203	5124	5046	4970	4895	4821	4748	4677	4607	4538	4469	4402	19
20	5202	5123	5045	4969	4894	4820	4747	4676	4606	4536	4468	4401	20
21	5201	5122	5044	4967	4892	4819	4746	4675	4604	4535	4467	4400	21
22	5199	5120	5043	4966	4891	4817	4745	4673	4603	4534	4466	4399	22
23	5198	5119	5041	4965	4890	4816	4744	4672	4602	4533	4465	4398	23
24	5197	5118	5040	4964	4889	4815	4742	4671	4601	4532	4464	4397	24
25	5195	5116	5039	4962	4887	4814	4741	4670	4600	4531	4463	4396	25
26	5194	5115	5037	4961	4886	4812	4740	4669	4599	4530	4462	4395	26
27	5193	5114	5036	4960	4885	4811	4739	4668	4597	4528	4460	4394	27
28	5191	5112	5035	4959	4884	4810	4738	4666	4596	4527	4459	4393	28
29	5190	5111	5034	4957	4882	4809	4736	4665	4595	4526	4458	4391	29
30	5189	5110	5032	4956	4881	4808	4735	4664	4594	4525	4457	4390	30
31	5187	5108	5031	4955	4880	4806	4734	4663	4593	4524	4456	4389	31
32	5186	5107	5030	4954	4879	4805	4733	4662	4592	4523	4455	4388	32
33	5185	5106	5028	4952	4877	4804	4732	4660	4590	4522	4454	4387	33
34	5183	5105	5027	4951	4876	4803	4730	4659	4589	4520	4453	4386	34
35	5182	5103	5026	4950	4875	4801	4729	4658	4588	4519	4452	4385	35
36	5181	5102	5025	4949	4874	4800	4728	4657	4587	4518	4450	4384	36
37	5179	5101	5023	4947	4873	4799	4727	4656	4586	4517	4449	4383	37
38	5178	5099	5022	4946	4871	4798	4726	4655	4585	4516	4448	4381	38
39	5177	5098	5021	4945	4870	4797	4724	4653	4584	4515	4447	4380	39
40	5175	5097	5019	4943	4869	4795	4723	4652	4582	4514	4446	4379	40
41	5174	5095	5018	4942	4868	4794	4722	4651	4581	4512	4445	4378	41
42	5173	5094	5017	4941	4866	4793	4721	4650	4580	4511	4444	4377	42
43	5172	5093	5016	4940	4865	4792	4720	4649	4579	4510	4443	4376	43
44	5170	5092	5014	4938	4864	4791	4718	4648	4578	4509	4441	4375	44
45	5169	5090	5013	4937	4863	4789	4717	4646	4577	4508	4440	4374	45
46	5168	5089	5012	4936	4861	4788	4716	4645	4575	4507	4439	4373	46
47	5166	5088	5011	4935	4860	4787	4715	4644	4574	4506	4438	4372	47
48	5165	5086	5009	4933	4859	4786	4714	4643	4573	4505	4437	4370	48
49	5164	5085	5008	4932	4858	4785	4712	4642	4572	4503	4436	4369	49
50	5162	5084	5007	4931	4856	4783	4711	4640	4571	4502	4435	4368	50
51	5161	5082	5005	4930	4855	4782	4710	4639	4570	4501	4434	4367	51
52	5160	5081	5004	4928	4854	4781	4709	4638	4569	4500	4433	4366	52
53	5158	5080	5003	4927	4853	4780	4708	4637	4567	4499	4431	4365	53
54	5157	5079	5002	4926	4852	4778	4707	4636	4566	4498	4430	4364	54
55	5156	5077	5000	4925	4850	4777	4705	4635	4565	4497	4429	4363	55
56	5154	5076	4999	4923	4849	4776	4704	4633	4564	4495	4428	4362	56
57	5153	5075	4998	4922	4848	4775	4703	4632	4563	4494	4427	4361	57
58	5152	5073	4997	4921	4847	4774	4702	4631	4562	4493	4426	4359	58
59	5150	5072	4995	4920	4845	4772	4701	4630	4560	4492	4425	4358	59
S.	0° 54'	0° 55'	0° 56'	0° 57'	0° 58'	0° 59'	1° 0'	1° 1'	1° 2'	1° 3'	1° 4'	1° 5'	S.

S.	h m 1° 6′	h m 1° 7′	h m 1° 8′	h m 1° 9′	h m 1° 10′	h m 1° 11′	h m 1° 12′	h m 1° 13′	h m 1° 14′	h m 1° 15′	h m 1° 16′	h m 1° 17′	S.
0	4357	4292	4228	4164	4102	4040	3979	3919	3860	3802	3745	3688	0
1	4356	4291	4227	4163	4101	4039	3978	3919	3859	3801	3744	3687	1
2	4355	4290	4226	4162	4100	4038	3977	3918	3858	3800	3743	3686	2
3	4354	4289	4224	4161	4099	4037	3976	3917	3857	3799	3742	3685	3
4	4353	4288	4223	4160	4098	4036	3975	3916	3856	3798	3741	3684	4
5	4352	4287	4222	4159	4097	4035	3974	3915	3856	3797	3740	3683	5
6	4351	4285	4221	4158	4096	4034	3973	3914	3855	3796	3739	3682	6
7	4350	4284	4220	4157	4095	4033	3972	3913	3854	3795	3738	3681	7
8	4349	4283	4219	4156	4093	4032	3971	3912	3853	3794	3737	3680	8
9	4347	4282	4218	4155	4092	4031	3970	3911	3852	3793	3736	3679	9
10	4346	4281	4217	4154	4091	4030	3969	3910	3851	3792	3735	3678	10
11	4345	4280	4216	4153	4090	4029	3968	3909	3850	3792	3734	3677	11
12	4344	4279	4215	4152	4089	4028	3967	3908	3849	3791	3733	3677	12
13	4343	4278	4214	4151	4088	4027	3966	3907	3848	3790	3732	3676	13
14	4342	4277	4213	4150	4087	4026	3965	3906	3847	3789	3731	3675	14
15	4341	4276	4212	4149	4086	4025	3964	3905	3846	3788	3730	3674	15
16	4340	4275	4211	4147	4085	4024	3963	3904	3845	3787	3729	3673	16
17	4339	4274	4210	4146	4084	4023	3962	3903	3844	3786	3728	3672	17
18	4338	4273	4209	4145	4083	4022	3961	3902	3843	3785	3727	3671	18
19	4336	4271	4207	4144	4082	4021	3960	3901	3842	3784	3727	3670	19
20	4335	4270	4206	4143	4081	4020	3959	3900	3841	3783	3726	3669	20
21	4334	4269	4205	4142	4080	4019	3958	3899	3840	3782	3725	3668	21
22	4333	4268	4204	4141	4079	4018	3957	3898	3839	3781	3724	3667	22
23	4332	4267	4203	4140	4078	4017	3956	3897	3838	3780	3723	3666	23
24	4331	4266	4202	4139	4077	4016	3955	3896	3837	3779	3722	3665	24
25	4330	4265	4201	4138	4076	4015	3954	3895	3836	3778	3721	3664	25
26	4329	4264	4200	4137	4075	4014	3953	3894	3835	3777	3720	3663	26
27	4328	4263	4199	4136	4074	4013	3952	3893	3834	3776	3719	3663	27
28	4327	4262	4198	4135	4073	4012	3951	3892	3833	3775	3718	3662	28
29	4326	4261	4197	4134	4072	4011	3950	3891	3832	3774	3717	3661	29
30	4325	4260	4196	4133	4071	4010	3949	3890	3831	3773	3716	3660	30
31	4323	4259	4195	4132	4070	4009	3948	3889	3830	3772	3715	3659	31
32	4322	4258	4194	4131	4069	4008	3947	3888	3829	3771	3714	3658	32
33	4321	4256	4193	4130	4068	4007	3946	3887	3828	3770	3713	3657	33
34	4320	4255	4192	4129	4067	4006	3945	3886	3827	3769	3712	3656	34
35	4319	4254	4191	4128	4066	4005	3944	3885	3826	3768	3711	3655	35
36	4318	4253	4189	4127	4065	4004	3943	3884	3825	3768	3710	3654	36
37	4317	4252	4188	4126	4064	4003	3942	3883	3824	3767	3709	3653	37
38	4316	4251	4187	4125	4063	4002	3941	3882	3823	3766	3709	3652	38
39	4315	4250	4186	4124	4062	4001	3940	3881	3822	3765	3708	3651	39
40	4314	4249	4185	4122	4061	4000	3939	3880	3821	3764	3707	3650	40
41	4313	4248	4184	4121	4060	3999	3938	3879	3820	3763	3706	3649	41
42	4311	4247	4183	4120	4059	3998	3937	3878	3820	3762	3705	3649	42
43	4310	4246	4182	4119	4058	3997	3936	3877	3819	3761	3704	3648	43
44	4309	4245	4181	4118	4056	3996	3935	3876	3818	3760	3703	3647	44
45	4308	4244	4180	4117	4055	3995	3934	3875	3817	3759	3702	3646	45
46	4307	4243	4179	4116	4054	3993	3933	3874	3816	3758	3701	3645	46
47	4306	4241	4178	4115	4053	3992	3932	3873	3815	3757	3700	3644	47
48	4305	4240	4177	4114	4052	3991	3931	3872	3814	3756	3699	3643	48
49	4304	4239	4176	4113	4051	3990	3930	3871	3813	3755	3698	3642	49
50	4303	4238	4175	4112	4050	3989	3929	3870	3812	3754	3697	3641	50
51	4302	4237	4174	4111	4049	3988	3928	3869	3811	3753	3696	3640	51
52	4301	4236	4173	4110	4048	3987	3927	3868	3810	3752	3695	3639	52
53	4300	4235	4172	4109	4047	3986	3926	3867	3809	3751	3694	3638	53
54	4298	4234	4171	4108	4046	3985	3925	3866	3808	3750	3693	3637	54
55	4297	4233	4169	4107	4045	3984	3924	3865	3807	3749	3693	3636	55
56	4296	4232	4168	4106	4044	3983	3923	3864	3806	3748	3692	3635	56
57	4295	4231	4167	4105	4043	3982	3922	3863	3805	3747	3691	3635	57
58	4294	4230	4166	4104	4042	3981	3921	3862	3804	3746	3690	3634	58
59	4293	4229	4165	4103	4041	3980	3920	3861	3803	3746	3689	3633	59
S.	1° 6′	1° 7′	1° 8′	1° 9′	1° 10′	1° 11′	1° 12′	1° 13′	1° 14′	1° 15′	1° 16′	1° 17′	S.

Table XXIII. Proportional Logarithms.

S.	h m 1° 18′	h m 1° 19′	h m 1° 20′	h m 1° 21′	h m 1° 22′	h m 1° 23′	h m 1° 24′	h m 1° 25′	h m 1° 26′	h m 1° 27′	h m 1° 28′	h m 1° 29′	S.
0	3632	3576	3522	3468	3415	3362	3310	3259	3208	3158	3108	3059	0
1	3631	3576	3521	3467	3414	3361	3309	3258	3207	3157	3107	3058	1
2	3630	3575	3520	3466	3413	3360	3308	3257	3206	3156	3106	3057	2
3	3629	3574	3519	3465	3412	3359	3307	3256	3205	3155	3105	3056	3
4	3628	3573	3518	3464	3411	3358	3306	3255	3204	3154	3105	3056	4
5	3627	3572	3517	3463	3410	3358	3306	3254	3204	3153	3104	3055	5
6	3626	3571	3516	3463	3409	3357	3305	3253	3203	3153	3103	3054	6
7	3625	3570	3515	3462	3408	3356	3304	3253	3202	3152	3102	3053	7
8	3624	3569	3515	3461	3408	3355	3303	3252	3201	3151	3101	3052	8
9	3623	3568	3514	3460	3407	3354	3302	3251	3200	3150	3101	3052	9
10	3623	3567	3513	3459	3406	3353	3301	3250	3199	3149	3100	3051	10
11	3622	3566	3512	3458	3405	3352	3300	3249	3198	3148	3099	3050	11
12	3621	3565	3511	3457	3404	3351	3300	3248	3198	3148	3098	3049	12
13	3620	3565	3510	3456	3403	3351	3299	3247	3197	3147	3097	3048	13
14	3619	3564	3509	3455	3402	3350	3298	3247	3196	3146	3096	3047	14
15	3618	3563	3508	3454	3401	3349	3297	3246	3195	3145	3096	3047	15
16	3617	3562	3507	3454	3400	3348	3296	3245	3194	3144	3095	3046	16
17	3616	3561	3506	3453	3400	3347	3295	3244	3193	3143	3094	3045	17
18	3615	3560	3506	3452	3399	3346	3294	3243	3193	3143	3093	3044	18
19	3614	3559	3505	3451	3398	3345	3294	3242	3192	3142	3092	3043	19
20	3613	3558	3504	3450	3397	3345	3293	3242	3191	3141	3091	3043	20
21	3612	3557	3503	3449	3396	3344	3292	3241	3190	3140	3091	3042	21
22	3611	3556	3502	3448	3395	3343	3291	3240	3189	3139	3090	3041	22
23	3610	3555	3501	3447	3394	3342	3290	3239	3188	3138	3089	3040	23
24	3610	3555	3500	3446	3393	3341	3289	3238	3188	3138	3088	3039	24
25	3609	3554	3499	3446	3393	3340	3288	3237	3187	3137	3087	3039	25
26	3608	3553	3498	3445	3392	3339	3288	3236	3186	3136	3087	3038	26
27	3607	3552	3497	3444	3391	3338	3287	3236	3185	3135	3086	3037	27
28	3606	3551	3497	3443	3390	3338	3286	3235	3184	3134	3085	3036	28
29	3605	3550	3496	3442	3389	3337	3285	3234	3183	3133	3084	3035	29
30	3604	3549	3495	3441	3388	3336	3284	3233	3183	3133	3083	3034	30
31	3603	3548	3494	3440	3387	3335	3283	3232	3182	3132	3082	3034	31
32	3602	3547	3493	3439	3386	3334	3282	3231	3181	3131	3082	3033	32
33	3601	3546	3492	3438	3386	3333	3282	3231	3180	3130	3081	3032	33
34	3600	3545	3491	3438	3385	3332	3281	3230	3179	3129	3080	3031	34
35	3599	3545	3490	3437	3384	3332	3280	3229	3178	3129	3079	3030	35
36	3598	3544	3489	3436	3383	3331	3279	3228	3178	3128	3078	3030	36
37	3598	3543	3488	3435	3382	3330	3278	3227	3177	3127	3078	3029	37
38	3597	3542	3488	3434	3381	3329	3277	3226	3176	3126	3077	3028	38
39	3596	3541	348-	3433	3380	3328	3276	3225	3175	3125	3076	3027	39
40	3595	3540	3486	3432	3379	3327	3276	3225	3174	3124	3075	3026	40
41	3594	3539	3485	3431	3379	3326	3275	3224	3173	3124	3074	3026	41
42	3593	3538	3484	3431	3378	3325	3274	3223	3173	3123	3073	3025	42
43	3592	3537	3483	3430	3377	3325	3273	3222	3172	3122	3073	3024	43
44	3591	3536	3482	3429	3376	3324	3272	3221	3171	3121	3072	3023	44
45	3590	3535	3481	3428	3375	3323	3271	3220	3170	3120	3071	3022	45
46	3589	3535	3480	3427	3374	3322	3270	3220	3169	3119	3070	3022	46
47	3588	3534	3480	3426	3373	3321	3270	3219	3168	3119	3069	3021	47
48	3587	3533	3479	3425	3372	3320	3269	3218	3168	3118	3069	3020	48
49	3587	3532	3478	3424	3372	3319	3268	3217	3167	3117	3068	3019	49
50	3586	3531	3477	3423	3371	3319	3267	3216	3166	3116	3067	3018	50
51	3585	3530	3476	3423	3370	3318	3266	3215	3165	3115	3066	3018	51
52	3584	3529	3475	3422	3369	3317	3265	3214	3164	3114	3065	3017	52
53	3583	3528	3474	3421	3368	3316	3265	3214	3163	3114	3065	3016	53
54	3582	3527	3473	3420	3367	3315	3264	3213	3163	3113	3064	3015	54
55	3581	3526	3472	3419	3366	3314	3263	3212	3162	3112	3063	3014	55
56	3580	3525	3471	3418	3365	3313	3262	3211	3161	3111	3062	3014	56
57	3579	3525	3471	3417	3365	3313	3261	3210	3160	3110	3061	3013	57
58	3578	3524	3470	3416	3364	3312	3260	3209	3159	3110	3060	3012	58
59	3577	3523	3469	3415	3363	3311	3259	3209	3158	3109	3060	3011	59
S.	1° 18′	1° 19′	1° 20′	1° 21′	1° 22′	1° 23′	1° 24′	1° 25′	1° 26′	1° 27′	1° 28′	1° 29′	S.

Table XXIII. Proportional Logarithms.

S.	h m 1° 30′	h m 1° 31′	h m 1° 32′	h m 1° 33′	h m 1° 34′	h m 1° 35′	h m 1° 36′	h m 1° 37′	h m 1° 38′	h m 1° 39′	h m 1° 40′	h m 1° 41′	S.
0	3010	2962	2915	2868	2821	2775	2730	2685	2640	2596	2553	2510	0
1	3009	2962	2914	2867	2821	2775	2729	2684	2640	2596	2552	2509	1
2	3009	2961	2913	2866	2820	2774	2729	2684	2639	2595	2551	2508	2
3	3008	2960	2912	2866	2819	2773	2728	2683	2638	2594	2551	2507	3
4	3007	2959	2912	2865	2818	2772	2727	2682	2638	2593	2550	2507	4
5	3006	2958	2911	2864	2818	2772	2726	2681	2637	2593	2549	2506	5
6	3005	2958	2910	2863	2817	2771	2725	2681	2636	2592	2548	2505	6
7	3005	2957	2909	2862	2816	2770	2725	2680	2635	2591	2548	2504	7
8	3004	2956	2909	2862	2815	2769	2724	2679	2635	2591	2547	2504	8
9	3003	2955	2908	2861	2815	2769	2723	2678	2634	2590	2546	2503	9
10	3002	2954	2907	2860	2814	2768	2722	2678	2633	2589	2545	2502	10
11	3001	2954	2906	2859	2813	2767	2722	2677	2632	2588	2545	2502	11
12	3001	2953	2905	2859	2812	2766	2721	2676	2632	2588	2544	2501	12
13	3000	2952	2905	2858	2811	2766	2720	2675	2631	2587	2543	2500	13
14	2999	2951	2904	2857	2811	2765	2719	2675	2630	2586	2543	2499	14
15	2998	2950	2903	2856	2810	2764	2719	2674	2629	2585	2542	2499	15
16	2997	2950	2902	2855	2809	2763	2718	2673	2629	2585	2541	2498	16
17	2997	2949	2901	2855	2808	2763	2717	2672	2628	2584	2540	2497	17
18	2996	2948	2901	2854	2808	2762	2716	2672	2627	2583	2540	2497	18
19	2995	2947	2900	2853	2807	2761	2716	2671	2626	2583	2539	2496	19
20	2994	2946	2899	2852	2806	2760	2715	2670	2626	2582	2538	2495	20
21	2993	2946	2898	2852	2805	2760	2714	2669	2625	2581	2538	2494	21
22	2993	2945	2898	2851	2805	2759	2713	2669	2624	2580	2537	2494	22
23	2992	2944	2897	2850	2804	2758	2713	2668	2624	2580	2536	2493	23
24	2991	2943	2896	2849	2803	2757	2712	2667	2623	2579	2535	2492	24
25	2990	2942	2895	2848	2802	2756	2711	2666	2622	2578	2535	2492	25
26	2989	2942	2894	2848	2801	2756	2710	2666	2621	2577	2534	2491	26
27	2989	2941	2894	2847	2801	2755	2710	2665	2621	2577	2533	2490	27
28	2988	2940	2893	2846	2800	2754	2709	2664	2620	2576	2533	2489	28
29	2987	2939	2892	2845	2799	2753	2708	2663	2619	2575	2532	2489	29
30	2986	2939	2891	2845	2798	2753	2707	2663	2618	2574	2531	2488	30
31	2985	2938	2891	2844	2798	2752	2707	2662	2618	2574	2530	2487	31
32	2985	2937	2890	2843	2797	2751	2706	2661	2617	2573	2530	2487	32
33	2984	2936	2889	2842	2796	2750	2705	2660	2616	2572	2529	2486	33
34	2983	2935	2888	2842	2795	2750	2704	2660	2615	2572	2528	2485	34
35	2982	2935	2887	2841	2795	2749	2704	2659	2615	2571	2527	2485	35
36	2981	2934	2887	2840	2794	2748	2703	2658	2614	2570	2527	2484	36
37	2981	2933	2886	2839	2793	2747	2702	2657	2613	2569	2526	2483	37
38	2980	2932	2885	2838	2792	2747	2701	2657	2612	2569	2525	2482	38
39	2979	2931	2884	2838	2792	2746	2701	2656	2612	2568	2525	2482	39
40	2978	2931	2883	2837	2791	2745	2700	2655	2611	2567	2524	2481	40
41	2977	2930	2883	2836	2790	2744	2699	2655	2610	2566	2523	2480	41
42	2977	2929	2882	2835	2789	2744	2698	2654	2610	2566	2522	2480	42
43	2976	2928	2881	2835	2788	2743	2698	2653	2609	2565	2522	2479	43
44	2975	2927	2880	2834	2788	2742	2697	2652	2608	2564	2521	2478	44
45	2974	2927	2880	2833	2787	2741	2696	2652	2607	2564	2520	2477	45
46	2973	2926	2879	2832	2786	2741	2695	2651	2607	2563	2520	2477	46
47	2973	2925	2878	2831	2785	2740	2695	2650	2606	2562	2519	2476	47
48	2972	2924	2877	2831	2785	2739	2694	2649	2605	2561	2518	2475	48
49	2971	2924	2876	2830	2784	2738	2693	2649	2604	2561	2517	2475	49
50	2970	2923	2876	2829	2783	2738	2692	2648	2604	2560	2517	2474	50
51	2969	2922	2875	2828	2782	2737	2692	2647	2603	2559	2516	2473	51
52	2969	2921	2874	2828	2782	2736	2691	2646	2602	2559	2515	2472	52
53	2968	2920	2873	2827	2781	2735	2690	2646	2601	2558	2515	2472	53
54	2967	2920	2873	2826	2780	2735	2689	2645	2601	2557	2514	2471	54
55	2966	2919	2872	2825	2779	2734	2689	2644	2600	2556	2513	2470	55
56	2965	2918	2871	2825	2779	2733	2688	2643	2599	2556	2512	2470	56
57	2965	2917	2870	2824	2778	2732	2687	2643	2599	2555	2512	2469	57
58	2964	2916	2869	2823	2777	2732	2687	2642	2598	2554	2511	2468	58
59	2963	2916	2869	2822	2776	2731	2686	2641	2597	2553	2510	2467	59
S.	1° 30′	1° 31′	1° 32′	1° 33′	1° 34′	1° 35′	1° 36′	1° 37′	1° 38′	1° 39′	1° 40′	1° 41′	S.

S.	h m 1° 42'	h m 1° 43'	h m 1° 44'	h m 1° 45'	h m 1° 46'	h m 1° 47'	h m 1° 48'	h m 1° 49'	h m 1° 50'	h m 1° 51'	h m 1° 52'	h m 1° 53'	S.
0	2467	2424	2382	2341	2300	2259	2218	2178	2139	2099	2061	2022	0
1	2466	2424	2382	2340	2299	2258	2218	2178	2138	2099	2060	2021	1
2	2465	2423	2381	2339	2298	2258	2217	2177	2137	2098	2059	2021	2
3	2465	2422	2380	2339	2298	2257	2216	2176	2137	2098	2059	2020	3
4	2464	2422	2380	2338	2297	2256	2216	2176	2136	2097	2058	2019	4
5	2463	2421	2379	2337	2296	2256	2215	2175	2136	2096	2057	2019	5
6	2462	2420	2378	2337	2296	2255	2214	2174	2135	2096	2057	2018	6
7	2462	2419	2378	2336	2295	2254	2214	2174	2134	2095	2056	2017	7
8	2461	2419	2377	2335	2294	2253	2213	2173	2134	2094	2055	2017	8
9	2460	2418	2376	2335	2294	2253	2212	2172	2133	2094	2055	2016	9
10	2460	2417	2375	2334	2293	2252	2212	2172	2132	2093	2054	2016	10
11	2459	2417	2375	2333	2292	2251	2211	2171	2132	2092	2053	2015	11
12	2458	2416	2374	2333	2291	2251	2210	2170	2131	2092	2053	2014	12
13	2458	2415	2373	2332	2291	2250	2210	2170	2130	2091	2052	2014	13
14	2457	2415	2373	2331	2290	2249	2209	2169	2130	2090	2052	2013	14
15	2456	2414	2372	2331	2289	2249	2208	2169	2129	2090	2051	2012	15
16	2455	2413	2371	2330	2289	2248	2208	2168	2128	2089	2050	2012	16
17	2455	2412	2371	2329	2288	2247	2207	2167	2128	2088	2050	2011	17
18	2454	2412	2370	2328	2287	2247	2206	2167	2127	2088	2049	2010	18
19	2453	2411	2369	2328	2287	2246	2206	2166	2126	2087	2048	2010	19
20	2453	2410	2368	2327	2286	2245	2205	2165	2126	2086	2048	2009	20
21	2452	2410	2368	2326	2285	2245	2204	2165	2125	2086	2047	2009	21
22	2451	2409	2367	2326	2285	2244	2204	2164	2124	2085	2046	2008	22
23	2450	2408	2366	2325	2284	2243	2203	2163	2124	2085	2046	2007	23
24	2450	2408	2366	2324	2283	2243	2202	2163	2123	2084	2045	2007	24
25	2449	2407	2365	2324	2283	2242	2202	2162	2122	2083	2044	2006	25
26	2448	2406	2364	2323	2282	2241	2201	2161	2122	2083	2044	2005	26
27	2448	2405	2364	2322	2281	2241	2200	2161	2121	2082	2043	2005	27
28	2447	2405	2363	2322	2281	2240	2200	2160	2120	2081	2042	2004	28
29	2446	2404	2362	2321	2280	2239	2199	2159	2120	2081	2042	2003	29
30	2445	2403	2362	2320	2279	2239	2198	2159	2119	2080	2041	2003	30
31	2445	2403	2361	2320	2279	2238	2198	2158	2118	2079	2041	2002	31
32	2444	2402	2360	2319	2278	2237	2197	2157	2118	2079	2040	2001	32
33	2443	2401	2359	2318	2277	2237	2196	2157	2117	2078	2039	2001	33
34	2443	2401	2359	2317	2277	2236	2196	2156	2116	2077	2039	2000	34
35	2442	2400	2358	2317	2276	2235	2195	2155	2116	2077	2038	2000	35
36	2441	2399	2357	2316	2275	2235	2194	2155	2115	2076	2037	1999	36
37	2441	2398	2357	2315	2274	2234	2194	2154	2115	2075	2037	1998	37
38	2440	2398	2356	2315	2274	2233	2193	2153	2114	2075	2036	1998	38
39	2439	2397	2355	2314	2273	2233	2192	2153	2113	2074	2035	1997	39
40	2438	2396	2355	2313	2272	2232	2192	2152	2113	2073	2035	1996	40
41	2438	2396	2354	2313	2272	2231	2191	2151	2112	2073	2034	1996	41
42	2437	2395	2353	2312	2271	2231	2190	2151	2111	2072	2033	1995	42
43	2436	2394	2353	2311	2270	2230	2190	2150	2111	2072	2033	1994	43
44	2436	2394	2352	2311	2270	2229	2189	2149	2110	2071	2032	1994	44
45	2435	2393	2351	2310	2269	2229	2188	2149	2109	2070	2032	1993	45
46	2434	2392	2350	2309	2268	2228	2188	2148	2109	2070	2031	1993	46
47	2433	2391	2350	2309	2268	2227	2187	2147	2108	2069	2030	1992	47
48	2433	2391	2349	2308	2267	2227	2186	2147	2107	2068	2030	1991	48
49	2432	2390	2348	2307	2266	2226	2186	2146	2107	2068	2029	1991	49
50	2431	2389	2348	2307	2266	2225	2185	2145	2106	2067	2028	1990	50
51	2431	2389	2347	2306	2265	2225	2184	2145	2105	2066	2028	1989	51
52	2430	2388	2346	2305	2264	2224	2184	2144	2105	2066	2027	1989	52
53	2429	2387	2346	2304	2264	2223	2183	2143	2104	2065	2026	1988	53
54	2429	2387	2345	2304	2263	2223	2182	2143	2103	2064	2026	1987	54
55	2428	2386	2344	2303	2262	2222	2182	2142	2103	2064	2025	1987	55
56	2427	2385	2344	2302	2262	2221	2181	2141	2102	2063	2025	1986	56
57	2426	2384	2343	2302	2261	2220	2180	2141	2101	2062	2024	1986	57
58	2426	2384	2342	2301	2260	2220	2180	2140	2101	2062	2023	1985	58
59	2425	2383	2342	2300	2260	2219	2179	2139	2100	2061	2023	1984	59
S.	1° 42'	1° 43'	1° 44'	1° 45'	1° 46'	1° 47'	1° 48'	1° 49'	1° 50'	1° 51'	1° 52'	1° 53'	S.

S.	h m 1°54'	h m 1°55'	h m 1°56'	h m 1°57'	h m 1°58'	h m 1°59'	h m 2° 0'	h m 2° 1'	h m 2° 2'	h m 2° 3'	h m 2° 4'	S.
0	1984	1946	1908	1871	1834	1797	1761	1725	1689	1654	1619	0
1	1983	1945	1908	1870	1833	1797	1760	1724	1689	1653	1618	1
2	1982	1944	1907	1870	1833	1796	1760	1724	1688	1652	1617	2
3	1982	1944	1906	1869	1832	1795	1759	1723	1687	1652	1617	3
4	1981	1943	1906	1868	1831	1795	1759	1722	1687	1651	1616	4
5	1981	1943	1905	1868	1831	1794	1758	1722	1686	1651	1616	5
6	1980	1942	1904	1867	1830	1794	1757	1721	1686	1650	1615	6
7	1979	1941	1904	1867	1830	1793	1757	1721	1685	1650	1614	7
8	1979	1941	1903	1866	1829	1792	1756	1720	1684	1649	1614	8
9	1978	1940	1903	1865	1828	1792	1755	1719	1684	1648	1613	9
10	1977	1939	1902	1865	1828	1791	1755	1719	1683	1648	1613	10
11	1977	1939	1901	1864	1827	1791	1754	1718	1683	1647	1612	11
12	1976	1938	1901	1863	1827	1790	1754	1718	1682	1647	1612	12
13	1975	1938	1900	1863	1826	1789	1753	1717	1681	1646	1611	13
14	1975	1937	1899	1862	1825	1789	1752	1717	1681	1645	1610	14
15	1974	1936	1899	1862	1825	1788	1752	1716	1680	1645	1610	15
16	1974	1936	1898	1861	1824	1788	1751	1715	1680	1644	1609	16
17	1973	1935	1898	1860	1823	1787	1751	1715	1679	1644	1609	17
18	1972	1934	1897	1860	1823	1786	1750	1714	1678	1643	1608	18
19	1972	1934	1896	1859	1822	1786	1749	1714	1678	1643	1607	19
20	1971	1933	1896	1859	1822	1785	1749	1713	1677	1642	1607	20
21	1970	1933	1895	1858	1821	1785	1748	1712	1677	1641	1606	21
22	1970	1932	1894	1857	1820	1784	1748	1712	1676	1641	1606	22
23	1969	1931	1894	1857	1820	1783	1747	1711	1676	1640	1605	23
24	1968	1931	1893	1856	1819	1783	1746	1711	1675	1640	1605	24
25	1968	1930	1893	1855	1819	1782	1746	1710	1674	1639	1604	25
26	1967	1929	1892	1855	1818	1781	1745	1709	1674	1638	1603	26
27	1967	1929	1891	1854	1817	1781	1745	1709	1673	1638	1603	27
28	1966	1928	1891	1854	1817	1780	1744	1708	1673	1637	1602	28
29	1965	1928	1890	1853	1816	1780	1743	1708	1672	1637	1602	29
30	1965	1927	1889	1852	1816	1779	1743	1707	1671	1636	1601	30
31	1964	1926	1889	1852	1815	1778	1742	1706	1671	1635	1600	31
32	1963	1926	1888	1851	1814	1778	1742	1706	1670	1635	1600	32
33	1963	1925	1888	1850	1814	1777	1741	1705	1670	1634	1599	33
34	1962	1924	1887	1850	1813	1777	1740	1705	1669	1634	1599	34
35	1962	1924	1886	1849	1812	1776	1740	1704	1668	1633	1598	35
36	1961	1923	1886	1849	1812	1775	1739	1703	1668	1633	1598	36
37	1960	1923	1885	1848	1811	1775	1739	1703	1667	1632	1597	37
38	1960	1922	1884	1847	1811	1774	1738	1702	1667	1631	1596	38
39	1959	1921	1884	1847	1810	1774	1737	1702	1666	1631	1596	39
40	1958	1921	1883	1846	1809	1773	1737	1701	1665	1630	1595	40
41	1958	1920	1883	1846	1809	1772	1736	1700	1665	1630	1595	41
42	1957	1919	1882	1845	1808	1772	1736	1700	1664	1629	1594	42
43	1956	1919	1881	1844	1808	1771	1735	1699	1664	1628	1593	43
44	1956	1918	1881	1844	1807	1771	1734	1699	1663	1628	1593	44
45	1955	1918	1880	1843	1806	1770	1734	1698	1663	1627	1592	45
46	1955	1917	1880	1843	1806	1769	1733	1697	1662	1627	1592	46
47	1954	1916	1879	1842	1805	1769	1733	1697	1661	1626	1591	47
48	1953	1916	1878	1841	1805	1768	1732	1696	1661	1626	1591	48
49	1953	1915	1878	1841	1804	1768	1731	1696	1660	1625	1590	49
50	1952	1914	1877	1840	1803	1767	1731	1695	1660	1624	1589	50
51	1951	1914	1876	1839	1803	1766	1730	1694	1659	1624	1589	51
52	1951	1913	1876	1839	1802	1766	1730	1694	1658	1623	1588	52
53	1950	1913	1875	1838	1802	1765	1729	1693	1658	1623	1588	53
54	1950	1912	1875	1838	1801	1765	1728	1693	1657	1622	1587	54
55	1949	1911	1874	1837	1800	1764	1728	1692	1657	1621	1587	55
56	1948	1911	1873	1836	1800	1763	1727	1692	1656	1621	1586	56
57	1948	1910	1873	1836	1799	1763	1727	1691	1655	1620	1585	57
58	1947	1909	1872	1835	1798	1762	1726	1690	1655	1620	1585	58
59	1946	1909	1871	1835	1798	1762	1725	1690	1654	1619	1584	59
S.	1°54'	1°55'	1°56'	1°57'	1°58'	1°59'	2° 0'	2° 1'	2° 2'	2° 3'	2° 4'	S.

S.	h m 2° 5'	h m 2° 6'	h m 2° 7'	h m 2° 8'	h m 2° 9'	h m 2° 10'	h m 2° 11'	h m 2° 12'	h m 2° 13'	h m 2° 14'	h m 2° 15'	S.
0	1584	1549	1515	1481	1447	1413	1380	1347	1314	1282	1249	0
1	1583	1548	1514	1480	1446	1413	1379	1346	1314	1281	1249	1
2	1582	1548	1514	1479	1446	1412	1379	1346	1313	1281	1248	2
3	1582	1547	1513	1479	1445	1412	1378	1345	1313	1280	1248	3
4	1581	1547	1512	1478	1445	1411	1378	1345	1312	1280	1247	4
5	1581	1546	1512	1478	1444	1411	1377	1344	1311	1279	1247	5
6	1580	1546	1511	1477	1443	1410	1377	1344	1311	1278	1246	6
7	1580	1545	1511	1477	1443	1409	1376	1343	1310	1278	1246	7
8	1579	1544	1510	1476	1442	1409	1376	1343	1310	1277	1245	8
9	1578	1544	1510	1476	1442	1408	1375	1342	1309	1277	1245	9
10	1578	1543	1509	1475	1441	1408	1374	1342	1309	1276	1244	10
11	1577	1543	1508	1474	1441	1407	1374	1341	1308	1276	1243	11
12	1577	1542	1508	1474	1440	1407	1373	1340	1308	1275	1243	12
13	1576	1542	1507	1473	1440	1406	1373	1340	1307	1275	1242	13
14	1576	1541	1507	1473	1439	1406	1372	1339	1307	1274	1242	14
15	1575	1540	1506	1472	1438	1405	1372	1339	1306	1274	1241	15
16	1574	1540	1506	1472	1438	1404	1371	1338	1306	1273	1241	16
17	1574	1539	1505	1471	1437	1404	1371	1338	1305	1273	1240	17
18	1573	1539	1504	1470	1437	1403	1370	1337	1304	1272	1240	18
19	1573	1538	1504	1470	1436	1403	1370	1337	1304	1271	1239	19
20	1572	1538	1503	1469	1436	1402	1369	1336	1303	1271	1239	20
21	1571	1537	1503	1469	1435	1402	1368	1335	1303	1270	1238	21
22	1571	1536	1502	1468	1435	1401	1368	1335	1302	1270	1238	22
23	1570	1536	1502	1468	1434	1401	1367	1334	1302	1269	1237	23
24	1570	1535	1501	1467	1433	1400	1367	1334	1301	1269	1237	24
25	1569	1535	1500	1467	1433	1399	1366	1333	1301	1268	1236	25
26	1569	1534	1500	1466	1432	1399	1366	1333	1300	1268	1235	26
27	1568	1534	1499	1465	1432	1398	1365	1332	1300	1267	1235	27
28	1567	1533	1499	1465	1431	1398	1365	1332	1299	1267	1234	28
29	1567	1532	1498	1464	1431	1397	1364	1331	1298	1266	1234	29
30	1566	1532	1498	1464	1430	1397	1363	1331	1298	1266	1233	30
31	1566	1531	1497	1463	1429	1396	1363	1330	1297	1265	1233	31
32	1565	1531	1496	1463	1429	1396	1362	1329	1297	1264	1232	32
33	1565	1530	1496	1462	1428	1395	1362	1329	1296	1264	1232	33
34	1564	1530	1495	1461	1428	1394	1361	1328	1296	1263	1231	34
35	1563	1529	1495	1461	1427	1394	1361	1328	1295	1263	1231	35
36	1563	1528	1494	1460	1427	1393	1360	1327	1295	1262	1230	36
37	1562	1528	1494	1460	1426	1393	1360	1327	1294	1262	1230	37
38	1562	1527	1493	1459	1426	1392	1359	1326	1294	1261	1229	38
39	1561	1527	1493	1459	1425	1392	1359	1326	1293	1261	1229	39
40	1561	1526	1492	1458	1424	1391	1358	1325	1292	1260	1228	40
41	1560	1526	1491	1458	1424	1391	1357	1325	1292	1260	1227	41
42	1559	1525	1491	1457	1423	1390	1357	1324	1291	1259	1227	42
43	1559	1524	1490	1456	1423	1389	1356	1323	1291	1259	1226	43
44	1558	1524	1490	1456	1422	1389	1356	1323	1290	1258	1226	44
45	1558	1523	1489	1455	1422	1388	1355	1322	1290	1257	1225	45
46	1557	1523	1489	1455	1421	1388	1355	1322	1289	1257	1225	46
47	1556	1522	1488	1454	1421	1387	1354	1321	1289	1256	1224	47
48	1556	1522	1487	1454	1420	1387	1354	1321	1288	1256	1224	48
49	1555	1521	1487	1453	1419	1386	1353	1320	1288	1255	1223	49
50	1555	1520	1486	1452	1419	1386	1352	1320	1287	1255	1223	50
51	1554	1520	1486	1452	1418	1385	1352	1319	1287	1254	1222	51
52	1554	1519	1485	1451	1418	1384	1351	1319	1286	1254	1222	52
53	1553	1519	1485	1451	1417	1384	1351	1318	1285	1253	1221	53
54	1552	1518	1484	1450	1417	1383	1350	1317	1285	1253	1221	54
55	1552	1518	1483	1450	1416	1383	1350	1317	1284	1252	1220	55
56	1551	1517	1483	1449	1416	1382	1349	1316	1284	1252	1219	56
57	1551	1516	1482	1449	1415	1382	1349	1316	1283	1251	1219	57
58	1550	1516	1482	1448	1414	1381	1348	1315	1283	1250	1218	58
59	1550	1515	1481	1447	1414	1381	1348	1315	1282	1250	1218	59
S.	2° 5'	2° 6'	2° 7'	2° 8'	2° 9'	2° 10'	2° 11'	2° 12'	2° 13'	2° 14'	2° 15'	S.

Table XXIII. Proportional Logarithms.

S.	h m 2° 16′	h m 2° 17′	h m 2° 18′	h m 2° 19′	h m 2° 20′	h m 2° 21′	h m 2° 22′	h m 2° 23′	h m 2° 24′	h m 2° 25′	h m 2° 26′	S.
0	1217	1186	1154	1123	1091	1061	1030	0999	0969	0939	0909	0
1	1217	1185	1153	1122	1091	1060	1029	0999	0969	0939	0909	1
2	1216	1184	1153	1122	1090	1060	1029	0998	0968	0938	0908	2
3	1216	1184	1152	1121	1090	1059	1028	0998	0968	0938	0908	3
4	1215	1183	1152	1120	1089	1058	1028	0997	0967	0937	0907	4
5	1215	1183	1151	1120	1089	1058	1027	0997	0967	0937	0907	5
6	1214	1182	1151	1119	1088	1057	1027	0996	0966	0936	0906	6
7	1214	1182	1150	1119	1088	1057	1026	0996	0966	0936	0906	7
8	1213	1181	1150	1118	1087	1056	1026	0995	0965	0935	0905	8
9	1213	1181	1149	1118	1087	1056	1025	0995	0965	0935	0905	9
10	1212	1180	1149	1117	1086	1055	1025	0994	0964	0934	0904	10
11	1211	1180	1148	1117	1086	1055	1024	0994	0964	0934	0904	11
12	1211	1179	1148	1116	1085	1054	1024	0993	0963	0933	0903	12
13	1210	1179	1147	1116	1085	1054	1023	0993	0963	0933	0903	13
14	1210	1178	1147	1115	1084	1053	1023	0992	0962	0932	0902	14
15	1209	1178	1146	1115	1084	1053	1022	0992	0962	0932	0902	15
16	1209	1177	1146	1114	1083	1052	1022	0991	0961	0931	0901	16
17	1208	1177	1145	1114	1083	1052	1021	0991	0961	0931	0901	17
18	1208	1176	1145	1113	1082	1051	1021	0990	0960	0930	0900	18
19	1207	1175	1144	1113	1082	1051	1020	0990	0960	0930	0900	19
20	1207	1175	1143	1112	1081	1050	1020	0989	0959	0929	0899	20
21	1206	1174	1143	1112	1081	1050	1019	0989	0959	0929	0899	21
22	1206	1174	1142	1111	1080	1049	1019	0988	0958	0928	0898	22
23	1205	1173	1142	1111	1080	1049	1018	0988	0958	0928	0898	23
24	1205	1173	1141	1110	1079	1048	1018	0987	0957	0927	0897	24
25	1204	1172	1141	1110	1079	1048	1017	0987	0957	0927	0897	25
26	1204	1172	1140	1109	1078	1047	1017	0986	0956	0926	0896	26
27	1203	1171	1140	1109	1078	1047	1016	0986	0956	0926	0896	27
28	1202	1171	1139	1108	1077	1046	1016	0985	0955	0925	0895	28
29	1202	1170	1139	1108	1076	1046	1015	0985	0955	0925	0895	29
30	1201	1170	1138	1107	1076	1045	1015	0984	0954	0924	0894	30
31	1201	1169	1138	1106	1075	1045	1014	0984	0954	0924	0894	31
32	1200	1169	1137	1106	1075	1044	1014	0983	0953	0923	0893	32
33	1200	1168	1137	1105	1074	1044	1013	0983	0953	0923	0893	33
34	1199	1168	1136	1105	1074	1043	1013	0982	0952	0922	0892	34
35	1199	1167	1136	1104	1073	1043	1012	0982	0952	0922	0892	35
36	1198	1167	1135	1104	1073	1042	1012	0981	0951	0921	0891	36
37	1198	1166	1135	1103	1072	1042	1011	0981	0951	0921	0891	37
38	1197	1165	1134	1103	1072	1041	1011	0980	0950	0920	0890	38
39	1197	1165	1134	1102	1071	1041	1010	0980	0950	0920	0890	39
40	1196	1164	1133	1102	1071	1040	1009	0979	0949	0919	0889	40
41	1196	1164	1132	1101	1070	1040	1009	0979	0949	0919	0889	41
42	1195	1163	1132	1101	1070	1039	1008	0978	0948	0918	0888	42
43	1195	1163	1131	1100	1069	1039	1008	0978	0948	0918	0888	43
44	1194	1162	1131	1100	1069	1038	1007	0977	0947	0917	0887	44
45	1193	1162	1130	1099	1068	1037	1007	0977	0947	0917	0887	45
46	1193	1161	1130	1099	1068	1037	1006	0976	0946	0916	0886	46
47	1192	1161	1129	1098	1067	1036	1006	0976	0946	0916	0886	47
48	1192	1160	1129	1098	1067	1036	1005	0975	0945	0915	0885	48
49	1191	1160	1128	1097	1066	1035	1005	0975	0945	0915	0885	49
50	1191	1159	1128	1097	1066	1035	1004	0974	0944	0914	0884	50
51	1190	1159	1127	1096	1065	1034	1004	0974	0944	0914	0884	51
52	1190	1158	1127	1096	1065	1034	1003	0973	0943	0913	0883	52
53	1189	1158	1126	1095	1064	1033	1003	0973	0943	0913	0883	53
54	1189	1157	1126	1095	1064	1033	1002	0972	0942	0912	0883	54
55	1188	1157	1125	1094	1063	1032	1002	0972	0942	0912	0882	55
56	1188	1156	1125	1094	1063	1032	1001	0971	0941	0911	0882	56
57	1187	1156	1124	1093	1062	1031	1001	0971	0941	0911	0881	57
58	1187	1155	1124	1092	1062	1031	1000	0970	0940	0910	0881	58
59	1186	1154	1123	1092	1061	1030	1000	0970	0940	0910	0880	59
S.	2° 16′	2° 17′	2° 18′	2° 19′	2° 20′	2° 21′	2° 22′	2° 23′	2° 24′	2° 25′	2° 26′	S.

S.	h m 2° 27′	h m 2° 28′	h m 2° 29′	h m 2° 30′	h m 2° 31′	h m 2° 32′	h m 2° 33′	h m 2° 34′	h m 2° 35′	h m 2° 36′	h m 2° 37′
0	0880	0850	0821	0792	0763	0734	0706	0678	0649	0621	0594
1	0879	0850	0820	0791	0762	0734	0705	0677	0649	0621	0593
2	0879	0849	0820	0791	0762	0733	0705	0677	0648	0621	0593
3	0878	0849	0819	0790	0762	0733	0704	0676	0648	0620	0592
4	0878	0848	0819	0790	0761	0732	0704	0676	0648	0620	0592
5	0877	0848	0818	0789	0761	0732	0703	0675	0647	0619	0591
6	0877	0847	0818	0789	0760	0731	0703	0675	0647	0619	0591
7	0876	0847	0817	0788	0760	0731	0703	0674	0646	0618	0591
8	0876	0846	0817	0788	0759	0730	0702	0674	0646	0618	0590
9	0875	0846	0816	0787	0759	0730	0702	0673	0645	0617	0590
10	0875	0845	0816	0787	0758	0730	0701	0673	0645	0617	0589
11	0874	0845	0816	0787	0758	0729	0701	0672	0644	0616	0589
12	0874	0844	0815	0786	0757	0729	0700	0672	0644	0616	0588
13	0873	0844	0815	0786	0757	0728	0700	0671	0643	0615	0588
14	0873	0843	0814	0785	0756	0728	0699	0671	0643	0615	0587
15	0872	0843	0814	0785	0756	0727	0699	0670	0642	0615	0587
16	0872	0842	0813	0784	0755	0727	0698	0670	0642	0614	0586
17	0871	0842	0813	0784	0755	0726	0698	0670	0641	0614	0586
18	0871	0841	0812	0783	0754	0726	0697	0669	0641	0613	0585
19	0870	0841	0812	0783	0754	0725	0697	0669	0641	0613	0585
20	0870	0840	0811	0782	0753	0725	0696	0668	0640	0612	0585
21	0869	0840	0811	0782	0753	0724	0696	0668	0640	0612	0584
22	0869	0839	0810	0781	0752	0724	0695	0667	0639	0611	0584
23	0868	0839	0810	0781	0752	0723	0695	0667	0639	0611	0583
24	0868	0838	0809	0780	0751	0723	0694	0666	0638	0610	0583
25	0867	0838	0809	0780	0751	0722	0694	0666	0638	0610	0582
26	0867	0837	0808	0779	0751	0722	0694	0665	0637	0609	0582
27	0866	0837	0808	0779	0750	0721	0693	0665	0637	0609	0581
28	0866	0836	0807	0778	0750	0721	0693	0664	0636	0609	0581
29	0865	0836	0807	0778	0749	0721	0692	0664	0636	0608	0580
30	0865	0835	0806	0777	0749	0720	0692	0663	0635	0608	0580
31	0864	0835	0806	0777	0748	0720	0691	0663	0635	0607	0579
32	0864	0834	0805	0776	0748	0719	0691	0663	0634	0607	0579
33	0863	0834	0805	0776	0747	0719	0690	0662	0634	0606	0579
34	0863	0834	0804	0775	0747	0718	0690	0662	0634	0606	0578
35	0862	0833	0804	0775	0746	0718	0689	0661	0633	0605	0578
36	0862	0833	0803	0774	0746	0717	0689	0661	0633	0605	0577
37	0861	0832	0803	0774	0745	0717	0688	0660	0632	0604	0577
38	0861	0832	0802	0774	0745	0716	0688	0660	0632	0604	0576
39	0860	0831	0802	0773	0744	0716	0687	0659	0631	0603	0576
40	0860	0831	0801	0773	0744	0715	0687	0659	0631	0603	0575
41	0859	0830	0801	0772	0743	0715	0686	0658	0630	0602	0575
42	0859	0830	0801	0772	0743	0714	0686	0658	0630	0602	0574
43	0858	0829	0800	0771	0742	0714	0686	0657	0629	0602	0574
44	0858	0829	0800	0771	0742	0713	0685	0657	0629	0601	0573
45	0857	0828	0799	0770	0741	0713	0685	0656	0628	0601	0573
46	0857	0828	0799	0770	0741	0712	0684	0656	0628	0600	0573
47	0856	0827	0798	0769	0740	0712	0684	0655	0628	0600	0572
48	0856	0827	0798	0769	0740	0711	0683	0655	0627	0599	0572
49	0855	0826	0797	0768	0740	0711	0683	0655	0627	0599	0571
50	0855	0826	0797	0768	0739	0711	0682	0654	0626	0598	0571
51	0855	0825	0796	0767	0739	0710	0682	0654	0626	0598	0570
52	0854	0825	0796	0767	0738	0710	0681	0653	0625	0597	0570
53	0854	0824	0795	0766	0738	0709	0681	0653	0625	0597	0569
54	0853	0824	0795	0766	0737	0709	0680	0652	0624	0596	0569
55	0853	0823	0794	0765	0737	0708	0680	0652	0624	0596	0568
56	0852	0823	0794	0765	0736	0708	0679	0651	0623	0596	0568
57	0852	0822	0793	0764	0736	0707	0679	0651	0623	0595	0568
58	0851	0822	0793	0764	0735	0707	0678	0650	0622	0595	0567
59	0851	0821	0792	0763	0735	0706	0678	0650	0622	0594	0567
S.	2° 27′	2° 28′	2° 29′	2° 30′	2° 31′	2° 32′	2° 33′	2° 34′	2° 35′	2° 36′	2° 37′

TABLE XXIII. Proportional Logarithms.

S.	h m 2° 38'	h m 2° 39'	h m 2° 40'	h m 2° 41'	h m 2° 42'	h m 2° 43'	h m 2° 44'	h m 2° 45'	h m 2° 46'	h m 2° 47'	h m 2° 48'	S.
0	0566	0539	0512	0484	0458	0431	0404	0378	0352	0326	0300	0
1	0566	0538	0511	0484	0457	0430	0404	0377	0351	0325	0299	1
2	0565	0538	0511	0484	0457	0430	0403	0377	0351	0325	0299	2
3	0565	0537	0510	0483	0456	0430	0403	0377	0350	0324	0298	3
4	0564	0537	0510	0483	0456	0429	0403	0376	0350	0324	0298	4
5	0564	0536	0509	0482	0455	0429	0402	0376	0349	0323	0297	5
6	0563	0536	0509	0482	0455	0428	0402	0375	0349	0323	0297	6
7	0563	0536	0508	0481	0454	0428	0401	0375	0349	0323	0297	7
8	0562	0535	0508	0481	0454	0427	0401	0374	0348	0322	0296	8
9	0562	0535	0507	0480	0454	0427	0400	0374	0348	0322	0296	9
10	0562	0534	0507	0480	0453	0426	0400	0374	0347	0321	0295	10
11	0561	0534	0507	0480	0453	0426	0399	0373	0347	0321	0295	11
12	0561	0533	0506	0479	0452	0426	0399	0373	0346	0320	0294	12
13	0560	0533	0506	0479	0452	0425	0399	0372	0346	0320	0294	13
14	0560	0532	0505	0478	0451	0425	0398	0372	0346	0319	0294	14
15	0559	0532	0505	0478	0451	0424	0398	0371	0345	0319	0293	15
16	0559	0531	0504	0477	0450	0424	0397	0371	0345	0319	0293	16
17	0558	0531	0504	0477	0450	0423	0397	0370	0344	0318	0292	17
18	0558	0531	0503	0476	0450	0423	0396	0370	0344	0318	0292	18
19	0557	0530	0503	0476	0449	0422	0396	0370	0343	0317	0291	19
20	0557	0530	0502	0475	0449	0422	0395	0369	0343	0317	0291	20
21	0557	0529	0502	0475	0448	0422	0395	0369	0342	0316	0291	21
22	0556	0529	0502	0475	0448	0421	0395	0368	0342	0316	0290	22
23	0556	0528	0501	0474	0447	0421	0394	0368	0342	0316	0290	23
24	0555	0528	0501	0474	0447	0420	0394	0367	0341	0315	0289	24
25	0555	0527	0500	0473	0446	0420	0393	0367	0341	0315	0289	25
26	0554	0527	0500	0473	0446	0419	0393	0366	0340	0314	0288	26
27	0554	0526	0499	0472	0446	0419	0392	0366	0340	0314	0288	27
28	0553	0526	0499	0472	0445	0418	0392	0366	0339	0313	0288	28
29	0553	0526	0408	0471	0445	0418	0392	0365	0339	0313	0287	29
30	0552	0525	0498	0471	0444	0418	0391	0365	0339	0313	0287	30
31	0552	0525	0498	0471	0444	0417	0391	0364	0338	0312	0286	31
32	0552	0524	0497	0470	0443	0417	0390	0364	0338	0312	0286	32
33	0551	0524	0497	0470	0443	0416	0390	0363	0337	0311	0285	33
34	0551	0523	0496	0469	0442	0416	0389	0363	0337	0311	0285	34
35	0550	0523	0496	0469	0442	0415	0389	0363	0336	0310	0285	35
36	0550	0522	0495	0468	0442	0415	0388	0362	0336	0310	0284	36
37	0549	0522	0495	0468	0441	0414	0388	0362	0336	0310	0284	37
38	0549	0521	0494	0467	0441	0414	0388	0361	0335	0309	0283	38
39	0548	0521	0494	0467	0440	0414	0387	0361	0335	0309	0283	39
40	0548	0521	0493	0467	0440	0413	0387	0360	0334	0308	0282	40
41	0547	0520	0493	0466	0439	0413	0386	0360	0334	0308	0282	41
42	0547	0520	0493	0466	0439	0412	0386	0359	0333	0307	0282	42
43	0546	0519	0492	0465	0438	0412	0385	0359	0333	0307	0281	43
44	0546	0519	0492	0465	0438	0411	0385	0359	0333	0307	0281	44
45	0546	0518	0491	0464	0438	0411	0384	0358	0332	0306	0280	45
46	0545	0518	0491	0464	0437	0410	0384	0358	0332	0306	0280	46
47	0545	0517	0490	0463	0437	0410	0384	0357	0331	0305	0279	47
48	0544	0517	0490	0463	0436	0410	0383	0357	0331	0305	0279	48
49	0544	0517	0489	0462	0436	0409	0383	0356	0330	0304	0279	49
50	0543	0516	0489	0462	0435	0409	0382	0356	0330	0304	0278	50
51	0543	0516	0489	0462	0435	0408	0382	0356	0329	0304	0278	51
52	0542	0515	0488	0461	0434	0408	0381	0355	0329	0303	0277	52
53	0542	0515	0488	0461	0434	0407	0381	0355	0329	0303	0277	53
54	0541	0514	0487	0460	0434	0407	0381	0354	0328	0302	0276	54
55	0541	0514	0487	0460	0433	0406	0380	0354	0328	0302	0276	55
56	0541	0513	0486	0459	0433	0406	0380	0353	0327	0301	0276	56
57	0540	0513	0486	0459	0432	0406	0379	0353	0327	0301	0275	57
58	0540	0512	0485	0458	0432	0405	0379	0353	0326	0300	0275	58
59	0539	0512	0485	0458	0431	0405	0378	0352	0326	0300	0274	59
S.	2° 38'	2° 39'	2° 40'	2° 41'	2° 42'	2° 43'	2° 44'	2° 45'	2° 46'	2° 47'	2° 48'	S.

Table XXIII. Proportional Logarithms.

S	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	S.
	2° 49'	2° 50'	2° 51'	2° 52'	2° 53'	2° 54'	2° 55'	2° 56'	2° 57'	2° 58'	2° 59'	
0	0274	0248	0223	0197	0172	0147	0122	0098	0073	0049	0024	0
1	0273	0248	0222	0197	0172	0147	0122	0097	0073	0048	0024	1
2	0273	0247	0222	0197	0171	0146	0122	0097	0072	0048	0023	2
3	0273	0247	0221	0196	0171	0146	0121	0096	0072	0047	0023	3
4	0272	0247	0221	0196	0171	0146	0121	0096	0071	0047	0023	4
5	0272	0246	0221	0195	0170	0145	0120	0096	0071	0046	0022	5
6	0271	0246	0220	0195	0170	0145	0120	0095	0071	0046	0022	6
7	0271	0245	0220	0194	0169	0144	0119	0095	0070	0046	0021	7
8	0270	0245	0219	0194	0169	0144	0119	0094	0070	0045	0021	8
9	0270	0244	0219	0194	0169	0143	0119	0094	0069	0045	0021	9
10	0270	0244	0219	0193	0168	0143	0118	0093	0069	0044	0020	10
11	0269	0244	0218	0193	0168	0143	0118	0093	0068	0044	0020	11
12	0269	0243	0218	0192	0167	0142	0117	0093	0068	0044	0019	12
13	0268	0243	0217	0192	0167	0142	0117	0092	0068	0043	0019	13
14	0268	0242	0217	0192	0166	0141	0117	0092	0067	0043	0019	14
15	0267	0242	0216	0191	0166	0141	0116	0091	0067	0042	0018	15
16	0267	0241	0216	0191	0166	0141	0116	0091	0066	0042	0018	16
17	0267	0241	0216	0190	0165	0140	0115	0091	0066	0042	0017	17
18	0266	0241	0215	0190	0165	0140	0115	0090	0066	0041	0017	18
19	0266	0240	0215	0189	0164	0139	0114	0090	0065	0041	0017	19
20	0265	0240	0214	0189	0164	0139	0114	0089	0065	0040	0016	20
21	0265	0239	0214	0189	0163	0139	0114	0089	0064	0040	0016	21
22	0264	0239	0213	0188	0163	0138	0113	0089	0064	0040	0015	22
23	0264	0238	0213	0188	0163	0138	0113	0088	0064	0039	0015	23
24	0264	0238	0213	0187	0162	0137	0112	0088	0063	0039	0015	24
25	0263	0238	0212	0187	0162	0137	0112	0087	0063	0038	0014	25
26	0263	0237	0212	0187	0161	0136	0112	0087	0062	0038	0014	26
27	0262	0237	0211	0186	0161	0136	0111	0087	0062	0038	0013	27
28	0262	0236	0211	0186	0161	0136	0111	0086	0062	0037	0013	28
29	0261	0236	0211	0185	0160	0135	0110	0086	0061	0037	0012	29
30	0261	0235	0210	0185	0160	0135	0110	0085	0061	0036	0012	30
31	0261	0235	0210	0184	0159	0134	0110	0085	0060	0036	0012	31
32	0260	0235	0209	0184	0159	0134	0109	0084	0060	0036	0011	32
33	0260	0234	0209	0184	0158	0134	0109	0084	0060	0035	0011	33
34	0259	0234	0208	0183	0158	0133	0108	0084	0059	0035	0010	34
35	0259	0233	0208	0183	0158	0133	0108	0083	0059	0034	0010	35
36	0258	0233	0208	0182	0157	0132	0107	0083	0058	0034	0010	36
37	0258	0233	0207	0182	0157	0132	0107	0082	0058	0034	0009	37
38	0258	0232	0207	0181	0156	0131	0107	0082	0057	0033	0009	38
39	0257	0232	0206	0181	0156	0131	0106	0082	0057	0033	0008	39
40	0257	0231	0206	0181	0156	0131	0106	0081	0057	0032	0008	40
41	0256	0231	0205	0180	0155	0130	0105	0081	0056	0032	0008	41
42	0256	0230	0205	0180	0155	0130	0105	0080	0056	0031	0007	42
43	0255	0230	0205	0179	0154	0129	0105	0080	0055	0031	0007	43
44	0255	0230	0204	0179	0154	0129	0104	0080	0055	0031	0006	44
45	0255	0229	0204	0179	0153	0129	0104	0079	0055	0030	0006	45
46	0254	0229	0203	0178	0153	0128	0103	0079	0054	0030	0006	46
47	0254	0228	0203	0178	0153	0128	0103	0078	0054	0029	0005	47
48	0253	0228	0202	0177	0152	0127	0103	0078	0053	0029	0005	48
49	0253	0227	0202	0177	0152	0127	0102	0077	0053	0029	0004	49
50	0252	0227	0202	0176	0151	0126	0102	0077	0053	0028	0004	50
51	0252	0227	0201	0176	0151	0126	0101	0077	0052	0028	0004	51
52	0252	0226	0201	0176	0151	0126	0101	0076	0052	0027	0003	52
53	0251	0226	0200	0175	0150	0125	0100	0076	0051	0027	0003	53
54	0251	0225	0200	0175	0150	0125	0100	0075	0051	0027	0002	54
55	0250	0225	0200	0174	0149	0124	0100	0075	0051	0026	0002	55
56	0250	0224	0199	0174	0149	0124	0099	0075	0050	0026	0002	56
57	0250	0224	0199	0174	0148	0124	0099	0074	0050	0025	0001	57
58	0249	0224	0198	0173	0148	0123	0098	0074	0049	0025	0001	58
59	0249	0223	0198	0173	0148	0123	0098	0073	0049	0025	0000	59
S	2° 49'	2° 50'	2° 51'	2° 52'	2° 53'	2° 54'	2° 55'	2° 56'	2° 57'	2° 58'	2° 59'	S.

Of Logarithmic Sines, Tangents, and Secants, to every Point and Quarter Point of the Compass.

Points.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	
0		10.00000		Infinite.	10.00000	Infinite.	8
0 1/4	8.69080	9.99948	8.69132	11.30868	10.00052	11.30920	7 3/4
0 1/2	8.99130	9.99790	8.99340	11.00660	10.00210	11.00870	7 1/2
0 3/4	9.16652	9.99527	9.17125	10.82875	10.00473	10.83348	7 1/4
1	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	7
1 1/4	9.38557	9.98679	9.39879	10.60121	10.01321	10.61443	6 3/4
1 1/2	9.46282	9.98088	9.48194	10.51806	10.01912	10.53718	6 1/2
1 3/4	9.52749	9.97384	9.55365	10.44635	10.02616	10.47251	6 1/4
2	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	6
2 1/4	9.63099	9.95616	9.67483	10.32517	10.04384	10.36901	5 3/4
2 1/2	9.67339	9.94543	9.72796	10.27204	10.05457	10.32661	5 1/2
2 3/4	9.71105	9.93335	9.77770	10.22230	10.06665	10.28895	5 1/4
3	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	5
3 1/4	9.77503	9.90483	9.87020	10.12980	10.09517	10.22497	4 3/4
3 1/2	9.80236	9.88819	9.91417	10.08583	10.11181	10.19764	4 1/2
3 3/4	9.82708	9.86979	9.95729	10.04271	10.13021	10.17292	4 1/4
4	9.84949	9.84949	10.00000	10.00000	10.15051	10.15051	4
	Co-sine	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	Points

Logarithms of Numbers.

N°. 1——100. Log. 0.00000——2.00000.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.00000	21	1.32222	41	1.61278	61	1.78533	81	1.90849
2	0.30103	22	1.34242	42	1.62325	62	1.79239	82	1.91381
3	0.47712	23	1.36173	43	1.63347	63	1.79934	83	1.91908
4	0.60206	24	1.38021	44	1.64345	64	1.80618	84	1.92428
5	0.69897	25	1.39794	45	1.65321	65	1.81291	85	1.92942
6	0.77815	26	1.41497	46	1.66276	66	1.81954	86	1.93450
7	0.84510	27	1.43136	47	1.67210	67	1.82607	87	1.93952
8	0.90309	28	1.44716	48	1.68124	68	1.83251	88	1.94448
9	0.95424	29	1.46240	49	1.69020	69	1.83885	89	1.94939
10	1.00000	30	1.47712	50	1.69897	70	1.84510	90	1.95424
11	1.04139	31	1.49136	51	1.70757	71	1.85126	91	1.95904
12	1.07918	32	1.50515	52	1.71600	72	1.85733	92	1.96379
13	1.11394	33	1.51851	53	1.72428	73	1.86332	93	1.96848
14	1.14613	34	1.53148	54	1.73239	74	1.86923	94	1.97313
15	1.17609	35	1.54407	55	1.74036	75	1.87506	95	1.97772
16	1.20412	36	1.55630	56	1.74819	76	1.88081	96	1.98227
17	1.23045	37	1.56820	57	1.75587	77	1.88649	97	1.98677
18	1.25527	38	1.57978	58	1.76343	78	1.89209	98	1.99123
19	1.27875	39	1.59106	59	1.77085	79	1.89763	99	1.99564
20	1.30103	40	1.60206	60	1.77815	80	1.90309	100	2.00000

N° 100——1600 Log. 00000——20412

N°	0	1	2	3	4	5	6	7	8	9
100	00000	00043	00087	00130	00173	00217	00260	00303	00346	00389
101	00432	00475	00518	00561	00604	00647	00689	00732	00775	00817
102	00860	00903	00945	00988	01030	01072	01115	01157	01199	01242
103	01284	01326	01368	01410	01452	01494	01536	01578	01620	01662
104	01703	01745	01787	01828	01870	01912	01953	01995	02036	02078
105	02119	02160	02202	02243	02284	02325	02366	02407	02449	02490
106	02531	02572	02612	02653	02694	02735	02776	02816	02857	02898
107	02938	02979	03019	03060	03100	03141	03181	03222	03262	03302
108	03342	03383	03423	03463	03503	03543	03583	03623	03663	03703
109	03743	03782	03822	03862	03902	03941	03981	04021	04060	04100
110	04139	04179	04218	04258	04297	04336	04376	04415	04454	04493
111	04532	04571	04610	04650	04689	04727	04766	04805	04844	04883
112	04922	04961	04999	05038	05077	05115	05154	05192	05231	05269
113	05308	05346	05385	05423	05461	05500	05538	05576	05614	05652
114	05690	05729	05767	05805	05843	05881	05918	05956	05994	06032
115	06070	06108	06145	06183	06221	06258	06296	06333	06371	06408
116	06446	06483	06521	06558	06595	06633	06670	06707	06744	06781
117	06819	06856	06893	06930	06967	07004	07041	07078	07115	07151
118	07188	07225	07262	07298	07335	07372	07408	07445	07482	07518
119	07555	07591	07628	07664	07700	07737	07773	07809	07846	07882
120	07918	07954	07990	08027	08063	08099	08135	08171	08207	08243
121	08279	08314	08350	08386	08422	08458	08493	08529	08565	08600
122	08636	08672	08707	08743	08778	08814	08849	08884	08920	08955
123	08991	09026	09061	09096	09132	09167	09202	09237	09272	09307
124	09342	09377	09412	09447	09482	09517	09552	09587	09621	09656
125	09691	09726	09760	09795	09830	09864	09899	09934	09968	10003
126	10037	10072	10106	10140	10175	10209	10243	10278	10312	10346
127	10380	10415	10449	10483	10517	10551	10585	10619	10653	10687
128	10721	10755	10789	10823	10857	10890	10924	10958	10992	11025
129	11059	11093	11126	11160	11193	11227	11261	11294	11327	11361
130	11394	11428	11461	11494	11528	11561	11594	11628	11661	11694
131	11727	11760	11793	11826	11860	11893	11926	11959	11992	12024
132	12057	12090	12123	12156	12189	12222	12254	12287	12320	12352
133	12385	12418	12450	12483	12516	12548	12581	12613	12646	12678
134	12710	12743	12775	12808	12840	12872	12905	12937	12969	13001
135	13033	13066	13098	13130	13162	13194	13226	13258	13290	13322
136	13354	13386	13418	13450	13481	13513	13545	13577	13609	13640
137	13672	13704	13735	13767	13799	13830	13862	13893	13925	13956
138	13988	14019	14051	14082	14114	14145	14176	14208	14239	14270
139	14301	14333	14364	14395	14426	14457	14489	14520	14551	14582
140	14613	14644	14675	14706	14737	14768	14799	14829	14860	14891
141	14922	14953	14983	15014	15045	15076	15106	15137	15168	15198
142	15229	15259	15290	15320	15351	15381	15412	15442	15473	15503
143	15534	15564	15594	15625	15655	15685	15715	15746	15776	15806
144	15836	15866	15897	15927	15957	15987	16017	16047	16077	16107
145	16137	16167	16197	16227	16256	16286	16316	16346	16376	16406
146	16435	16465	16495	16524	16554	16584	16613	16643	16673	16702
147	16732	16761	16791	16820	16850	16879	16909	16938	16967	16997
148	17026	17056	17085	17114	17143	17173	17202	17231	17260	17289
149	17319	17348	17377	17406	17435	17464	17493	17522	17551	17580
150	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869
151	17898	17926	17955	17984	18013	18041	18070	18099	18127	18156
152	18184	18213	18241	18270	18298	18327	18355	18384	18412	18441
153	18469	18498	18526	18554	18583	18611	18639	18667	18696	18724
154	18752	18780	18808	18837	18865	18893	18921	18949	18977	19005
155	19033	19061	19089	19117	19145	19173	19201	19229	19257	19285
156	19312	19340	19368	19396	19424	19451	19479	19507	19535	19562
157	19590	19618	19645	19673	19700	19728	19756	19783	19811	19838
158	19866	19893	19921	19948	19976	20003	20030	20058	20085	20112
159	20140	20167	20194	20222	20249	20276	20303	20330	20358	20385
N°	0	1	2	3	4	5	6	7	8	9

N° 1600——2200. Log. 20412——34242.

No.	0	1	2	3	4	5	6	7	8	9
160	20412	20439	20466	20493	20520	20548	20575	20602	20629	20656
161	20683	20710	20737	20763	20790	20817	20844	20871	20898	20925
162	20952	20978	21005	21032	21059	21085	21112	21139	21165	21192
163	21219	21245	21272	21299	21325	21352	21378	21405	21431	21458
164	21484	21511	21537	21564	21590	21617	21643	21669	21696	21722
165	21748	21775	21801	21827	21854	21880	21906	21932	21958	21985
166	22011	22037	22063	22089	22115	22141	22167	22194	22220	22246
167	22272	22298	22324	22350	22376	22401	22427	22453	22479	22505
168	22531	22557	22583	22608	22634	22660	22686	22712	22737	22763
169	22789	22814	22840	22866	22891	22917	22943	22968	22994	23019
170	23045	23070	23096	23121	23147	23172	23198	23223	23249	23274
171	23300	23325	23350	23376	23401	23426	23452	23477	23502	23528
172	23553	23578	23603	23629	23654	23679	23704	23729	23754	23779
173	23805	23830	23855	23880	23905	23930	23955	23980	24005	24030
174	24055	24080	24105	24130	24155	24180	24204	24229	24254	24279
175	24304	24329	24353	24378	24403	24428	24452	24477	24502	24527
176	24551	24576	24601	24625	24650	24674	24699	24724	24748	24773
177	24797	24822	24846	24871	24895	24920	24944	24969	24993	25018
178	25042	25066	25091	25115	25139	25164	25188	25212	25237	25261
179	25285	25310	25334	25358	25382	25406	25431	25455	25479	25503
180	25527	25551	25575	25600	25624	25648	25672	25696	25720	25744
181	25768	25792	25816	25840	25864	25888	25912	25935	25959	25983
182	26007	26031	26055	26079	26102	26126	26150	26174	26198	26221
183	26245	26269	26293	26316	26340	26364	26387	26411	26435	26458
184	26482	26505	26529	26553	26576	26600	26623	26647	26670	26694
185	26717	26741	26764	26788	26811	26834	26858	26881	26905	26928
186	26951	26975	26998	27021	27045	27068	27091	27114	27138	27161
187	27184	27207	27231	27254	27277	27300	27323	27346	27370	27393
188	27416	27439	27462	27485	27508	27531	27554	27577	27600	27623
189	27646	27669	27692	27715	27738	27761	27784	27807	27830	27852
190	27875	27898	27921	27944	27967	27989	28012	28035	28058	28081
191	28103	28126	28149	28171	28194	28217	28240	28262	28285	28307
192	28330	28353	28375	28398	28421	28443	28466	28488	28511	28533
193	28556	28578	28601	28623	28646	28668	28691	28713	28735	28758
194	28780	28803	28825	28847	28870	28892	28914	28937	28959	28981
195	29003	29026	29048	29070	29092	29115	29137	29159	29181	29203
196	29226	29248	29270	29292	29314	29336	29358	29380	29403	29425
197	29447	29469	29491	29513	29535	29557	29579	29601	29623	29645
198	29667	29688	29710	29732	29754	29776	29798	29820	29842	29863
199	29885	29907	29929	29951	29973	29994	30016	30038	30060	30081
200	30103	30125	30146	30168	30190	30211	30233	30255	30276	30298
201	30320	30341	30363	30384	30406	30428	30449	30471	30492	30514
202	30535	30557	30578	30600	30621	30643	30664	30685	30707	30728
203	30750	30771	30792	30814	30835	30856	30878	30899	30920	30942
204	30963	30984	31006	31027	31048	31069	31091	31112	31133	31154
205	31175	31197	31218	31239	31260	31281	31302	31323	31345	31366
206	31387	31408	31429	31450	31471	31492	31513	31534	31555	31576
207	31597	31618	31639	31660	31681	31702	31723	31744	31765	31785
208	31806	31827	31848	31869	31890	31911	31931	31952	31973	31994
209	32015	32035	32056	32077	32098	32118	32139	32160	32181	32201
210	32222	32243	32263	32284	32305	32325	32346	32366	32387	32408
211	32428	32449	32469	32490	32510	32531	32552	32572	32593	32613
212	32634	32654	32675	32695	32715	32736	32756	32777	32797	32818
213	32838	32858	32879	32899	32919	32940	32960	32980	33001	33021
214	33041	33062	33082	33102	33122	33143	33163	33183	33203	33224
215	33244	33264	33284	33304	33325	33345	33365	33385	33405	33425
216	33445	33465	33486	33506	33526	33546	33566	33586	33606	33626
217	33646	33666	33686	33706	33726	33746	33766	33786	33806	33826
218	33846	33866	33885	33905	33925	33945	33965	33985	34005	34025
219	34044	34064	34084	34104	34124	34143	34163	34183	34203	34223
No.	0	1	2	3	4	5	6	7	8	9

No. 2200 —— 2800. Log. 34242 —— 44716.

No.	0	1	2	3	4	5	6	7	8	9
220	34242	34262	34282	34301	34321	34341	34361	34380	34400	34420
221	34439	34459	34479	34498	34518	34537	34557	34577	34596	34616
222	34635	34655	34674	34694	34713	34733	34753	34772	34792	34811
223	34830	34850	34869	34889	34908	34928	34947	34967	34986	35005
224	35025	35044	35064	35083	35102	35122	35141	35160	35180	35199
225	35218	35238	35257	35276	35295	35315	35334	35353	35372	35392
226	35411	35430	35449	35468	35488	35507	35526	35545	35564	35583
227	35603	35622	35641	35660	35679	35698	35717	35736	35755	35774
228	35793	35813	35832	35851	35870	35889	35908	35927	35946	35965
229	35984	36003	36021	36040	36059	36078	36097	36116	36135	36154
230	36173	36192	36211	36229	36248	36267	36286	36305	36324	36342
231	36361	36380	36399	36418	36436	36455	36474	36493	36511	36530
232	36549	36568	36586	36605	36624	36642	36661	36680	36698	36717
233	36736	36754	36773	36791	36810	36829	36847	36866	36884	36903
234	36922	36940	36959	36977	36996	37014	37033	37051	37070	37088
235	37107	37125	37144	37162	37181	37199	37218	37236	37254	37273
236	37291	37310	37328	37346	37365	37383	37401	37420	37438	37457
237	37475	37493	37511	37530	37548	37566	37585	37603	37621	37639
238	37658	37676	37694	37712	37731	37749	37767	37785	37803	37822
239	37840	37858	37876	37894	37912	37931	37949	37967	37985	38003
240	38021	38039	38057	38075	38093	38112	38130	38148	38166	38184
241	38202	38220	38238	38256	38274	38292	38310	38328	38346	38364
242	38382	38399	38417	38435	38453	38471	38489	38507	38525	38543
243	38561	38578	38596	38614	38632	38650	38668	38686	38703	38721
244	38739	38757	38775	38792	38810	38828	38846	38863	38881	38899
245	38917	38934	38952	38970	38987	39005	39023	39041	39058	39076
246	39094	39111	39129	39146	39164	39182	39199	39217	39235	39252
247	39270	39287	39305	39322	39340	39358	39375	39393	39410	39428
248	39445	39463	39480	39498	39515	39533	39550	39568	39585	39602
249	39620	39637	39655	39672	39690	39707	39724	39742	39759	39777
250	39794	39811	39829	39846	39863	39881	39898	39915	39933	39950
251	39967	39985	40002	40019	40037	40054	40071	40088	40106	40123
252	40140	40157	40175	40192	40209	40226	40243	40261	40278	40295
253	40312	40329	40346	40364	40381	40398	40415	40432	40449	40466
254	40483	40500	40518	40535	40552	40569	40586	40603	40620	40637
255	40654	40671	40688	40705	40722	40739	40756	40773	40790	40807
256	40824	40841	40858	40875	40892	40909	40926	40943	40960	40976
257	40993	41010	41027	41044	41061	41078	41095	41111	41128	41145
258	41162	41179	41196	41212	41229	41246	41263	41280	41296	41313
259	41330	41347	41363	41380	41397	41414	41430	41447	41464	41481
260	41497	41514	41531	41547	41564	41581	41597	41614	41631	41647
261	41664	41681	41697	41714	41731	41747	41764	41780	41797	41814
262	41830	41847	41863	41880	41896	41913	41929	41946	41963	41979
263	41996	42012	42029	42045	42062	42078	42095	42111	42127	42144
264	42160	42177	42193	42210	42226	42243	42259	42275	42292	42308
265	42325	42341	42357	42374	42390	42406	42423	42439	42455	42472
266	42488	42504	42521	42537	42553	42570	42586	42602	42619	42635
267	42651	42667	42684	42700	42716	42732	42749	42765	42781	42797
268	42813	42830	42846	42862	42878	42894	42911	42927	42943	42959
269	42975	42991	43008	43024	43040	43056	43072	43088	43104	43120
270	43136	43152	43169	43185	43201	43217	43233	43249	43265	43281
271	43297	43313	43329	43345	43361	43377	43393	43409	43425	43441
272	43457	43473	43489	43505	43521	43537	43553	43569	43584	43600
273	43616	43632	43648	43664	43680	43696	43712	43727	43743	43759
274	43775	43791	43807	43823	43838	43854	43870	43886	43902	43917
275	43933	43949	43965	43981	43996	44012	44028	44044	44059	44075
276	44091	44107	44122	44138	44154	44170	44185	44201	44217	44232
277	44248	44264	44279	44295	44311	44326	44342	44358	44373	44389
278	44404	44420	44436	44451	44467	44483	44498	44514	44529	44545
279	44560	44576	44592	44607	44623	44638	44654	44669	44685	44700
No.	0	1	2	3	4	5	6	7	8	9

No. 2800——3400. Log. 44716——53148.

N°	0	1	2	3	4	5	6	7	8	9
280	44716	44731	44747	44762	44778	44793	44809	44824	44840	44855
281	44871	44886	44902	44917	44932	44948	44963	44979	44994	45010
282	45025	45040	45056	45071	45086	45102	45117	45133	45148	45163
283	45179	45194	45209	45225	45240	45255	45271	45286	45301	45317
284	45332	45347	45362	45378	45393	45408	45423	45439	45454	45469
285	45484	45500	45515	45530	45545	45561	45576	45591	45606	45621
286	45637	45652	45667	45682	45697	45712	45728	45743	45758	45773
287	45788	45803	45818	45834	45849	45864	45879	45894	45909	45924
288	45939	45954	45969	45984	46000	46015	46030	46045	46060	46075
289	46090	46105	46120	46135	46150	46165	46180	46195	46210	46225
290	46240	46255	46270	46285	46300	46315	46330	46345	46359	46374
291	46389	46404	46419	46434	46449	46464	46479	46494	46509	46523
292	46538	46553	46568	46583	46598	46613	46627	46642	46657	46672
293	46687	46702	46716	46731	46746	46761	46776	46790	46805	46820
294	46835	46850	46864	46879	46894	46909	46923	46938	46953	46967
295	46982	46997	47012	47026	47041	47056	47070	47085	47100	47114
296	47129	47144	47159	47173	47188	47202	47217	47232	47246	47261
297	47276	47290	47305	47319	47334	47349	47363	47378	47392	47407
298	47422	47436	47451	47465	47480	47494	47509	47524	47538	47553
299	47567	47582	47596	47611	47625	47640	47654	47669	47683	47698
300	47712	47727	47741	47756	47770	47784	47799	47813	47828	47842
301	47857	47871	47885	47900	47914	47929	47943	47958	47972	47986
302	48001	48015	48029	48044	48058	48073	48087	48101	48116	48130
303	48144	48159	48173	48187	48202	48216	48230	48244	48259	48273
304	48287	48302	48316	48330	48344	48359	48373	48387	48401	48416
305	48430	48444	48458	48473	48487	48501	48515	48530	48544	48558
306	48572	48586	48601	48615	48629	48643	48657	48671	48686	48700
307	48714	48728	48742	48756	48770	48785	48799	48813	48827	48841
308	48855	48869	48883	48897	48911	48926	48940	48954	48968	48982
309	48996	49010	49024	49038	49052	49066	49080	49094	49108	49122
310	49136	49150	49164	49178	49192	49206	49220	49234	49248	49262
311	49276	49290	49304	49318	49332	49346	49360	49374	49388	49402
312	49415	49429	49443	49457	49471	49485	49499	49513	49527	49541
313	49554	49568	49582	49596	49610	49624	49638	49651	49665	49679
314	49693	49707	49721	49734	49748	49762	49776	49790	49803	49817
315	49831	49845	49859	49872	49886	49900	49914	49927	49941	49955
316	49969	49982	49996	50010	50024	50037	50051	50065	50079	50092
317	50106	50120	50133	50147	50161	50174	50188	50202	50215	50229
318	50243	50256	50270	50284	50297	50311	50325	50338	50352	50365
319	50379	50393	50406	50420	50433	50447	50461	50474	50488	50501
320	50515	50529	50542	50556	50569	50583	50596	50610	50623	50637
321	50651	50664	50678	50691	50705	50718	50732	50745	50759	50772
322	50786	50799	50813	50826	50840	50853	50866	50880	50893	50907
323	50920	50934	50947	50961	50974	50987	51001	51014	51028	51041
324	51055	51068	51081	51095	51108	51121	51135	51148	51162	51175
325	51188	51202	51215	51228	51242	51255	51268	51282	51295	51308
326	51322	51335	51348	51362	51375	51388	51402	51415	51428	51441
327	51455	51468	51481	51495	51508	51521	51534	51548	51561	51574
328	51587	51601	51614	51627	51640	51654	51667	51680	51693	51706
329	51720	51733	51746	51759	51772	51786	51799	51812	51825	51838
330	51851	51865	51878	51891	51904	51917	51930	51943	51957	51970
331	51983	51996	52009	52022	52035	52048	52061	52075	52088	52101
332	52114	52127	52140	52153	52166	52179	52192	52205	52218	52231
333	52244	52257	52270	52284	52297	52310	52323	52336	52349	52362
334	52375	52388	52401	52414	52427	52440	52453	52466	52479	52492
335	52504	52517	52530	52543	52556	52569	52582	52595	52608	52621
336	52634	52647	52660	52673	52686	52699	52711	52724	52737	52750
337	52763	52776	52789	52802	52815	52827	52840	52853	52866	52879
338	52892	52905	52917	52930	52943	52956	52969	52982	52994	53007
339	53020	53033	53046	53058	53071	53084	53097	53110	53122	53135
N°	0	1	2	3	4	5	6	7	8	9

N° 3400——4000. Log. 53148——60206.

No.	0	1	2	3	4	5	6	7	8	9
340	53148	53161	53173	53186	53199	53212	53224	53237	53250	53263
341	53275	53288	53301	53314	53326	53339	53352	53364	53377	53390
342	53403	53415	53428	53441	53453	53466	53479	53491	53504	53517
343	53529	53542	53555	53567	53580	53593	53605	53618	53631	53643
344	53656	53668	53681	53694	53706	53719	53732	53744	53757	53769
345	53782	53794	53807	53820	53832	53845	53857	53870	53882	53895
346	53908	53920	53933	53945	53958	53970	53983	53995	54008	54020
347	54033	54045	54058	54070	54083	54095	54108	54120	54133	54145
348	54158	54170	54183	54195	54208	54220	54233	54245	54258	54270
349	54283	54295	54307	54320	54332	54345	54357	54370	54382	54394
350	54407	54419	54432	54444	54456	54469	54481	54494	54506	54518
351	54531	54543	54555	54568	54580	54593	54605	54617	54630	54642
352	54654	54667	54679	54691	54704	54716	54728	54741	54753	54765
353	54777	54790	54802	54814	54827	54839	54851	54864	54876	54888
354	54900	54913	54925	54937	54949	54962	54974	54986	54998	55011
355	55023	55035	55047	55060	55072	55084	55096	55108	55121	55133
356	55145	55157	55169	55182	55194	55206	55218	55230	55242	55255
357	55267	55279	55291	55303	55315	55328	55340	55352	55364	55376
358	55388	55400	55413	55425	55437	55449	55461	55473	55485	55497
359	55509	55522	55534	55546	55558	55570	55582	55594	55606	55618
360	55630	55642	55654	55666	55678	55691	55703	55715	55727	55739
361	55751	55763	55775	55787	55799	55811	55823	55835	55847	55859
362	55871	55883	55895	55907	55919	55931	55943	55955	55967	55979
363	55991	56003	56015	56027	56038	56050	56062	56074	56086	56098
364	56110	56122	56134	56146	56158	56170	56182	56194	56205	56217
365	56229	56241	56253	56265	56277	56289	56301	56312	56324	56336
366	56348	56360	56372	56384	56396	56407	56419	56431	56443	56455
367	56467	56478	56490	56502	56514	56526	56538	56549	56561	56573
368	56585	56597	56608	56620	56632	56644	56656	56667	56679	56691
369	56703	56714	56726	56738	56750	56761	56773	56785	56797	56808
370	56820	56832	56844	56855	56867	56879	56891	56902	56914	56926
371	56937	56949	56961	56972	56984	56996	57008	57019	57031	57043
372	57054	57066	57078	57089	57101	57113	57124	57136	57148	57159
373	57171	57183	57194	57206	57217	57229	57241	57252	57264	57276
374	57287	57299	57310	57322	57334	57345	57357	57368	57380	57392
375	57403	57415	57426	57438	57449	57461	57473	57484	57496	57507
376	57519	57530	57542	57553	57565	57576	57588	57600	57611	57623
377	57634	57646	57657	57669	57680	57692	57703	57715	57726	57738
378	57749	57761	57772	57784	57795	57807	57818	57830	57841	57852
379	57864	57875	57887	57898	57910	57921	57933	57944	57955	57967
380	57978	57990	58001	58013	58024	58035	58047	58058	58070	58081
381	58092	58104	58115	58127	58138	58149	58161	58172	58184	58195
382	58206	58218	58229	58240	58252	58263	58274	58286	58297	58309
383	58320	58331	58343	58354	58365	58377	58388	58399	58410	58422
384	58433	58444	58456	58467	58478	58490	58501	58512	58524	58535
385	58546	58557	58569	58580	58591	58602	58614	58625	58636	58647
386	58659	58670	58681	58692	58704	58715	58726	58737	58749	58760
387	58771	58782	58794	58805	58816	58827	58838	58850	58861	58872
388	58883	58894	58906	58917	58928	58939	58950	58961	58973	58984
389	58995	59006	59017	59028	59040	59051	59062	59073	59084	59095
390	59106	59118	59129	59140	59151	59162	59173	59184	59195	59207
391	59218	59229	59240	59251	59262	59273	59284	59295	59306	59318
392	59329	59340	59351	59362	59373	59384	59395	59406	59417	59428
393	59439	59450	59461	59472	59483	59494	59506	59517	59528	59539
394	59550	59561	59572	59583	59594	59605	59616	59627	59638	59649
395	59660	59671	59682	59693	59704	59715	59726	59737	59748	59759
396	59770	59780	59791	59802	59813	59824	59835	59846	59857	59868
397	59879	59890	59901	59912	59923	59934	59945	59956	59966	59977
398	59988	59999	60010	60021	60032	60043	60054	60065	60076	60086
399	60097	60108	60119	60130	60141	60152	60163	60173	60184	60195
No.	0	1	2	3	4	5	6	7	8	9

N° 4000 —— 4600.										Log. 60206 —— 66276.
N°	0	1	2	3	4	5	6	7	8	9
400	60206	60217	60228	60239	60249	60260	60271	60282	60293	60304
401	60314	60325	60336	60347	60358	60369	60379	60390	60401	60412
402	60423	60433	60444	60455	60466	60477	60487	60498	60509	60520
403	60531	60541	60552	60563	60574	60584	60595	60606	60617	60627
404	60638	60649	60660	60670	60681	60692	60703	60713	60724	60735
405	60746	60756	60767	60778	60788	60799	60810	60821	60831	60842
406	60853	60863	60874	60885	60895	60906	60917	60927	60938	60949
407	60959	60970	60981	60991	61002	61013	61023	61034	61045	61055
408	61066	61077	61087	61098	61109	61119	61130	61140	61151	61162
409	61172	61183	61194	61204	61215	61225	61236	61247	61257	61268
410	61278	61289	61300	61310	61321	61331	61342	61352	61363	61374
411	61384	61395	61405	61416	61426	61437	61448	61458	61469	61479
412	61490	61500	61511	61521	61532	61542	61553	61563	61574	61584
413	61595	61606	61616	61627	61637	61648	61658	61669	61679	61690
414	61700	61711	61721	61731	61742	61752	61763	61773	61784	61794
415	61805	61815	61826	61836	61847	61857	61868	61878	61888	61899
416	61909	61920	61930	61941	61951	61962	61972	61982	61993	62003
417	62014	62024	62034	62045	62055	62066	62076	62086	62097	62107
418	62118	62128	62138	62149	62159	62170	62180	62190	62201	62211
419	62221	62232	62242	62252	62263	62273	62284	62294	62304	62315
420	62325	62335	62346	62356	62366	62377	62387	62397	62408	62418
421	62428	62439	62449	62459	62469	62480	62490	62500	62511	62521
422	62531	62542	62552	62562	62572	62583	62593	62603	62613	62624
423	62634	62644	62655	62665	62675	62685	62696	62706	62716	62726
424	62737	62747	62757	62767	62778	62788	62798	62808	62818	62829
425	62839	62849	62859	62870	62880	62890	62900	62910	62921	62931
426	62941	62951	62961	62972	62982	62992	63002	63012	63022	63033
427	63043	63053	63063	63073	63083	63094	63104	63114	63124	63134
428	63144	63155	63165	63175	63185	63195	63205	63215	63225	63236
429	63246	63256	63266	63276	63286	63296	63306	63317	63327	63337
430	63347	63357	63367	63377	63387	63397	63407	63417	63428	63438
431	63448	63458	63468	63478	63488	63498	63508	63518	63528	63538
432	63548	63558	63568	63579	63589	63599	63609	63619	63629	63639
433	63649	63659	63669	63679	63689	63699	63709	63719	63729	63739
434	63749	63759	63769	63779	63789	63799	63809	63819	63829	63839
435	63849	63859	63869	63879	63889	63899	63909	63919	63929	63939
436	63949	63959	63969	63979	63988	63998	64008	64018	64028	64038
437	64048	64058	64068	64078	64088	64098	64108	64118	64128	64137
438	64147	64157	64167	64177	64187	64197	64207	64217	64227	64237
439	64246	64256	64266	64276	64286	64296	64306	64316	64326	64335
440	64345	64355	64365	64375	64385	64395	64404	64414	64424	64434
441	64444	64454	64464	64473	64483	64493	64503	64513	64523	64532
442	64542	64552	64562	64572	64582	64591	64601	64611	64621	64631
443	64640	64650	64660	64670	64680	64689	64699	64709	64719	64729
444	64738	64748	64758	64768	64777	64787	64797	64807	64816	64826
445	64836	64846	64856	64865	64875	64885	64895	64904	64914	64924
446	64933	64943	64953	64963	64972	64982	64992	65002	65011	65021
447	65031	65040	65050	65060	65070	65079	65089	65099	65108	65118
448	65128	65137	65147	65157	65167	65176	65186	65196	65205	65215
449	65325	65234	65244	65254	65263	65273	65283	65292	65302	65312
450	65321	65331	65341	65350	65360	65369	65379	65389	65398	65408
451	65418	65427	65437	65447	65456	65466	65475	65485	65495	65504
452	65514	65523	65533	65543	65552	65562	65571	65581	65591	65600
453	65610	65619	65629	65639	65648	65658	65667	65677	65686	65696
454	65706	65715	65725	65734	65744	65753	65763	65772	65782	65792
455	65801	65811	65820	65830	65839	65849	65858	65868	65877	65887
456	65896	65906	65916	65925	65935	65944	65954	65963	65973	65982
457	65992	66001	66011	66020	66030	66039	66049	66058	66068	66077
458	66087	66096	66106	66115	66124	66134	66143	66153	66162	66172
459	66181	66191	66200	66210	66219	66229	66238	66247	66257	66266
N°	0	1	2	3	4	5	6	7	8	9

No. 4600——5200. Log. 66276——71600.

No.	0	1	2	3	4	5	6	7	8	9
460	66276	66285	66295	66304	66314	66323	66332	66342	66351	66361
461	66370	66380	66389	66398	66408	66417	66427	66436	66445	66455
462	66464	66474	66483	66492	66502	66511	66521	66530	66539	66549
463	66558	66567	66577	66586	66596	66605	66614	66624	66633	66642
464	66652	66661	66671	66680	66689	66699	66708	66717	66727	66736
465	66745	66755	66764	66773	66783	66792	66801	66811	66820	66829
466	66839	66848	66857	66867	66876	66885	66894	66904	66913	66922
467	66932	66941	66950	66960	66969	66978	66987	66997	67006	67015
468	67025	67034	67043	67052	67062	67071	67080	67089	67099	67108
469	67117	67127	67136	67145	67154	67164	67173	67182	67191	67201
470	67210	67219	67228	67237	67247	67256	67265	67274	67284	67293
471	67302	67311	67321	67330	67339	67348	67357	67367	67376	67385
472	67394	67403	67413	67422	67431	67440	67449	67459	67468	67477
473	67486	67495	67504	67514	67523	67532	67541	67550	67560	67569
474	67578	67587	67596	67605	67614	67624	67633	67642	67651	67660
475	67669	67679	67688	67697	67706	67715	67724	67733	67742	67752
476	67761	67770	67779	67788	67797	67806	67815	67825	67834	67843
477	67852	67861	67870	67879	67888	67897	67906	67916	67925	67934
478	67943	67952	67961	67970	67979	67988	67997	68006	68015	68024
479	68034	68043	68052	68061	68070	68079	68088	68097	68106	68115
480	68124	68133	68142	68151	68160	68169	68178	68187	68196	68205
481	68215	68224	68233	68242	68251	68260	68269	68278	68287	68296
482	68305	68314	68323	68332	68341	68350	68359	68368	68377	68386
483	68395	68404	68413	68422	68431	68440	68449	68458	68467	68476
484	68485	68494	68502	68511	68520	68529	68538	68547	68556	68565
485	68574	68583	68592	68601	68610	68619	68628	68637	68646	68655
486	68664	68673	68681	68690	68699	68708	68717	68726	68735	68744
487	68753	68762	68771	68780	68789	68797	68806	68815	68824	68833
488	68842	68851	68860	68869	68878	68886	68895	68904	68913	68922
489	68931	68940	68949	68958	68966	68975	68984	68993	69002	69011
490	69020	69028	69037	69046	69055	69064	69073	69082	69090	69099
491	69108	69117	69126	69135	69144	69152	69161	69170	69179	69188
492	69197	69205	69214	69223	69232	69241	69249	69258	69267	69276
493	69285	69294	69302	69311	69320	69329	69338	69346	69355	69364
494	69373	69381	69390	69399	69408	69417	69425	69434	69443	69452
495	69461	69469	69478	69487	69496	69504	69513	69522	69531	69539
496	69548	69557	69566	69574	69583	69592	69601	69609	69618	69627
497	69636	69644	69653	69662	69671	69679	69688	69697	69705	69714
498	69723	69732	69740	69749	69758	69767	69775	69784	69793	69801
499	69810	69819	69827	69836	69845	69854	69862	69871	69880	69888
500	69897	69906	69914	69923	69932	69940	69949	69958	69966	69975
501	69984	69992	70001	70010	70018	70027	70036	70044	70053	70062
502	70070	70079	70088	70096	70105	70114	70122	70131	70140	70148
503	70157	70165	70174	70183	70191	70200	70209	70217	70226	70234
504	70243	70252	70260	70269	70278	70286	70295	70303	70312	70321
505	70329	70338	70346	70355	70364	70372	70381	70389	70398	70406
506	70415	70424	70432	70441	70449	70458	70467	70475	70484	70492
507	70501	70509	70518	70526	70535	70544	70552	70561	70569	70578
508	70586	70595	70603	70612	70621	70629	70638	70646	70655	70663
509	70672	70680	70689	70697	70706	70714	70723	70731	70740	70749
510	70757	70766	70774	70783	70791	70800	70808	70817	70825	70834
511	70842	70851	70859	70868	70876	70885	70893	70902	70910	70919
512	70927	70935	70944	70952	70961	70969	70978	70986	70995	71003
513	71012	71020	71029	71037	71046	71054	71063	71071	71079	71088
514	71096	71105	71113	71122	71130	71139	71147	71155	71164	71172
515	71181	71189	71198	71206	71214	71223	71231	71240	71248	71257
516	71265	71273	71282	71290	71299	71307	71315	71324	71332	71341
517	71349	71357	71366	71374	71383	71391	71399	71408	71416	71425
518	71433	71441	71450	71458	71466	71475	71483	71492	71500	71508
519	71517	71525	71533	71542	71550	71559	71567	71575	71584	71592
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXIV. Logarithms of Numbers.

N° 5200——5800. Log. 71600——76343.

N°	0	1	2	3	4	5	6	7	8	9
520	71600	71609	71617	71625	71634	71642	71650	71659	71667	71675
521	71684	71692	71700	71709	71717	71725	71734	71742	71750	71759
522	71767	71775	71784	71792	71800	71809	71817	71825	71834	71842
523	71850	71858	71867	71875	71883	71892	71900	71908	71917	71925
524	71933	71941	71950	71958	71966	71975	71983	71991	71999	72008
525	72016	72024	72032	72041	72049	72057	72066	72074	72082	72090
526	72099	72107	72115	72123	72132	72140	72148	72156	72165	72173
527	72181	72189	72198	72206	72214	72222	72230	72239	72247	72255
528	72263	72272	72280	72288	72296	72304	72313	72321	72329	72337
529	72346	72354	72362	72370	72378	72387	72395	72403	72411	72419
530	72428	72436	72444	72452	72460	72469	72477	72485	72493	72501
531	72509	72518	72526	72534	72542	72550	72558	72567	72575	72583
532	72591	72599	72607	72616	72624	72632	72640	72648	72656	72665
533	72673	72681	72689	72697	72705	72713	72722	72730	72738	72746
534	72754	72762	72770	72779	72787	72795	72803	72811	72819	72827
535	72835	72843	72852	72860	72868	72876	72884	72892	72900	72908
536	72916	72925	72933	72941	72949	72957	72965	72973	72981	72989
537	72997	73006	73014	73022	73030	73038	73046	73054	73062	73070
538	73078	73086	73094	73102	73111	73119	73127	73135	73143	73151
539	73159	73167	73175	73183	73191	73199	73207	73215	73223	73231
540	73239	73247	73255	73263	73272	73280	73288	73296	73304	73312
541	73320	73328	73336	73344	73352	73360	73368	73376	73384	73392
542	73400	73408	73416	73424	73432	73440	73448	73456	73464	73472
543	73480	73488	73496	73504	73512	73520	73528	73536	73544	73552
544	73560	73568	73576	73584	73592	73600	73608	73616	73624	73632
545	73640	73648	73656	73664	73672	73679	73687	73695	73703	73711
546	73719	73727	73735	73743	73751	73759	73767	73775	73783	73791
547	73799	73807	73815	73823	73830	73838	73846	73854	73862	73870
548	73878	73886	73894	73902	73910	73918	73926	73933	73941	73949
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550	74036	74044	74052	74060	74068	74076	74084	74092	74099	74107
551	74115	74123	74131	74139	74147	74155	74162	74170	74178	74186
552	74194	74202	74210	74218	74225	74233	74241	74249	74257	74265
553	74273	74280	74288	74296	74304	74312	74320	74327	74335	74343
554	74351	74359	74367	74374	74382	74390	74398	74406	74414	74421
555	74429	74437	74445	74453	74461	74468	74476	74484	74492	74500
556	74507	74515	74523	74531	74539	74547	74554	74562	74570	74578
557	74586	74593	74601	74609	74617	74624	74632	74640	74648	74656
558	74663	74671	74679	74687	74695	74702	74710	74718	74726	74733
559	74741	74749	74757	74764	74772	74780	74788	74796	74803	74811
560	74819	74827	74834	74842	74850	74858	74865	74873	74881	74889
561	74896	74904	74912	74920	74927	74935	74943	74950	74958	74966
562	74974	74981	74989	74997	75005	75012	75020	75028	75035	75043
563	75051	75059	75066	75074	75082	75089	75097	75105	75113	75120
564	75128	75136	75143	75151	75159	75166	75174	75182	75189	75197
565	75205	75213	75220	75228	75236	75243	75251	75259	75266	75274
566	75282	75289	75297	75305	75312	75320	75328	75335	75343	75351
567	75358	75366	75374	75381	75389	75397	75404	75412	75420	75427
568	75435	75442	75450	75458	75465	75473	75481	75488	75496	75504
569	75511	75519	75526	75534	75542	75549	75557	75565	75572	75580
570	75587	75595	75603	75610	75618	75626	75633	75641	75648	75656
571	75664	75671	75679	75686	75694	75702	75709	75717	75724	75732
572	75740	75747	75755	75762	75770	75778	75785	75793	75800	75808
573	75815	75823	75831	75838	75846	75853	75861	75868	75876	75884
574	75891	75899	75906	75914	75921	75929	75937	75944	75952	75959
575	75967	75974	75982	75989	75997	76005	76012	76020	76027	76035
576	76042	76050	76057	76065	76072	76080	76087	76095	76103	76110
577	76118	76125	76133	76140	76148	76155	76163	76170	76178	76185
578	76193	76200	76208	76215	76223	76230	76238	76245	76253	76260
579	76268	76275	76283	76290	76298	76305	76313	76320	76328	76335
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N° 5800——6400. Log. 76343——80618.

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582	76492	76500	76507	76515	76522	76530	76537	76545	76552	76559
583	76567	76574	76582	76589	76597	76604	76612	76619	76626	76634
584	76641	76649	76656	76664	76671	76678	76686	76693	76701	76708
585	76716	76723	76730	76738	76745	76753	76760	76768	76775	76782
586	76790	76797	76805	76812	76819	76827	76834	76842	76849	76856
587	76864	76871	76879	76886	76893	76901	76908	76916	76923	76930
588	76938	76945	76953	76960	76967	76975	76982	76989	76997	77004
589	77012	77019	77026	77034	77041	77048	77056	77063	77070	77078
590	77085	77093	77100	77107	77115	77122	77129	77137	77144	77151
591	77159	77166	77173	77181	77188	77195	77203	77210	77217	77225
592	77232	77240	77247	77254	77262	77269	77276	77283	77291	77298
593	77305	77313	77320	77327	77335	77342	77349	77357	77364	77371
594	77379	77386	77393	77401	77408	77415	77422	77430	77437	77444
595	77452	77459	77466	77474	77481	77488	77495	77503	77510	77517
596	77525	77532	77539	77546	77554	77561	77568	77576	77583	77590
597	77597	77605	77612	77619	77627	77634	77641	77648	77656	77663
598	77670	77677	77685	77692	77699	77706	77714	77721	77728	77735
599	77743	77750	77757	77764	77772	77779	77786	77793	77801	77808
600	77815	77822	77830	77837	77844	77851	77859	77866	77873	77880
601	77887	77895	77902	77909	77916	77924	77931	77938	77945	77952
602	77960	77967	77974	77981	77988	77996	78003	78010	78017	78025
603	78032	78039	78046	78053	78061	78068	78075	78082	78089	78097
604	78104	78111	78118	78125	78132	78140	78147	78154	78161	78168
605	78176	78183	78190	78197	78204	78211	78219	78226	78233	78240
606	78247	78254	78262	78269	78276	78283	78290	78297	78305	78312
607	78319	78326	78333	78340	78347	78355	78362	78369	78376	78383
608	78390	78398	78405	78412	78419	78426	78433	78440	78447	78455
609	78462	78469	78476	78483	78490	78497	78504	78512	78519	78526
610	78533	78540	78547	78554	78561	78569	78576	78583	78590	78597
611	78604	78611	78618	78625	78633	78640	78647	78654	78661	78668
612	78675	78682	78689	78696	78704	78711	78718	78725	78732	78739
613	78746	78753	78760	78767	78774	78781	78789	78796	78803	78810
614	78817	78824	78831	78838	78845	78852	78859	78866	78873	78880
615	78888	78895	78902	78909	78916	78923	78930	78937	78944	78951
616	78958	78965	78972	78979	78986	78993	79000	79007	79014	79021
617	79029	79036	79043	79050	79057	79064	79071	79078	79085	79092
618	79099	79106	79113	79120	79127	79134	79141	79148	79155	79162
619	79169	79176	79183	79190	79197	79204	79211	79218	79225	79232
620	79239	79246	79253	79260	79267	79274	79281	79288	79295	79302
621	79309	79316	79323	79330	79337	79344	79351	79358	79365	79372
622	79379	79386	79393	79400	79407	79414	79421	79428	79435	79442
623	79449	79456	79463	79470	79477	79484	79491	79498	79505	79511
624	79518	79525	79532	79539	79546	79553	79560	79567	79574	79581
625	79588	79595	79602	79609	79616	79623	79630	79637	79644	79650
626	79657	79664	79671	79678	79685	79692	79699	79706	79713	79720
627	79727	79734	79741	79748	79754	79761	79768	79775	79782	79789
628	79796	79803	79810	79817	79824	79831	79837	79844	79851	79858
629	79865	79872	79879	79886	79893	79900	79906	79913	79920	79927
630	79934	79941	79948	79955	79962	79969	79975	79982	79989	79996
631	80003	80010	80017	80024	80030	80037	80044	80051	80058	80065
632	80072	80079	80085	80092	80099	80106	80113	80120	80127	80134
633	80140	80147	80154	80161	80168	80175	80182	80188	80195	80202
634	80209	80216	80223	80229	80236	80243	80250	80257	80264	80271
635	80277	80284	80291	80298	80305	80312	80318	80325	80332	80339
636	80346	80353	80359	80366	80373	80380	80387	80393	80400	80407
637	80414	80421	80428	80434	80441	80448	80455	80462	80468	80475
638	80482	80489	80406	80502	80509	80516	80523	80530	80536	80543
639	80550	80557	80564	80570	80577	80584	80591	80598	80604	80611
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Nº 6400 —— 7000.							Log. 80618 —— 84510.			
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641	80686	80693	80699	80706	80713	80720	80726	80733	80740	80747
642	80754	80760	80767	80774	80781	80787	80794	80801	80808	80814
643	80821	80828	80835	80841	80848	80855	80862	80868	80875	80882
644	80889	80895	80902	80909	80916	80922	80929	80936	80943	80949
645	80956	80963	80969	80976	80983	80990	80996	81003	81010	81017
646	81023	81030	81037	81043	81050	81057	81064	81070	81077	81084
647	81090	81097	81104	81111	81117	81124	81131	81137	81144	81151
648	81158	81164	81171	81178	81184	81191	81198	81204	81211	81218
649	81224	81231	81238	81245	81251	81258	81265	81271	81278	81285
650	81291	81298	81305	81311	81318	81325	81331	81338	81345	81351
651	81358	81365	81371	81378	81385	81391	81398	81405	81411	81418
652	81425	81431	81438	81445	81451	81458	81465	81471	81478	81485
653	81491	81498	81505	81511	81518	81525	81531	81538	81544	81551
654	81558	81564	81571	81578	81584	81591	81598	81604	81611	81617
655	81624	81631	81637	81644	81651	81657	81664	81671	81677	81684
656	81690	81697	81704	81710	81717	81723	81730	81737	81743	81750
657	81757	81763	81770	81776	81783	81790	81796	81803	81809	81816
658	81823	81829	81836	81842	81849	81856	81862	81869	81875	81882
659	81889	81895	81902	81908	81915	81921	81928	81935	81941	81948
660	81954	81961	81968	81974	81981	81987	81994	82000	82007	82014
661	82020	82027	82033	82040	82046	82053	82060	82066	82073	82079
662	82086	82092	82099	82105	82112	82119	82125	82132	82138	82145
663	82151	82158	82164	82171	82178	82184	82191	82197	82204	82210
664	82217	82223	82230	82236	82243	82249	82256	82263	82269	82276
665	82282	82289	82295	82302	82308	82315	82321	82328	82334	82341
666	82347	82354	82360	82367	82373	82380	82387	82393	82400	82406
667	82413	82419	82426	82432	82439	82445	82452	82458	82465	82471
668	82478	82484	82491	82497	82504	82510	82517	82523	82530	82536
669	82543	82549	82556	82562	82569	82575	82582	82588	82595	82601
670	82607	82614	82620	82627	82633	82640	82646	82653	82659	82666
671	82672	82679	82685	82692	82698	82705	82711	82718	82724	82730
672	82737	82743	82750	82756	82763	82769	82776	82782	82789	82795
673	82802	82808	82814	82821	82827	82834	82840	82847	82853	82860
674	82866	82872	82879	82885	82892	82898	82905	82911	82918	82924
675	82930	82937	82943	82950	82956	82963	82969	82975	82982	82988
676	82995	83001	83008	83014	83020	83027	83033	83040	83046	83052
677	83059	83065	83072	83078	83085	83091	83097	83104	83110	83117
678	83123	83129	83136	83142	83149	83155	83161	83168	83174	83181
679	83187	83193	83200	83206	83213	83219	83225	83232	83238	83245
680	83251	83257	83264	83270	83276	83283	83289	83296	83302	83308
681	83315	83321	83327	83334	83340	83347	83353	83359	83366	83372
682	83378	83385	83391	83398	83404	83410	83417	83423	83429	83436
683	83442	83448	83455	83461	83467	83474	83480	83487	83493	83499
684	83506	83512	83518	83525	83531	83537	83544	83550	83556	83563
685	83569	83575	83582	83588	83594	83601	83607	83613	83620	83626
686	83632	83639	83645	83651	83658	83664	83670	83677	83683	83689
687	83696	83702	83708	83715	83721	83727	83734	83740	83746	83753
688	83759	83765	83771	83778	83784	83790	83797	83803	83809	83816
689	83822	83828	83835	83841	83847	83853	83860	83866	83872	83879
690	83885	83891	83897	83904	83910	83916	83923	83929	83935	83942
691	83948	83954	83960	83967	83973	83979	83985	83992	83998	84004
692	84011	84017	84023	84029	84036	84042	84048	84055	84061	84067
693	84073	84080	84086	84092	84098	84105	84111	84117	84123	84130
694	84136	84142	84148	84155	84161	84167	84173	84180	84186	84192
695	84198	84205	84211	84217	84223	84230	84236	84242	84248	84255
696	84261	84267	84273	84280	84286	84292	84298	84305	84311	84317
697	84323	84330	84336	84342	84348	84354	84361	84367	84373	84379
698	84386	84392	84398	84404	84410	84417	84423	84429	84435	84442
699	84448	84454	84460	84466	84473	84479	84485	84491	84497	84504
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701	84572	84578	84584	84590	84597	84603	84609	84615	84621	84628
702	84634	84640	84646	84652	84658	84665	84671	84677	84683	84689
703	84696	84702	84708	84714	84720	84726	84733	84739	84745	84751
704	84757	84763	84770	84776	84782	84788	84794	84800	84807	84813
705	84819	84825	84831	84837	84844	84850	84856	84862	84868	84874
706	84880	84887	84893	84899	84905	84911	84917	84924	84930	84936
707	84942	84948	84954	84960	84967	84973	84979	84985	84991	84997
708	85003	85009	85016	85022	85028	85034	85040	85046	85052	85058
709	85065	85071	85077	85083	85089	85095	85101	85107	85114	85120
710	85126	85132	85138	85144	85150	85156	85163	85169	85175	85181
711	85187	85193	85199	85205	85211	85217	85224	85230	85236	85242
712	85248	85254	85260	85266	85272	85278	85285	85291	85297	85303
713	85309	85315	85321	85327	85333	85339	85345	85352	85358	85364
714	85370	85376	85382	85388	85394	85400	85406	85412	85418	85425
715	85431	85437	85443	85449	85455	85461	85467	85473	85479	85485
716	85491	85497	85503	85509	85516	85522	85528	85534	85540	85546
717	85552	85558	85564	85570	85576	85582	85588	85594	85600	85606
718	85612	85618	85625	85631	85637	85643	85649	85655	85661	85667
719	85673	85679	85685	85691	85697	85703	85709	85715	85721	85727
720	85733	85739	85745	85751	85757	85763	85769	85775	85781	85788
721	85794	85800	85806	85812	85818	85824	85830	85836	85842	85848
722	85854	85860	85866	85872	85878	85884	85890	85896	85902	85908
723	85914	85920	85926	85932	85938	85944	85950	85956	85962	85968
724	85974	85980	85986	85992	85998	86004	86010	86016	86022	86028
725	86034	86040	86046	86052	86058	86064	86070	86076	86082	86088
726	86094	86100	86106	86112	86118	86124	86130	86136	86141	86147
727	86153	86159	86165	86171	86177	86183	86189	86195	86201	86207
728	86213	86219	86225	86231	86237	86243	86249	86255	86261	86267
729	86273	86279	86285	86291	86297	86303	86308	86314	86320	86326
730	86332	86338	86344	86350	86356	86362	86368	86374	86380	86386
731	86392	86398	86404	86410	86415	86421	86427	86433	86439	86445
732	86451	86457	86463	86469	86475	86481	86487	86493	86499	86504
733	86510	86516	86522	86528	86534	86540	86546	86552	86558	86564
734	86570	86576	86581	86587	86593	86599	86605	86611	86617	86623
735	86629	86635	86641	86646	86652	86658	86664	86670	86676	86682
736	86688	86694	86700	86705	86711	86717	86723	86729	86735	86741
737	86747	86753	86759	86764	86770	86776	86782	86788	86794	86800
738	86806	86812	86817	86823	86829	86835	86841	86847	86853	86859
739	86864	86870	86876	86882	86888	86894	86900	86906	86911	86917
740	86923	86929	86935	86941	86947	86953	86958	86964	86970	86976
741	86982	86988	86994	86999	87005	87011	87017	87023	87029	87035
742	87040	87046	87052	87058	87064	87070	87075	87081	87087	87093
743	87099	87105	87111	87116	87122	87128	87134	87140	87146	87151
744	87157	87163	87169	87175	87181	87186	87192	87198	87204	87210
745	87216	87221	87227	87233	87239	87245	87251	87256	87262	87268
746	87274	87280	87286	87291	87297	87303	87309	87315	87320	87326
747	87332	87338	87344	87349	87355	87361	87367	87373	87379	87384
748	87390	87396	87402	87408	87413	87419	87425	87431	87437	87442
749	87448	87454	87460	87466	87471	87477	87483	87489	87495	87500
750	87506	87512	87518	87523	87529	87535	87541	87547	87552	87558
751	87564	87570	87576	87581	87587	87593	87599	87604	87610	87616
752	87622	87628	87633	87639	87645	87651	87656	87662	87668	87674
753	87679	87685	87691	87697	87703	87708	87714	87720	87726	87731
754	87737	87743	87749	87754	87760	87766	87772	87777	87783	87789
755	87795	87800	87806	87812	87818	87823	87829	87835	87841	87846
756	87852	87858	87864	87869	87875	87881	87887	87892	87898	87904
757	87910	87915	87921	87927	87933	87938	87944	87950	87955	87961
758	87967	87973	87978	87984	87990	87996	88001	88007	88013	88018
759	88024	88030	88036	88041	88047	88053	88058	88064	88070	88076
N°	0	1	2	3	4	5	6	7	8	9

TABLE XXIV. Logarithms of Numbers.

N° 7600——8200. Log. 88081——91381.

No.	0	1	2	3	4	5	6	7	8	9
760	88081	88087	88093	88098	88104	88110	88116	88121	88127	88133
761	88138	88144	88150	88156	88161	88167	88173	88178	88184	88190
762	88195	88201	88207	88213	88218	88224	88230	88235	88241	88247
763	88252	88258	88264	88270	88275	88281	88287	88292	88298	88304
764	88309	88315	88321	88326	88332	88338	88343	88349	88355	88360
765	88366	88372	88377	88383	88389	88395	88400	88406	88412	88417
766	88423	88429	88434	88440	88446	88451	88457	88463	88468	88474
767	88480	88485	88491	88497	88502	88508	88513	88519	88525	88530
768	88536	88542	88547	88553	88559	88564	88570	88576	88581	88587
769	88593	88598	88604	88610	88615	88621	88627	88632	88638	88643
770	88649	88655	88660	88666	88672	88677	88683	88689	88694	88700
771	88705	88711	88717	88722	88728	88734	88739	88745	88750	88756
772	88762	88767	88773	88779	88784	88790	88795	88801	88807	88812
773	88818	88824	88829	88835	88840	88846	88852	88857	88863	88868
774	88874	88880	88885	88891	88897	88902	88908	88913	88919	88925
775	88930	88936	88941	88947	88953	88958	88964	88969	88975	88981
776	88986	88992	88997	89003	89009	89014	89020	89025	89031	89037
777	89042	89048	89053	89059	89064	89070	89076	89081	89087	89092
778	89098	89104	89109	89115	89120	89126	89131	89137	89143	89148
779	89154	89159	89165	89170	89176	89182	89187	89193	89198	89204
780	89209	89215	89221	89226	89232	89237	89243	89248	89254	89260
781	89265	89271	89276	89282	89287	89293	89298	89304	89310	89315
782	89321	89326	89332	89337	89343	89348	89354	89360	89365	89371
783	89376	89382	89387	89393	89398	89404	89409	89415	89421	89426
784	89432	89437	89443	89448	89454	89459	89465	89470	89476	89481
785	89487	89492	89498	89504	89509	89515	89520	89526	89531	89537
786	89542	89548	89553	89559	89564	89570	89575	89581	89586	89592
787	89597	89603	89609	89614	89620	89625	89631	89636	89642	89647
788	89653	89658	89664	89669	89675	89680	89686	89691	89697	89702
789	89708	89713	89719	89724	89730	89735	89741	89746	89752	89757
790	89763	89768	89774	89779	89785	89790	89796	89801	89807	89812
791	89818	89823	89829	89834	89840	89845	89851	89856	89862	89867
792	89873	89878	89883	89889	89894	89900	89905	89911	89916	89922
793	89927	89933	89938	89944	89949	89955	89960	89966	89971	89977
794	89982	89988	89993	89998	90004	90009	90015	90020	90026	90031
795	90037	90042	90048	90053	90059	90064	90069	90075	90080	90086
796	90091	90097	90102	90108	90113	90119	90124	90129	90135	90140
797	90146	90151	90157	90162	90168	90173	90179	90184	90189	90195
798	90200	90206	90211	90217	90222	90227	90233	90238	90244	90249
799	90255	90260	90266	90271	90276	90282	90287	90293	90298	90304
800	90309	90314	90320	90325	90331	90336	90342	90347	90352	90358
801	90363	90369	90374	90380	90385	90390	90396	90401	90407	90412
802	90417	90423	90428	90434	90439	90445	90450	90455	90461	90466
803	90472	90477	90482	90488	90493	90499	90504	90509	90515	90520
804	90526	90531	90536	90542	90547	90553	90558	90563	90569	90574
805	90580	90585	90590	90596	90601	90607	90612	90617	90623	90628
806	90634	90639	90644	90650	90655	90660	90666	90671	90677	90682
807	90687	90693	90698	90703	90709	90714	90720	90725	90730	90736
808	90741	90747	90752	90757	90763	90768	90773	90779	90784	90789
809	90795	90800	90806	90811	90816	90822	90827	90832	90838	90843
810	90849	90854	90859	90865	90870	90875	90881	90886	90891	90897
811	90902	90907	90913	90918	90924	90929	90934	90940	90945	90950
812	90956	90961	90966	90972	90977	90982	90988	90993	90998	91004
813	91009	91014	91020	91025	91030	91036	91041	91046	91052	91057
814	91062	91068	91073	91078	91084	91089	91094	91100	91105	91110
815	91116	91121	91126	91132	91137	91142	91148	91153	91158	91164
816	91169	91174	91180	91185	91190	91196	91201	91206	91212	91217
817	91222	91228	91233	91238	91243	91249	91254	91259	91265	91270
818	91275	91281	91286	91291	91297	91302	91307	91312	91318	91323
819	91328	91334	91339	91344	91350	91355	91360	91365	91371	91376
No.	0	1	2	3	4	5	6	7	8	9

N° 8200——8800. Log. 91381——94448.

N°	0	1	2	3	4	5	6	7	8	9
820	91381	91387	91392	91397	91403	91408	91413	91418	91424	91429
821	91434	91440	91445	91450	91455	91461	91466	91471	91477	91482
822	91487	91492	91498	91503	91508	91514	91519	91524	91529	91535
823	91540	91545	91551	91556	91561	91566	91572	91577	91582	91587
824	91593	91598	91603	91609	91614	91619	91624	91630	91635	91640
825	91645	91651	91656	91661	91666	91672	91677	91682	91687	91693
826	91698	91703	91709	91714	91719	91724	91730	91735	91740	91745
827	91751	91756	91761	91766	91772	91777	91782	91787	91793	91798
828	91803	91808	91814	91819	91824	91829	91834	91840	91845	91850
829	91855	91861	91866	91871	91876	91882	91887	91892	91897	91903
830	91908	91913	91918	91924	91929	91934	91939	91944	91950	91955
831	91960	91965	91971	91976	91981	91986	91991	91997	92002	92007
832	92012	92018	92023	92028	92033	92038	92044	92049	92054	92059
833	92065	92070	92075	92080	92085	92091	92096	92101	92106	92111
834	92117	92122	92127	92132	92137	92143	92148	92153	92158	92163
835	92169	92174	92179	92184	92189	92195	92200	92205	92210	92215
836	92221	92226	92231	92236	92241	92247	92252	92257	92262	92267
837	92273	92278	92283	92288	92293	92298	92304	92309	92314	92319
838	92324	92330	92335	92340	92345	92350	92355	92361	92366	92371
839	92376	92381	92387	92392	92397	92402	92407	92412	92418	92423
840	92428	92433	92438	92443	92449	92454	92459	92464	92469	92474
841	92480	92485	92490	92495	92500	92505	92511	92516	92521	92526
842	92531	92536	92542	92547	92552	92557	92562	92567	92572	92578
843	92583	92588	92593	92598	92603	92609	92614	92619	92624	92629
844	92634	92639	92645	92650	92655	92660	92665	92670	92675	92681
845	92686	92691	92696	92701	92706	92711	92716	92722	92727	92732
846	92737	92742	92747	92752	92758	92763	92768	92773	92778	92783
847	92788	92793	92799	92804	92809	92814	92819	92824	92829	92834
848	92840	92845	92850	92855	92860	92865	92870	92875	92881	92886
849	92891	92896	92901	92906	92911	92916	92921	92927	92932	92937
850	92942	92947	92952	92957	92962	92967	92973	92978	92983	92988
851	92993	92998	93003	93008	93013	93018	93024	93029	93034	93039
852	93044	93049	93054	93059	93064	93069	93075	93080	93085	93090
853	93095	93100	93105	93110	93115	93120	93125	93131	93136	93141
854	93146	93151	93156	93161	93166	93171	93176	93181	93186	93192
855	93197	93202	93207	93212	93217	93222	93227	93232	93237	93242
856	93247	93252	93258	93263	93268	93273	93278	93283	93288	93293
857	93298	93303	93308	93313	93318	93323	93328	93334	93339	93344
858	93349	93354	93359	93364	93369	93374	93379	93384	93389	93394
859	93399	93404	93409	93414	93420	93425	93430	93435	93440	93445
860	93450	93455	93460	93465	93470	93475	93480	93485	93490	93495
861	93500	93505	93510	93515	93520	93526	93531	93536	93541	93546
862	93551	93556	93561	93566	93571	93576	93581	93586	93591	93596
863	93601	93606	93611	93616	93621	93626	93631	93636	93641	93646
864	93651	93656	93661	93666	93671	93676	93682	93687	93692	93697
865	93702	93707	93712	93717	93722	93727	93732	93737	93742	93747
866	93752	93757	93762	93767	93772	93777	93782	93787	93792	93797
867	93802	93807	93812	93817	93822	93827	93832	93837	93842	93847
868	93852	93857	93862	93867	93872	93877	93882	93887	93892	93897
869	93902	93907	93912	93917	93922	93927	93932	93937	93942	93947
870	93952	93957	93962	93967	93972	93977	93982	93987	93992	93997
871	94002	94007	94012	94017	94022	94027	94032	94037	94042	94047
872	94052	94057	94062	94067	94072	94077	94082	94086	94091	94096
873	94101	94106	94111	94116	94121	94126	94131	94136	94141	94146
874	94151	94156	94161	94166	94171	94176	94181	94186	94191	94196
875	94201	94206	94211	94216	94221	94226	94231	94236	94240	94245
876	94250	94255	94260	94265	94270	94275	94280	94285	94290	94295
877	94300	94305	94310	94315	94320	94325	94330	94335	94340	94345
878	94349	94354	94359	94364	94369	94374	94379	94384	94389	94394
879	94399	94404	94409	94414	94419	94424	94429	94433	94438	94443
N°	0	1	2	3	4	5	6	7	8	9

No. 8800——9400. Log. 94448——97313.

No.	0	1	2	3	4	5	6	7	8	9
880	94448	94453	94458	94463	94468	94473	94478	94483	94488	94493
881	94498	94503	94507	94512	94517	94522	94527	94532	94537	94542
882	94547	94552	94557	94562	94567	94571	94576	94581	94586	94591
883	94596	94601	94606	94611	94616	94621	94626	94630	94635	94640
884	94645	94650	94655	94660	94665	94670	94675	94680	94685	94689
885	94694	94699	94704	94709	94714	94719	94724	94729	94734	94738
886	94743	94748	94753	94758	94763	94768	94773	94778	94783	94787
887	94792	94797	94802	94807	94812	94817	94822	94827	94832	94836
888	94841	94846	94851	94856	94861	94866	94871	94876	94880	94885
889	94890	94895	94900	94905	94910	94915	94919	94924	94929	94934
890	94939	94944	94949	94954	94959	94963	94968	94973	94978	94983
891	94988	94993	94998	95002	95007	95012	95017	95022	95027	95032
892	95036	95041	95046	95051	95056	95061	95066	95071	95075	95080
893	95085	95090	95095	95100	95105	95109	95114	95119	95124	95129
894	95134	95139	95143	95148	95153	95158	95163	95168	95173	95177
895	95182	95187	95192	95197	95202	95207	95211	95216	95221	95226
896	95231	95236	95240	95245	95250	95255	95260	95265	95270	95274
897	95279	95284	95289	95294	95299	95303	95308	95313	95318	95323
898	95328	95332	95337	95342	95347	95352	95357	95361	95366	95371
899	95376	95381	95386	95390	95395	95400	95405	95410	95415	95419
900	95424	95429	95434	95439	95444	95448	95453	95458	95463	95468
901	95472	95477	95482	95487	95492	95497	95501	95506	95511	95516
902	95521	95525	95530	95535	95540	95545	95550	95554	95559	95564
903	95569	95574	95578	95583	95588	95593	95598	95602	95607	95612
904	95617	95622	95626	95631	95636	95641	95646	95650	95655	95660
905	95665	95670	95674	95679	95684	95689	95694	95698	95703	95708
906	95713	95718	95722	95727	95732	95737	95742	95746	95751	95756
907	95761	95766	95770	95775	95780	95785	95789	95794	95799	95804
908	95809	95813	95818	95823	95828	95832	95837	95842	95847	95852
909	95856	95861	95866	95871	95875	95880	95885	95890	95895	95899
910	95904	95909	95914	95918	95923	95928	95933	95938	95942	95947
911	95952	95957	95961	95966	95971	95976	95980	95985	95990	95995
912	95999	96004	96009	96014	96019	96023	96028	96033	96038	96042
913	96047	96052	96057	96061	96066	96071	96076	96080	96085	96090
914	96095	96099	96104	96109	96114	96118	96123	96128	96133	96137
915	96142	96147	96152	96156	96161	96166	96171	96175	96180	96185
916	96190	96194	96199	96204	96209	96213	96218	96223	96227	96232
917	96237	96242	96246	96251	96256	96261	96265	96270	96275	96280
918	96284	96289	96294	96298	96303	96308	96313	96317	96322	96327
919	96332	96336	96341	96346	96350	96355	96360	96365	96369	96374
920	96379	96384	96388	96393	96398	96402	96407	96412	96417	96421
921	96426	96431	96435	96440	96445	96450	96454	96459	96464	96468
922	96473	96478	96483	96487	96492	96497	96501	96506	96511	96515
923	96520	96525	96530	96534	96539	96544	96548	96553	96558	96562
924	96567	96572	96577	96581	96586	96591	96595	96600	96605	96609
925	96614	96619	96624	96628	96633	96638	96642	96647	96652	96656
926	96661	96666	96670	96675	96680	96685	96689	96694	96699	96703
927	96708	96713	96717	96722	96727	96731	96736	96741	96745	96750
928	96755	96759	96764	96769	96774	96778	96783	96788	96792	96797
929	96802	96806	96811	96816	96820	96825	96830	96834	96839	96844
930	96848	96853	96858	96862	96867	96872	96876	96881	96886	96890
931	96895	96900	96904	96909	96914	96918	96923	96928	96932	96937
932	96942	96946	96951	96956	96960	96965	96970	96974	96979	96984
933	96988	96993	96997	97002	97007	97011	97016	97021	97025	97030
934	97035	97039	97044	97049	97053	97058	97063	97067	97072	97077
935	97081	97086	97090	97095	97100	97104	97109	97114	97118	97123
936	97128	97132	97137	97142	97146	97151	97155	97160	97165	97169
937	97174	97179	97183	97188	97192	97197	97202	97206	97211	97216
938	97220	97225	97230	97234	97239	97243	97248	97253	97257	97262
939	97267	97271	97276	97280	97285	97290	97294	97299	97304	97308
No.	0	1	2	3	4	5	6	7	8	9

No. 9400——10000. Log. 97313——99996.

No.	0	1	2	3	4	5	6	7	8	9
940	97313	97317	97322	97327	97331	97336	97340	97345	97350	97354
941	97359	97364	97368	97373	97377	97382	97387	97391	97396	97400
942	97405	97410	97414	97419	97424	97428	97433	97437	97442	97447
943	97451	97456	97460	97465	97470	97474	97479	97483	97488	97493
944	97497	97502	97506	97511	97516	97520	97525	97529	97534	97539
945	97543	97548	97552	97557	97562	97566	97571	97575	97580	97585
946	97589	97594	97598	97603	97607	97612	97617	97621	97626	97630
947	97635	97640	97644	97649	97653	97658	97663	97667	97672	97676
948	97681	97685	97690	97695	97699	97704	97708	97713	97717	97722
949	97727	97731	97736	97740	97745	97749	97754	97759	97763	97768
950	97772	97777	97782	97786	97791	97795	97800	97804	97809	97813
951	97818	97823	97827	97832	97836	97841	97845	97850	97855	97859
952	97864	97868	97873	97877	97882	97886	97891	97896	97900	97905
953	97909	97914	97918	97923	97928	97932	97937	97941	97946	97950
954	97955	97959	97964	97968	97973	97978	97982	97987	97991	97996
955	98000	98005	98009	98014	98019	98023	98028	98032	98037	98041
956	98046	98050	98055	98059	98064	98068	98073	98078	98082	98087
957	98091	98096	98100	98105	98109	98114	98118	98123	98127	98132
958	98137	98141	98146	98150	98155	98159	98164	98168	98173	98177
959	98182	98186	98191	98195	98200	98204	98209	98214	98218	98223
960	98227	98232	98236	98241	98245	98250	98254	98259	98263	98268
961	98272	98277	98281	98286	98290	98295	98299	98304	98308	98313
962	98318	98322	98327	98331	98336	98340	98345	98349	98354	98358
963	98363	98367	98372	98376	98381	98385	98390	98394	98399	98403
964	98408	98412	98417	98421	98426	98430	98435	98439	98444	98448
965	98453	98457	98462	98466	98471	98475	98480	98484	98489	98493
966	98498	98502	98507	98511	98516	98520	98525	98529	98534	98538
967	98543	98547	98552	98556	98561	98565	98570	98574	98579	98583
968	98588	98592	98597	98601	98605	98610	98614	98619	98623	98628
969	98632	98637	98641	98646	98650	98655	98659	98664	98668	98673
970	98677	98682	98686	98691	98695	98700	98704	98709	98713	98717
971	98722	98726	98731	98735	98740	98744	98749	98753	98758	98762
972	98767	98771	98776	98780	98784	98789	98793	98798	98802	98807
973	98811	98816	98820	98825	98829	98834	98838	98843	98847	98851
974	98856	98860	98865	98869	98874	98878	98883	98887	98892	98896
975	98900	98905	98909	98914	98918	98923	98927	98932	98936	98941
976	98945	98949	98954	98958	98963	98967	98972	98976	98981	98985
977	98989	98994	98998	99003	99007	99012	99016	99021	99025	99029
978	99034	99038	99043	99047	99052	99056	99061	99065	99069	99074
979	99078	99083	99087	99092	99096	99100	99105	99109	99114	99118
980	99123	99127	99131	99136	99140	99145	99149	99154	99158	99162
981	99167	99171	99176	99180	99185	99189	99193	99198	99202	99207
982	99211	99216	99220	99224	99229	99233	99238	99242	99247	99251
983	99255	99260	99264	99269	99273	99277	99282	99286	99291	99295
984	99300	99304	99308	99313	99317	99322	99326	99330	99335	99339
985	99344	99348	99352	99357	99361	99366	99370	99374	99379	99383
986	99388	99392	99396	99401	99405	99410	99414	99419	99423	99427
987	99432	99436	99441	99445	99449	99454	99458	99463	99467	99471
988	99476	99480	99484	99489	99493	99498	99502	99506	99511	99515
989	99520	99524	99528	99533	99537	99542	99546	99550	99555	99559
990	99564	99568	99572	99577	99581	99585	99590	99594	99599	99603
991	99607	99612	99616	99621	99625	99629	99634	99638	99642	99647
992	99651	99656	99660	99664	99669	99673	99677	99682	99686	99691
993	99695	99699	99704	99708	99712	99717	99721	99726	99730	99734
994	99739	99743	99747	99752	99756	99760	99765	99769	99774	99778
995	99782	99787	99791	99795	99800	99804	99808	99813	99817	99822
996	99826	99830	99835	99839	99843	99848	99852	99856	99861	99865
997	99870	99874	99878	99883	99887	99891	99896	99900	99904	99909
998	99913	99917	99922	99926	99930	99935	99939	99944	99948	99952
999	99957	99961	99965	99970	99974	99978	99983	99987	99991	99996
No.	0	1	2	3	4	5	6	7	8	9

M	Hour AM	Hr. PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	12 0 0	0 0 0		10.00000		Infinite.	10.00000	Infinite.	60
1	11 59 52	0 8	6.46373	00000	6.46373	13.53627	00000	13.53627	59
2	59 44	0 16	76476	00000	76476	23524	00000	23524	58
3	59 36	0 24	94085	00000	94085	05915	00000	05915	57
4	59 28	0 32	7.06579	00000	7.06579	12.93421	00000	12.93421	56
5	11 59 20	0 0 40	7.16270	10.00000	7.16270	12.83730	10.00000	12.83730	55
6	59 12	0 48	24188	00000	24188	75812	00000	75812	54
7	59 4	0 56	30882	00000	30882	69118	00000	69118	53
8	58 56	1 4	36682	00000	36682	63318	00000	63318	52
9	58 48	1 12	41797	00000	41797	58203	00000	58203	51
10	58 40	1 20	46373	00000	46373	53627	00000	53627	50
11	11 58 32	0 1 28	7.50512	10.00000	7.50512	12.49488	10.00000	12.49488	49
12	58 24	1 36	54291	00000	54291	45709	00000	45709	48
13	58 16	1 44	57767	00000	57767	42233	00000	42233	47
14	58 8	1 52	60985	00000	60986	39014	00000	39015	46
15	58 0	2 0	63982	00000	63982	36018	00000	36018	45
16	11 57 52	0 2 8	7.66784	10.00000	7.66785	12.33215	10.00000	12.33216	44
17	57 44	2 16	69417	9.99999	69418	30582	00001	30583	43
18	57 36	2 24	71900	99999	71900	28100	00001	28100	42
19	57 28	2 32	74248	99999	74248	25752	00001	25752	41
20	57 20	2 40	76475	99999	76476	23524	00001	23525	40
21	11 57 12	0 2 48	7.78594	9.99999	7.78595	12.21405	10.00001	12.21406	39
22	57 4	2 56	80615	99999	80615	19385	00001	19385	38
23	56 56	3 4	82545	99999	82546	17454	00001	17455	37
24	56 48	3 12	84393	99999	84394	15606	00001	15607	36
25	56 40	3 20	86166	99999	86167	13833	00001	13834	35
26	11 56 32	0 3 28	7.87870	9.99999	7.87871	12.12129	10.00001	12.12130	34
27	56 24	3 36	89509	99999	89510	10490	00001	10491	33
28	56 16	3 44	91088	99999	91089	08911	00001	08912	32
29	56 8	3 52	92612	99998	92613	07387	00002	07388	31
30	56 0	4 0	94084	99998	94086	05914	00002	05916	30
31	11 55 52	0 4 8	7.95508	9.99998	7.95510	12.04490	10.00002	12.04492	29
32	55 44	4 16	96887	99998	96889	03111	00002	03113	28
33	55 36	4 24	98223	99998	98225	01775	00002	01777	27
34	55 28	4 32	99520	99998	99522	00478	00002	00480	26
35	55 20	4 40	8.00779	99998	8.00781	11.99219	00002	11.99221	25
36	11 55 12	0 4 48	8.02002	9.99998	8.02004	11.97996	10.00002	11.97998	24
37	55 4	4 56	03192	99997	03194	96806	00003	96808	23
38	54 56	5 4	04350	99997	04353	95647	00003	95650	22
39	54 48	5 12	05478	99997	05481	94519	00003	94522	21
40	54 40	5 20	06578	99997	06581	93419	00003	93422	20
41	11 54 32	0 5 28	8.07650	9.99997	8.07653	11.92347	10.00003	11.92350	19
42	54 24	5 36	08696	99997	08700	91300	00003	91304	18
43	54 16	5 44	09718	99997	09722	90278	00003	90282	17
44	54 8	5 52	10717	99996	10720	89280	00004	89283	16
45	54 0	6 0	11693	99996	11696	88304	00004	88307	15
46	11 53 52	0 6 8	8.12647	9.99996	8.12651	11.87349	10.00004	11.87353	14
47	53 44	6 16	13581	99996	13585	86415	00004	86419	13
48	53 36	6 24	14495	99996	14500	85500	00004	85505	12
49	53 28	6 32	15391	99996	15395	84605	00004	84609	11
50	53 20	6 40	16268	99995	16273	83727	00005	83732	10
51	11 53 12	0 6 48	8.17128	9.99995	8.17133	11.82867	10.00005	11.82872	9
52	53 4	6 56	17971	99995	17976	82024	00005	82029	8
53	52 56	7 4	18798	99995	18804	81196	00005	81202	7
54	52 48	7 12	19610	99995	19616	80384	00005	80390	6
55	52 40	7 20	20407	99994	20413	79587	00006	79593	5
56	11 52 32	0 7 28	8.21189	9.99994	8.21195	11.78805	10.00006	11.78811	4
57	52 24	7 36	21958	99994	21964	78036	00006	78042	3
58	52 16	7 44	22713	9999[illegible]	22720	77280	00006	77287	2
59	52 8	7 52	23456	9999[illegible]	23462	76538	00006	76544	1
60	52 0	8 0	24186	9999[illegible]	24192	75808	00007	75814	0
M	Hour PM	Hr. AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 52 0	0 8 0	8.24186	9.99993	8.24192	11.75808	10.00007	11.75814	60
1	51 52	8 8	24903	99993	24910	75090	00007	75097	59
2	51 44	8 16	25609	99993	25616	74384	00007	74391	58
3	51 36	8 24	26304	99993	26312	73688	00007	73696	57
4	51 28	8 32	26988	99992	26996	73004	00008	73012	56
5	11 51 20	0 8 40	8.27661	9.99992	8.27669	11.72331	10.00008	11.72339	55
6	51 12	8 48	28324	99992	28332	71668	00008	71676	54
7	51 4	8 56	28977	99992	28986	71014	00008	71023	53
8	50 56	9 4	29621	99992	29629	70371	00008	70379	52
9	50 48	9 12	30255	99991	30263	69737	00009	69745	51
10	11 50 40	0 9 20	8.30879	9.99991	8.30888	11.69112	10.00009	11.69121	50
11	50 32	9 28	31495	99991	31505	68495	00009	68505	49
12	50 24	9 36	32103	99990	32112	67888	00010	67897	48
13	50 16	9 44	32702	99990	32711	67289	00010	67298	47
14	50 8	9 52	33292	99990	33302	66698	00010	66708	46
15	11 50 0	0 10 0	8.33875	9.99990	8.33886	11.66114	10.00010	11.66125	45
16	49 52	10 8	34450	99989	34461	65539	00011	65550	44
17	49 44	10 16	35018	99989	35029	64971	00011	64982	43
18	49 36	10 24	35578	99989	35590	64410	00011	64422	42
19	49 28	10 32	36131	99989	36143	63857	00011	63869	41
20	11 49 20	0 10 40	8.36678	9.99988	8.36689	11.63311	10.00012	11.63322	40
21	49 12	10 48	37217	99988	37229	62771	00012	62783	39
22	49 4	10 56	37750	99988	37762	62238	00012	62250	38
23	48 56	11 4	38276	99987	38289	61711	00013	61724	37
24	48 48	11 12	38796	99987	38809	61191	00013	61204	36
25	11 48 40	0 11 20	8.39310	9.99987	8.39323	11.60677	10.00013	11.60690	35
26	48 32	11 28	39818	99986	39832	60168	00014	60182	34
27	48 24	11 36	40320	99986	40334	59666	00014	59680	33
28	48 16	11 44	40816	99986	40830	59170	00014	59184	32
29	48 8	11 52	41307	99985	41321	58679	00015	58693	31
30	11 48 0	0 12 0	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
31	47 52	12 8	42272	99985	42287	57713	00015	57728	29
32	47 44	12 16	42746	99984	42762	57238	00016	57254	28
33	47 36	12 24	43216	99984	43232	56768	00016	56784	27
34	47 28	12 32	43680	99984	43696	56304	00016	56320	26
35	11 47 20	0 12 40	8.44139	9.99983	8.44156	11.55844	10.00017	11.55861	25
36	47 12	12 48	44594	99983	44611	55389	00017	55406	24
37	47 4	12 56	45044	99983	45061	54939	00017	54956	23
38	46 56	13 4	45489	99982	45507	54493	00018	54511	22
39	46 48	13 12	45930	99982	45948	54052	00018	54070	21
40	11 46 40	0 13 20	8.46366	9.99982	8.46385	11.53615	10.00018	11.53634	20
41	46 32	13 28	46799	99981	46817	53183	00019	53201	19
42	46 24	13 36	47226	99981	47245	52755	00019	52774	18
43	46 16	13 44	47650	99981	47669	52331	00019	52350	17
44	46 8	13 52	48069	99980	48089	51911	00020	51931	16
45	11 46 0	0 14 0	8.48485	9.99980	8.48505	11.51495	10.00020	11.51515	15
46	45 52	14 8	48896	99979	48917	51083	00021	51104	14
47	45 44	14 16	49304	99979	49325	50675	00021	50696	13
48	45 36	14 24	49708	99979	49729	50271	00021	50292	12
49	45 28	14 32	50108	99978	50130	49870	00022	49892	11
50	11 45 20	0 14 40	8.50504	9.99978	8.50527	11.49473	10.00022	11.49496	10
51	45 12	14 48	50897	99977	50920	49080	00023	49103	9
52	45 4	14 56	51287	99977	51310	48690	00023	48713	8
53	44 56	15 4	51673	99977	51696	48304	00023	48327	7
54	44 48	15 12	52055	99976	52079	47921	00024	47945	6
55	11 44 40	0 15 20	8.52434	9.99976	8.52459	11.47541	10.00024	11.47566	5
56	44 32	15 28	52810	99975	52835	47165	00025	47190	4
57	44 24	15 36	53183	99975	53208	46792	00025	46817	3
58	44 16	15 44	53552	99974	53578	46422	00026	46448	2
59	44 8	15 52	53919	99974	53945	46055	00026	46081	1
60	44 0	16 0	54282	99974	54308	45692	00026	45718	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM.	Hour PM.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	11 44 0	0 16 0	8.54282	9.99974	8.54308	11.45692	10.00026	11.45718	60
1	43 52	16 8	54642	99973	54669	45331	00027	45358	59
2	43 44	16 16	54999	99973	55027	44973	00027	45001	58
3	43 36	16 24	55354	99972	55382	44618	00028	44646	57
4	43 28	16 32	55705	99972	55734	44266	00028	44295	56
5	11 43 20	0 16 40	8.56054	9.99971	8.56083	11.43917	10.00029	11.43946	55
6	43 12	16 48	56400	99971	56429	43571	00029	43600	54
7	43 4	16 56	56743	99970	56773	43227	00030	43257	53
8	42 56	17 4	57084	99970	57114	42886	00030	42916	52
9	42 48	17 12	57421	99969	57452	42548	00031	42579	51
10	11 42 40	0 17 20	8.57757	9.99969	8.57788	11.42212	10.00031	11.42243	50
11	42 32	17 28	58089	99968	58121	41879	00032	41911	49
12	42 24	17 36	58419	99968	58451	41549	00032	41581	48
13	42 16	17 44	58747	99967	58779	41221	00033	41253	47
14	42 8	17 52	59072	99967	59105	40895	00033	40928	46
15	11 42 0	0 18 0	8.59395	9.99967	8.59428	11.40572	10.00033	11.40605	45
16	41 52	18 8	59715	99966	59749	40251	00034	40285	44
17	41 44	18 16	60033	99966	60068	39932	00034	39967	43
18	41 36	18 24	60349	99965	60384	39616	00035	39651	42
19	41 28	18 32	60662	99964	60698	39302	00036	39338	41
20	11 41 20	0 18 40	8.60973	9.99964	8.61009	11.38991	10.00036	11.39027	40
21	41 12	18 48	61282	99963	61319	38681	00037	38718	39
22	41 4	18 56	61589	99963	61626	38374	00037	38411	38
23	40 56	19 4	61894	99962	61931	38069	00038	38106	37
24	40 48	19 12	62196	99962	62234	37766	00038	37804	36
25	11 40 40	0 19 20	8.62497	9.99961	8.62535	11.37465	10.00039	11.37503	35
26	40 32	19 28	62795	99961	62834	37166	00039	37205	34
27	40 24	19 36	63091	99960	63131	36869	00040	36909	33
28	40 16	19 44	63385	99960	63426	36574	00040	36615	32
29	40 8	19 52	63678	99959	63718	36282	00041	36322	31
30	11 40 0	0 20 0	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
31	39 52	20 8	64256	99958	64298	35702	00042	35744	29
32	39 44	20 16	64543	99958	64585	35415	00042	35457	28
33	39 36	20 24	64827	99957	64870	35130	00043	35173	27
34	39 28	20 32	65110	99956	65154	34846	00044	34890	26
35	11 39 20	0 20 40	8.65391	9.99956	8.65435	11.34565	10.00044	11.34609	25
36	39 12	20 48	65670	99955	65715	34285	00045	34330	24
37	39 4	20 56	65947	99955	65993	34007	00045	34053	23
38	38 56	21 4	66223	99954	66269	33731	00046	33777	22
39	38 48	21 12	66497	99954	66543	33457	00046	33503	21
40	11 38 40	0 21 20	8.66769	9.99953	8.66816	11.33184	10.00047	11.33231	20
41	38 32	21 28	67039	99952	67087	32913	00048	32961	19
42	38 24	21 36	67308	99952	67356	32644	00048	32692	18
43	38 16	21 44	67575	99951	67624	32376	00049	32425	17
44	38 8	21 52	67841	99951	67890	32110	00049	32159	16
45	11 38 0	0 22 0	8.68104	9.99950	8.68154	11.31846	10.00050	11.31896	15
46	37 52	22 8	68367	99949	68417	31583	00051	31633	14
47	37 44	22 16	68627	99949	68678	31322	00051	31373	13
48	37 36	22 24	68886	99948	68938	31062	00052	31114	12
49	37 28	22 32	69144	99948	69196	30804	00052	30856	11
50	11 37 20	0 22 40	8.69400	9.99947	8.69453	11.30547	10.00053	11.30600	10
51	37 12	22 48	69654	99946	69708	30292	00054	30346	9
52	37 4	22 56	69907	99946	69962	30038	00054	30093	8
53	36 56	23 4	70159	99945	70214	29786	00055	29841	7
54	36 48	23 12	70409	99944	70465	29535	00056	29591	6
55	11 36 40	0 23 20	8.70658	9.99944	8.70714	11.29286	10.00056	11.29342	5
56	36 32	23 28	70905	99943	70962	29038	00057	29095	4
57	36 24	23 36	71151	99942	71208	28792	00058	28849	3
58	36 16	23 44	71395	99942	71453	28547	00058	28605	2
59	36 8	23 52	71638	99941	71697	28303	00059	28362	1
60	36 0	24 0	71880	99940	71940	28060	00060	28120	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

3 Degs. TABLE XXV. Artificial Sines, Tangents & Secants. 176 Degs.

M	Hour A. M	Hour P. M	Sine.	Co-ſine.	Tangent.	Co-tang.	Secant.	Co-ſecant.	M
0	11 36 0	0 24 0	8.71880	9.99940	8.71940	11.28060	10.00060	11.28120	60
1	35 52	24 8	72120	99940	72181	27819	00060	27880	59
2	35 44	24 16	72359	99939	72420	27580	00061	27641	58
3	35 36	24 24	72597	99938	72659	27341	00062	27403	57
4	35 28	24 32	72834	99938	72896	27104	00062	27166	56
5	11 35 20	0 24 40	8.73069	9.99937	8.73132	11.26868	10.00063	11.26931	55
6	35 12	24 48	73303	99936	73366	26634	00064	26697	54
7	35 4	24 56	73535	99936	73600	26400	00064	26465	53
8	34 56	25 4	73767	99935	73832	26168	00065	26233	52
9	34 48	25 12	73997	99934	74063	25937	00066	26003	51
10	11 34 40	0 25 20	8.74226	9.99934	8.74292	11.25708	10.00066	11.25774	50
11	34 32	25 28	74454	99933	74521	25479	00067	25546	49
12	34 24	25 36	74680	99932	74748	25252	00068	25320	48
13	34 16	25 44	74906	99932	74974	25026	00068	25094	47
14	34 8	25 52	75130	99931	75199	24801	00069	24870	46
15	11 34 0	0 26 0	8.75353	9.99930	8.75423	11.24577	10.00070	11.24647	45
16	33 52	26 8	75575	99929	75645	24355	00071	24425	44
17	33 44	26 16	75795	99929	75867	24133	00071	24205	43
18	33 36	26 24	76015	99928	76087	23913	00072	23985	42
19	33 28	26 32	76234	99927	76306	23694	00073	23766	41
20	11 33 20	0 26 40	8.76451	9.99926	8.76525	11.23475	10.00074	11.23549	40
21	33 12	26 48	76667	99926	76742	23258	00074	23333	39
22	33 4	26 56	76883	99925	76958	23042	00075	23117	38
23	32 56	27 4	77097	99924	77173	22827	00076	22903	37
24	32 48	27 12	77310	99923	77387	22613	00077	22690	36
25	11 32 40	0 27 20	8.77522	9.99923	8.77600	11.22400	10.00077	11.22478	35
26	32 32	27 28	77733	99922	77811	22189	00078	22267	34
27	32 24	27 36	77943	99921	78022	21978	00079	22057	33
28	32 16	27 44	78152	99920	78232	21768	00080	21848	32
29	32 8	27 52	78360	99920	78441	21559	00080	21640	31
30	11 32 0	0 28 0	8.78568	9.99919	8.78649	11.21351	10.00081	11.21432	30
31	31 52	28 8	78774	99918	78855	21145	00082	21226	29
32	31 44	28 16	78979	99917	79061	20939	00083	21021	28
33	31 36	28 24	79183	99917	79266	20734	00083	20817	27
34	31 28	28 32	79386	99916	79470	20530	00084	20614	26
35	11 31 20	0 28 40	8.79588	9.99915	8.79673	11.20327	10.00085	11.20412	25
36	31 12	28 48	79789	99914	79875	20125	00086	20211	24
37	31 4	28 56	79990	99913	80076	19924	00087	20010	23
38	30 56	29 4	80189	99913	80277	19723	00087	19811	22
39	30 48	29 12	80388	99912	80476	19524	00088	19612	21
40	11 30 40	0 29 20	8.80585	9.99911	8.80674	11.19326	10.00089	11.19415	20
41	30 32	29 28	80782	99910	80872	19128	00090	19218	19
42	30 24	29 36	80978	99909	81068	18932	00091	19022	18
43	30 16	29 44	81173	99909	81264	18736	00091	18827	17
44	30 8	29 52	81367	99908	81459	18541	00092	18633	16
45	11 30 0	0 30 0	8.81560	9.99907	8.81653	11.18347	10.00093	11.18440	15
46	29 52	30 8	81752	99906	81846	18154	00094	18248	14
47	29 44	30 16	81944	99905	82038	17962	00095	18056	13
48	29 36	30 24	82134	99904	82230	17770	00096	17866	12
49	29 28	30 32	82324	99904	82420	17580	00096	17676	11
50	11 29 20	0 30 40	8.82513	9.99903	8.82610	11.17390	10.00097	11.17487	10
51	29 12	30 48	82701	99902	82799	17201	00098	17299	9
52	29 4	30 56	82888	99901	82987	17013	00099	17112	8
53	28 56	31 4	83075	99900	83175	16825	00100	16925	7
54	28 48	31 12	83261	99899	83361	16639	00101	16739	6
55	11 28 40	0 31 20	8.83446	9.99898	8.83547	11.16453	10.00102	11.16554	5
56	28 32	31 28	83630	99898	83732	16268	00102	16370	4
57	28 24	31 36	83813	99897	83916	16084	00103	16187	3
58	28 16	31 44	83996	99896	84100	15900	00104	16004	2
59	28 8	31 52	84177	99895	84282	15718	00105	15823	1
60	28 0	32 0	84358	99894	84464	15536	00106	15642	0
M	Hour P. M	Hour A. M	Co-ſine.	Sine.	Co-tang.	Tangent.	Co-ſecant	Secant.	M

93 Degs. 86 Degs.

M	Hour A.M	Hour P.M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 28 0	0 32 0	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
1	27 52	32 8	84539	99893	84646	15354	00107	15461	59
2	27 44	32 16	84718	99892	84826	15174	00108	15282	58
3	27 36	32 24	84897	99891	85006	14994	00109	15103	57
4	27 28	32 32	85075	99891	85185	14815	00109	14925	56
5	11 27 20	0 32 40	8.85252	9.99890	8.85363	11.14637	10.00110	11.14748	55
6	27 12	32 48	85429	99889	85540	14460	00111	14571	54
7	27 4	32 56	85605	99888	85717	14283	00112	14395	53
8	26 56	33 4	85780	99887	85893	14107	00113	14220	52
9	26 48	33 12	85955	99886	86069	13931	00114	14045	51
10	11 26 40	0 33 20	8.86128	9.99885	8.86243	11.13757	10.00115	11.13872	50
11	26 32	33 28	86301	99884	86417	13583	00116	13699	49
12	26 24	33 36	86474	99883	86591	13409	00117	13526	48
13	26 16	33 44	86645	99882	86763	13237	00118	13355	47
14	26 8	33 52	86816	99881	86935	13065	00119	13184	46
15	11 26 0	0 34 0	8.86987	9.99880	8.87106	11.12894	10.00120	11.13013	45
16	25 52	34 8	87156	99879	87277	12723	00121	12844	44
17	25 44	34 16	87325	99879	87447	12553	00121	12675	43
18	25 36	34 24	87494	99878	87616	12384	00122	12506	42
19	25 28	34 32	87661	99877	87785	12215	00123	12339	41
20	11 25 20	0 34 40	8.87829	9.99876	8.87953	11.12047	10.00124	11.12171	40
21	25 12	34 48	87995	99875	88120	11880	00125	12005	39
22	25 4	34 56	88161	99874	88287	11713	00126	11839	38
23	24 56	35 4	88326	99873	88453	11547	00127	11674	37
24	24 48	35 12	88490	99872	88618	11382	00128	11510	36
25	11 24 40	0 35 20	8.88654	9.99871	8.88783	11.11217	10.00129	11.11346	35
26	24 32	35 28	88817	99870	88948	11052	00130	11183	34
27	24 24	35 36	88980	99869	89111	10889	00131	11020	33
28	24 16	35 44	89142	99868	89274	10726	00132	10858	32
29	24 8	35 52	89304	99867	89437	10563	00133	10696	31
30	11 24 0	0 36 0	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
31	23 52	36 8	89625	99865	89760	10240	00135	10375	29
32	23 44	36 16	89784	99864	89920	10080	00136	10216	28
33	23 36	36 24	89943	99863	90080	09920	00137	10057	27
34	23 28	36 32	90102	99862	90240	09760	00138	09898	26
35	11 23 20	0 36 40	8.90260	9.99861	8.90399	11.09601	10.00139	11.09740	25
36	23 12	36 48	90417	99860	90557	09443	00140	09583	24
37	23 4	36 56	90574	99859	90715	09285	00141	09426	23
38	22 56	37 4	90730	99858	90872	09128	00142	09270	22
39	22 48	37 12	90885	99857	91029	08971	00143	09115	21
40	11 22 40	0 37 20	8.91040	9.99856	8.91185	11.08815	10.00144	11.08960	20
41	22 32	37 28	91195	99855	91340	08660	00145	08805	19
42	22 24	37 36	91349	99854	91495	08505	00146	08651	18
43	22 16	37 44	91502	99853	91650	08350	00147	08498	17
44	22 8	37 52	91655	99852	91803	08197	00148	08345	16
45	11 22 0	0 38 0	8.91807	9.99851	8.91957	11.08043	10.00149	11.08193	15
46	21 52	38 8	91959	99850	92110	07890	00150	08041	14
47	21 44	38 16	92110	99848	92262	07738	00152	07890	13
48	21 36	38 24	92261	99847	92414	07586	00153	07739	12
49	21 28	38 32	92411	99846	92565	07435	00154	07589	11
50	11 21 20	0 38 40	8.92561	9.99845	8.92716	11.07284	10.00155	11.07439	10
51	21 12	38 48	92710	99844	92866	07134	00156	07290	9
52	21 4	38 56	92859	99843	93016	06984	00157	07141	8
53	20 56	39 4	93007	99842	93165	06835	00158	06993	7
54	20 48	39 12	93154	99841	93313	06687	00159	06846	6
55	11 20 40	0 39 20	8.93301	9.99840	8.93462	11.06538	10.00160	11.06699	5
56	20 32	39 28	93448	99839	93609	06391	00161	06552	4
57	20 24	39 36	93594	99838	93756	06244	00162	06406	3
58	20 16	39 44	93740	99837	93903	06097	00163	06260	2
59	20 8	39 52	93885	99836	94049	05951	00164	06115	1
60	20 0	40 0	94030	99834	94195	05805	00166	05970	0
M	Hour P.M	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM.	Hour PM.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	11 20 0	0 40 0	8.94030	9.99834	8.94195	11.05805	10.00166	11.05970	60
1	19 52	40 8	94174	99833	94340	05660	00167	05826	59
2	19 44	40 16	94317	99832	94485	05515	00168	05683	58
3	19 36	40 24	94461	99831	94630	05370	00169	05539	57
4	19 28	40 32	94603	99830	94773	05227	00170	05397	56
5	11 19 20	0 40 40	8.94746	9.99829	8.94917	11.05083	10.00171	11.05254	55
6	19 12	40 48	94887	99828	95060	04940	00172	05113	54
7	19 4	40 56	95029	99827	95202	04798	00173	04971	53
8	18 56	41 4	95170	99825	95344	04656	00175	04830	52
9	18 48	41 12	95310	99824	95486	04514	00176	04690	51
10	11 18 40	0 41 20	8.95450	9.99823	8.95627	11.04373	10.00177	11.04550	50
11	18 32	41 28	95589	99822	95767	04233	00178	04411	49
12	18 24	41 36	95728	99821	95908	04092	00179	04272	48
13	18 16	41 44	95867	99820	96047	03953	00180	04133	47
14	18 8	41 52	96005	99819	96187	03813	00181	03995	46
15	11 18 0	0 42 0	8.96143	9.99817	8.96325	11.03675	10.00183	11.03857	45
16	17 52	42 8	96280	99816	96464	03536	00184	03720	44
17	17 44	42 16	96417	99815	96602	03398	00185	03583	43
18	17 36	42 24	96553	99814	96739	03261	00186	03447	42
19	17 28	42 32	96689	99813	96877	03123	00187	03311	41
20	11 17 20	0 42 40	8.96825	9.99812	8.97013	11.02987	10.00188	11.03175	40
21	17 12	42 48	96960	99810	97150	02850	00190	03040	39
22	17 4	42 56	97095	99809	97285	02715	00191	02905	38
23	16 56	43 4	97229	99808	97421	02579	00192	02771	37
24	16 48	43 12	97363	99807	97556	02444	00193	02637	36
25	11 16 40	0 43 20	8.97496	9.99806	8.97691	11.02309	10.00194	11.02504	35
26	16 32	43 28	97629	99804	97825	02175	00196	02371	34
27	16 24	43 36	97762	99803	97959	02041	00197	02238	33
28	16 16	43 44	97894	99802	98092	01908	00198	02106	32
29	16 8	43 52	98026	99801	98225	01775	00199	01974	31
30	11 16 0	0 44 0	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
31	15 52	44 8	98288	99798	98490	01510	00202	01712	29
32	15 44	44 16	98419	99797	98622	01378	00203	01581	28
33	15 36	44 24	98549	99796	98753	01247	00204	01451	27
34	15 28	44 32	98679	99795	98884	01116	00205	01321	26
35	11 15 20	0 44 40	8.98808	9.99793	8.99015	11.00985	10.00207	11.01192	25
36	15 12	44 48	98937	99792	99145	00855	00208	01063	24
37	15 4	44 56	99066	99791	99275	00725	00209	00934	23
38	14 56	45 4	99194	99790	99405	00595	00210	00806	22
39	14 48	45 12	99322	99788	99534	00466	00212	00678	21
40	11 14 40	0 45 20	8.99450	9.99787	8.99662	11.00338	10.00213	11.00550	20
41	14 32	45 28	99577	99786	99791	00209	00214	00423	19
42	14 24	45 36	99704	99785	99919	00081	00215	00296	18
43	14 16	45 44	99830	99783	9.00046	10.99954	00217	00170	17
44	14 8	45 52	99956	99782	00174	99826	00218	00044	16
45	11 14 0	0 46 0	9.00082	9.99781	9.00301	10.99699	10.00219	10.99918	15
46	13 52	46 8	00207	99780	00427	99573	00220	99793	14
47	13 44	46 16	00332	99778	00553	99447	00222	99668	13
48	13 36	46 24	00456	99777	00679	99321	00223	99544	12
49	13 28	46 32	00581	99776	00805	99195	00224	99419	11
50	11 13 20	0 46 40	9.00704	9.99775	9.00930	10.99070	10.00225	10.99296	10
51	13 12	46 48	00828	99773	01055	98945	00227	99172	9
52	13 4	46 56	00951	99772	01179	98821	00228	99049	8
53	12 56	47 4	01074	99771	01303	98697	00229	98926	7
54	12 48	47 12	01196	99769	01427	98573	00231	98804	6
55	11 12 40	0 47 20	9.01318	9.99768	9.01550	10.98450	10.00232	10.98682	5
56	12 32	47 28	01440	99767	01673	98327	00233	98560	4
57	12 24	47 36	01561	99765	01796	98204	00235	98439	3
58	12 16	47 44	01682	99764	01918	98082	00236	98318	2
59	12 8	47 52	01803	99763	02040	97960	00237	98197	1
60	12 0	48 0	01923	99761	02162	97838	00239	98077	0
M	Hour PM.	Hour AM.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	11 12 0	0 48 0	9.01923	9.99761	9.02162	10.97838	10.00239	10.98077	60
1	11 52	48 8	02043	99760	02283	97717	00240	97957	59
2	11 44	48 16	02165	99759	02404	97596	00241	97837	58
3	11 36	48 24	02283	99757	02525	97475	00243	97717	57
4	11 28	48 32	02402	99756	02645	97355	00244	97598	56
5	11 11 20	0 48 40	9.02520	9.99755	9.02766	10.97234	10.00245	10.97480	55
6	11 12	48 48	02639	99753	02885	97115	00247	97361	54
7	11 4	48 56	02757	99752	03005	96995	00248	97243	53
8	10 56	49 4	02874	99751	03124	96876	00249	97126	52
9	10 48	49 12	02992	99749	03242	96758	00251	97008	51
10	11 10 40	0 49 20	9.03109	9.99748	9.03361	10.96639	10.00252	10.96891	50
11	10 32	49 28	03226	99747	03479	96521	00253	96774	49
12	10 24	49 36	03342	99745	03597	96403	00255	96658	48
13	10 16	49 44	03458	99744	03714	96286	00256	96542	47
14	10 8	49 52	03574	99742	03832	96168	00258	96426	46
15	11 10 0	0 50 0	9.03690	9.99741	9.03948	10.96052	10.00259	10.96310	45
16	9 52	50 8	03805	99740	04065	95935	00260	96195	44
17	9 44	50 16	03920	99738	04181	95819	00262	96080	43
18	9 36	50 24	04034	99737	04297	95703	00263	95966	42
19	9 28	50 32	04149	99736	04413	95587	00264	95851	41
20	11 9 20	0 50 40	9.04262	9.99734	9.04528	10.95472	10.00266	10.95738	40
21	9 12	50 48	04376	99733	04643	95357	00267	95624	39
22	9 4	50 56	04490	99731	04758	95242	00269	95510	38
23	8 56	51 4	04603	99730	04873	95127	00270	95397	37
24	8 48	51 12	04715	99728	04987	95013	00272	95285	36
25	11 8 40	0 51 20	9.04828	9.99727	9.05101	10.94899	10.00273	10.95172	35
26	8 32	51 28	04940	99726	05214	94786	00274	95060	34
27	8 24	51 36	05052	99724	05328	94672	00276	94948	33
28	8 16	51 44	05164	99723	05441	94559	00277	94836	32
29	8 8	51 52	05275	99721	05553	94447	00279	94725	31
30	11 8 0	0 52 0	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
31	7 52	52 8	05497	99718	05778	94222	00282	94503	29
32	7 44	52 16	05607	99717	05890	94110	00283	94393	28
33	7 36	52 24	05717	99716	06002	93998	00284	94283	27
34	7 28	52 32	05827	99714	06113	93887	00286	94173	26
35	11 7 20	0 52 40	9.05937	9.99713	9.06224	10.93776	10.00287	10.94063	25
36	7 12	52 48	06046	99711	06335	93665	00289	93954	24
37	7 4	52 56	06155	99710	06445	93555	00290	93845	23
38	6 56	53 4	06264	99708	06556	93444	00292	93736	22
39	6 48	53 12	06372	99707	06666	93334	00293	93628	21
40	11 6 40	0 53 20	9.06481	9.99705	9.06775	10.93225	10.00295	10.93519	20
41	6 32	53 28	06589	99704	06885	93115	00296	93411	19
42	6 24	53 36	06696	99702	06994	93006	00298	93304	18
43	6 16	53 44	06804	99701	07103	92897	00299	93196	17
44	6 8	53 52	06911	99699	07211	92789	00301	93089	16
45	11 6 0	0 54 0	9.07018	9.99698	9.07320	10.92680	10.00302	10.92982	15
46	5 52	54 8	07124	99696	07428	92572	00304	92876	14
47	5 44	54 16	07231	99695	07536	92464	00305	92769	13
48	5 36	54 24	07337	99693	07643	92357	00307	92663	12
49	5 28	54 32	07442	99692	07751	92249	00308	92558	11
50	11 5 20	0 54 40	9.07548	9.99690	9.07858	10.92142	10.00310	10.92452	10
51	5 12	54 48	07653	99689	07964	92036	00311	92347	9
52	5 4	54 56	07758	99687	08071	91929	00313	92242	8
53	4 56	55 4	07863	99686	08177	91823	00314	92137	7
54	4 48	55 12	07968	99684	08283	91717	00316	92032	6
55	11 4 40	0 55 20	9.08072	9.99683	9.08389	10.91611	10.00317	10.91928	5
56	4 32	55 28	08176	99681	08495	91505	00319	91824	4
57	4 24	55 36	08280	99680	08600	91400	00320	91720	3
58	4 16	55 44	08383	99678	08705	91295	00322	91617	2
59	4 8	55 52	08486	99677	08810	91190	00323	91514	1
60	4 0	56 0	08589	99675	08914	91086	00325	91411	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour P.M	Sine.	Co-sine.	Tang.	Co-tang.	Secant.	Co secant.	M
0	11 4 0	0 56 0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
1	3 52	56 8	08692	99674	09019	90981	00326	91308	59
2	3 44	56 16	08795	99672	09123	90877	00328	91205	58
3	3 36	56 24	08897	99670	09227	90773	00330	91103	57
4	3 28	56 32	08999	99669	09330	90670	00331	91001	56
5	11 3 20	0 56 40	9.09101	9.99667	9.09434	10.90566	10.00333	10.90899	55
6	3 12	56 48	09202	99666	09537	90463	00334	90798	54
7	3 4	56 56	09304	99664	09640	90360	00336	90696	53
8	2 56	57 4	09405	99663	09742	90258	00337	90595	52
9	2 48	57 12	09506	99661	09845	90155	00339	90494	51
10	11 2 40	0 57 20	9.09606	9.99659	9.09947	10.90053	10.00341	10.90394	50
11	2 32	57 28	09707	99658	10049	89951	00342	90293	49
12	2 24	57 36	09807	99656	10150	89850	00344	90193	48
13	2 16	57 44	09907	99655	10252	89748	00345	90093	47
14	2 8	57 52	10006	99653	10353	89647	00347	89994	46
15	11 2 0	0 58 0	9.10106	9.99651	9.10454	10.89546	10.00349	10.89894	45
16	1 52	58 8	10205	99650	10555	89445	00350	89795	44
17	1 44	58 16	10304	99648	10656	89344	00352	89696	43
18	1 36	58 24	10402	99647	10756	89244	00353	89598	42
19	1 28	58 32	10501	99645	10856	89144	00355	89499	41
20	11 1 20	0 58 40	9.10599	9.99643	9.10956	10.89044	10.00357	10.89401	40
21	1 12	58 48	10697	99642	11056	88944	00358	89303	39
22	1 4	58 56	10795	99640	11155	88845	00360	89205	38
23	0 56	59 4	10893	99638	11254	88746	00362	89107	37
24	0 48	59 12	10990	99637	11353	88647	00363	89010	36
25	11 0 40	0 59 20	9.11087	9.99635	9.11452	10.88548	10.00365	10.88913	35
26	0 32	59 28	11184	99633	11551	88449	00367	88816	34
27	0 24	59 36	11281	99632	11649	88351	00368	88719	33
28	0 16	59 44	11377	99630	11747	88253	00370	88623	32
29	0 8	59 52	11474	99629	11845	88155	00371	88526	31
30	11 0 0	1 0 0	9.11570	9.99627	9.11943	10.88057	10.00373	10.88430	30
31	10 59 52	0 8	11666	99625	12040	87960	00375	88334	29
32	59 44	0 16	11761	99624	12138	87862	00376	88239	28
33	59 36	0 24	11857	99622	12235	87765	00378	88143	27
34	59 28	0 32	11952	99620	12332	87668	00380	88048	26
35	10 59 20	1 0 40	9.12047	9.99618	9.12428	10.87572	10.00382	10.87953	25
36	59 12	0 48	12142	99617	12525	87475	00383	87858	24
37	59 4	0 56	12236	99615	12621	87379	00385	87764	23
38	58 56	1 4	12331	99613	12717	87283	00387	87669	22
39	58 48	1 12	12425	99612	12813	87187	00388	87575	21
40	10 58 40	1 1 20	9.12519	9.99610	9.12909	10.87091	10.00390	10.87481	20
41	58 32	1 28	12612	99608	13004	86996	00392	87388	19
42	58 24	1 36	12706	99607	13099	86901	00393	87294	18
43	58 16	1 44	12799	99605	13194	86806	00395	87201	17
44	58 8	1 52	12892	99603	13289	86711	00397	87108	16
45	10 58 0	1 2 0	9.12985	9.99601	9.13384	10.86616	10.00399	10.87015	15
46	57 52	2 8	13078	99600	13478	86522	00400	86922	14
47	57 44	2 16	13171	99598	13573	86427	00402	86829	13
48	57 36	2 24	13263	99596	13667	86333	00404	86737	12
49	57 28	2 32	13355	99595	13761	86239	00405	86645	11
50	10 57 20	1 2 40	9.13447	9.99593	9.13854	10.86146	10.00407	10.86553	10
51	57 12	2 48	13539	99591	13948	86052	00409	86461	9
52	57 4	2 56	13630	99589	14041	85959	00411	86370	8
53	56 56	3 4	13722	99588	14134	85866	00412	86278	7
54	56 48	3 12	13813	99586	14227	85773	00414	86187	6
55	10 56 40	1 3 20	9.13904	9.99584	9.14320	10.85680	10.00416	10.86096	5
56	56 32	3 28	13994	99582	14412	85588	00418	86006	4
57	56 24	3 36	14085	99581	14504	85496	00419	85915	3
58	56 16	3 44	14175	99579	14597	85403	00421	85825	2
59	56 8	3 52	14266	99577	14688	85312	00423	85734	1
60	56 0	4 0	14356	99575	14780	85220	00425	85644	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-sec.	M
0	10 56 0	1 4 0	9.14356	9.99575	9.14780	10.85220	10.00425	10.85644	60
1	55 52	4 8	14445	99574	14872	85128	00426	85555	59
2	55 44	4 16	14535	99572	14963	85037	00428	85465	58
3	55 36	4 24	14624	99570	15054	84946	00430	85376	57
4	55 28	4 32	14714	99568	15145	84855	00432	85286	56
5	10 55 20	1 4 40	9.14803	9.99566	9.15236	10.84764	10.00434	10.85197	55
6	55 12	4 48	14891	99565	15327	84673	00435	85109	54
7	55 4	4 56	14980	99563	15417	84583	00437	85020	53
8	54 56	5 4	15069	99561	15508	84492	00439	84931	52
9	54 48	5 12	15157	99559	15598	84402	00441	84843	51
10	10 54 40	1 5 20	9.15245	9.99557	9.15688	10.84312	10.00443	10.84755	50
11	54 32	5 28	15333	99556	15777	84223	00444	84667	49
12	54 24	5 36	15421	99554	15867	84133	00446	84579	48
13	54 16	5 44	15508	99552	15956	84044	00448	84492	47
14	54 8	5 52	15596	99550	16046	83954	00450	84404	46
15	10 54 0	1 6 0	9.15683	9.99548	9.16135	10.83865	10.00452	10.84317	45
16	53 52	6 8	15770	99546	16224	83776	00454	84230	44
17	53 44	6 16	15857	99545	16312	83688	00455	84143	43
18	53 36	6 24	15944	99543	16401	83599	00457	84056	42
19	53 28	6 32	16030	99541	16489	83511	00459	83970	41
20	10 53 20	1 6 40	9.16116	9.99539	9.16577	10.83423	10.00461	10.83884	40
21	53 12	6 48	16203	99537	16665	83335	00463	83797	39
22	53 4	6 56	16289	99535	16753	83247	00465	83711	38
23	52 56	7 4	16374	99533	16841	83159	00467	83626	37
24	52 48	7 12	16460	99532	16928	83072	00468	83540	36
25	10 52 40	1 7 20	9.16545	9.99530	9.17016	10.82984	10.00470	10.83455	35
26	52 32	7 28	16631	99528	17103	82897	00472	83369	34
27	52 24	7 36	16716	99526	17190	82810	00474	83284	33
28	52 16	7 44	16801	99524	17277	82723	00476	83199	32
29	52 8	7 52	16886	99522	17363	82637	00478	83114	31
30	10 52 0	1 8 0	9.16970	9.99520	9.17450	10.82550	10.00480	10.83030	30
31	51 52	8 8	17055	99518	17536	82464	00482	82945	29
32	51 44	8 16	17139	99517	17622	82378	00483	82861	28
33	51 36	8 24	17223	99515	17708	82292	00485	82777	27
34	51 28	8 32	17307	99513	17794	82206	00487	82693	26
35	10 51 20	1 8 40	9.17391	9.99511	9.17880	10.82120	10.00489	10.82609	25
36	51 12	8 48	17474	99509	17965	82035	00491	82526	24
37	51 4	8 56	17558	99507	18051	81949	00493	82442	23
38	50 56	9 4	17641	99505	18136	81864	00495	82359	22
39	50 48	9 12	17724	99503	18221	81779	00497	82276	21
40	10 50 40	1 9 20	9.17807	9.99501	9.18306	10.81694	10.00499	10.82193	20
41	50 32	9 28	17890	99499	18391	81609	00501	82110	19
42	50 24	9 36	17973	99497	18475	81525	00503	82027	18
43	50 16	9 44	18055	99495	18560	81440	00505	81945	17
44	50 8	9 52	18137	99494	18644	81356	00506	81863	16
45	10 50 0	1 10 0	9.18220	9.99492	9.18728	10.81272	10.00508	10.81780	15
46	49 52	10 8	18302	99490	18812	81188	00510	81698	14
47	49 44	10 16	18383	99488	18896	81104	00512	81617	13
48	49 36	10 24	18465	99486	18979	81021	00514	81535	12
49	49 28	10 32	18547	99484	19063	80937	00516	81453	11
50	10 49 20	1 10 40	9.18628	9.99482	9.19146	10.80854	10.00518	10.81372	10
51	49 12	10 48	18709	99480	19229	80771	00520	81291	9
52	49 4	10 56	18790	99478	19312	80688	00522	81210	8
53	48 56	11 4	18871	99476	19395	80605	00524	81129	7
54	48 48	11 12	18952	99474	19478	80522	00526	81048	6
55	10 48 40	1 11 20	9.19033	9.99472	9.19561	10.80439	10.00528	10.80967	5
56	48 32	11 28	19113	99470	19643	80357	00530	80887	4
57	48 24	11 36	19193	99468	19725	80275	00532	80807	3
58	48 16	11 44	19273	99466	19807	80193	00534	80727	2
59	48 8	11 52	19353	99464	19889	80111	00536	80647	1
60	48 0	12 0	19433	99462	19971	80029	00538	80567	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-sec.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 48 0	1 12 0	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	60
1	47 52	12 8	19513	99460	20053	79947	00540	80487	59
2	47 44	12 16	19592	99458	20134	79866	00542	80408	58
3	47 36	12 24	19672	99456	20216	79784	00544	80328	57
4	47 28	12 32	19751	99454	20297	79703	00546	80249	56
5	10 47 20	1 12 40	9.19830	9.99452	9.20378	10.79622	10.00548	10.80170	55
6	47 12	12 48	19909	99450	20459	79541	00550	80091	54
7	47 4	12 56	19988	99448	20540	79460	00552	80012	53
8	46 56	13 4	20067	99446	20621	79379	00554	79933	52
9	46 48	13 12	20145	99444	20701	79299	00556	79855	51
10	10 46 40	1 13 20	9.20223	9.99442	9.20782	10.79218	10.00558	10.79777	50
11	46 32	13 28	20302	99440	20862	79138	00560	79698	49
12	46 24	13 36	20380	99438	20942	79058	00562	79620	48
13	46 16	13 44	20458	99436	21022	78978	00564	79542	47
14	46 8	13 52	20535	99434	21102	78898	00566	79465	46
15	10 46 0	1 14 0	9.20613	9.99432	9.21182	10.78818	10.00568	10.79387	45
16	45 52	14 8	20691	99429	21261	78739	00571	79309	44
17	45 44	14 16	20768	99427	21341	78659	00573	79232	43
18	45 36	14 24	20845	99425	21420	78580	00575	79155	42
19	45 28	14 32	20922	99423	21499	78501	00577	79078	41
20	10 45 20	1 14 40	9.20999	9.99421	9.21578	10.78422	10.00579	10.79001	40
21	45 12	14 48	21076	99419	21657	78343	00581	78924	39
22	45 4	14 56	21153	99417	21736	78264	00583	78847	38
23	44 56	15 4	21229	99415	21814	78186	00585	78771	37
24	44 48	15 12	21306	99413	21893	78107	00587	78694	36
25	10 44 40	1 15 20	9.21382	9.99411	9.21971	10.78029	10.00589	10.78618	35
26	44 32	15 28	21458	99409	22049	77951	00591	78542	34
27	44 24	15 36	21534	99407	22127	77873	00593	78466	33
28	44 16	15 44	21610	99404	22205	77795	00596	78390	32
29	44 8	15 52	21685	99402	22283	77717	00598	78315	31
30	10 44 0	1 16 0	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
31	43 52	16 8	21836	99398	22438	77562	00602	78164	29
32	43 44	16 16	21912	99396	22516	77484	00604	78088	28
33	43 36	16 24	21987	99394	22593	77407	00606	78013	27
34	43 28	16 32	22062	99392	22670	77330	00608	77938	26
35	10 43 20	1 16 40	9.22137	9.99390	9.22747	10.77253	10.00610	10.77863	25
36	43 12	16 48	22211	99388	22824	77176	00612	77789	24
37	43 4	16 56	22286	99385	22901	77099	00615	77714	23
38	42 56	17 4	22361	99383	22977	77023	00617	77639	22
39	42 48	17 12	22435	99381	23054	76946	00619	77565	21
40	10 42 40	1 17 20	9.22509	9.99379	9.23130	10.76870	10.00621	10.77491	20
41	42 32	17 28	22583	99377	23206	76794	00623	77417	19
42	42 24	17 36	22657	99375	23283	76717	00625	77343	18
43	42 16	17 44	22731	99372	23359	76641	00628	77269	17
44	42 8	17 52	22805	99370	23435	76565	00630	77195	16
45	10 42 0	1 18 0	9.22878	9.99368	9.23510	10.76490	10.00632	10.77122	15
46	41 52	18 8	22952	99366	23586	76414	00634	77048	14
47	41 44	18 16	23025	99364	23661	76339	00636	76975	13
48	41 36	18 24	23098	99362	23737	76263	00638	76902	12
49	41 28	18 32	23171	99359	23812	76188	00641	76829	11
50	10 41 20	1 18 40	9.23244	9.99357	9.23887	10.76113	10.00643	10.76756	10
51	41 12	18 48	23317	99355	23962	76038	00645	76683	9
52	41 4	18 56	23390	99353	24037	75963	00647	76610	8
53	40 56	19 4	23462	99351	24112	75888	00649	76538	7
54	40 48	19 12	23535	99348	24186	75814	00652	76465	6
55	10 40 40	1 19 20	9.23607	9.99346	9.24261	10.75739	10.00654	10.76393	5
56	40 32	19 28	23679	99344	24335	75665	00656	76321	4
57	40 24	19 36	23752	99342	24410	75590	00658	76248	3
58	40 16	19 44	23823	99340	24484	75516	00660	76177	2
59	40 8	19 52	23895	99337	24558	75442	00663	76105	1
60	40 0	20 0	23967	99335	24632	75368	00665	76033	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hr. P M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 40 0	1 20 0	9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	60
1	39 52	20 8	24039	99333	24706	75294	00667	75961	59
2	39 44	20 16	24110	99331	24779	75221	00669	75890	58
3	39 36	20 24	24181	99328	24853	75147	00672	75819	57
4	39 28	20 32	24253	99326	24926	75074	00674	75747	56
5	10 39 20	1 20 40	9.24324	9.99324	9.25000	10.75000	10.00676	10.75676	55
6	39 12	20 48	24395	99322	25073	74927	00678	75605	54
7	39 4	20 56	24466	99319	25146	74854	00681	75534	53
8	38 56	21 4	24536	99317	25219	74781	00683	75464	52
9	38 48	21 12	24607	99315	25292	74708	00685	75393	51
10	10 38 40	1 21 20	9.24677	9.99313	9.25365	10.74635	10.00687	10.75323	50
11	38 32	21 28	24748	99310	25437	74563	00690	75252	49
12	38 24	21 36	24818	99308	25510	74490	00692	75182	48
13	38 16	21 44	24888	99306	25582	74418	00694	75112	47
14	38 8	21 52	24958	99304	25655	74345	00696	75042	46
15	10 38 0	1 22 0	9.25028	9.99301	9.25727	10.74273	10.00699	10.74972	45
16	37 52	22 8	25098	99299	25799	74201	00701	74902	44
17	37 44	22 16	25168	99297	25871	74129	00703	74832	43
18	37 36	22 24	25237	99294	25943	74057	00706	74763	42
19	37 28	22 32	25307	99292	26015	73985	00708	74693	41
20	10 37 20	1 22 40	9.25376	9.99290	9.26086	10.73914	10.00710	10.74624	40
21	37 12	22 48	25445	99288	26158	73842	00712	74555	39
22	37 4	22 56	25514	99285	26229	73771	00715	74486	38
23	36 56	23 4	25583	99283	26301	73699	00717	74417	37
24	36 48	23 12	25652	99281	26372	73628	00719	74348	36
25	10 36 40	1 23 20	9.25721	9.99278	9.26443	10.73557	10.00722	10.74279	35
26	36 32	23 28	25790	99276	26514	73486	00724	74210	34
27	36 24	23 36	25858	99274	26585	73415	00726	74142	33
28	36 16	23 44	25927	99271	26655	73345	00729	74073	32
29	36 8	23 52	25995	99269	26726	73274	00731	74005	31
30	10 36 0	1 24 0	9.26063	9.99267	9.26797	10.73203	10.00733	10.73937	30
31	35 52	24 8	26131	99264	26867	73133	00736	73869	29
32	35 44	24 16	26199	99262	26937	73063	00738	73801	28
33	35 36	24 24	26267	99260	27008	72992	00740	73733	27
34	35 28	24 32	26335	99257	27078	72922	00743	73665	26
35	10 35 20	1 24 40	9.26403	9.99255	9.27148	10.72852	10.00745	10.73597	25
36	35 12	24 48	26470	99252	27218	72782	00748	73530	24
37	35 4	24 56	26538	99250	27288	72712	00750	73462	23
38	34 56	25 4	26605	99248	27357	72643	00752	73395	22
39	34 48	25 12	26672	99245	27427	72573	00755	73328	21
40	10 34 40	1 25 20	9.26739	9.99243	9.27496	10.72504	10.00757	10.73261	20
41	34 32	25 28	26806	99241	27566	72434	00759	73194	19
42	34 24	25 36	26873	99238	27635	72365	00762	73127	18
43	34 16	25 44	26940	99236	27704	72296	00764	73060	17
44	34 8	25 52	27007	99233	27773	72227	00767	72993	16
45	10 34 0	1 26 0	9.27073	9.99231	9.27842	10.72158	10.00769	10.72927	15
46	33 52	26 8	27140	99229	27911	72089	00771	72860	14
47	33 44	26 16	27206	99226	27980	72020	00774	72794	13
48	33 36	26 24	27273	99224	28049	71951	00776	72727	12
49	33 28	26 32	27339	99221	28117	71883	00779	72661	11
50	10 33 20	1 26 40	9.27405	9.99219	9.28186	10.71814	10.00781	10.72595	10
51	33 12	26 48	27471	99217	28254	71746	00783	72529	9
52	33 4	26 56	27537	99214	28323	71677	00786	72463	8
53	32 56	27 4	27602	99212	28391	71609	00788	72398	7
54	32 48	27 12	27668	99209	28459	71541	00791	72332	6
55	10 32 40	1 27 20	9.27734	9.99207	9.28527	10.71473	10.00793	10.72266	5
56	32 32	27 28	27799	99204	28595	71405	00796	72201	4
57	32 24	27 36	27864	99202	28662	71338	00798	72136	3
58	32 16	27 44	27930	99200	28730	71270	00800	72070	2
59	32 8	27 52	27995	99197	28798	71202	00803	72005	1
60	32 0	28 0	28060	99195	28865	71135	00805	71940	0
M	Hour PM	Hr. AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 32 0	1 28 0	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	60
1	31 52	28 8	28125	99192	28933	71067	00808	71875	59
2	31 44	28 16	28190	99190	29000	71000	00810	71810	58
3	31 36	28 24	28254	99187	29067	70933	00813	71746	57
4	31 28	28 32	28319	99185	29134	70866	00815	71681	56
5	10 31 20	1 28 40	9.28384	9.99182	9.29201	10.70799	10.00818	10.71616	55
6	31 12	28 48	28448	99180	29268	70732	00820	71552	54
7	31 4	28 56	28512	99177	29335	70665	00823	71488	53
8	30 56	29 4	28577	99175	29402	70598	00825	71423	52
9	30 48	29 12	28641	99172	29468	70532	00828	71359	51
10	10 30 40	1 29 20	9.28705	9.99170	9.29535	10.70465	10.00830	10.71295	50
11	30 32	29 28	28769	99167	29601	70399	00833	71231	49
12	30 24	29 36	28833	99165	29668	70332	00835	71167	48
13	30 16	29 44	28896	99162	29734	70266	00838	71104	47
14	30 8	29 52	28960	99160	29800	70200	00840	71040	46
15	10 30 0	1 30 0	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	45
16	29 52	30 8	29087	99155	29932	70068	00845	70913	44
17	29 44	30 16	29150	99152	29998	70002	00848	70850	43
18	29 36	30 24	29214	99150	30064	69936	00850	70786	42
19	29 28	30 32	29277	99147	30130	69870	00853	70723	41
20	10 29 20	1 30 40	9.29340	9.99145	9.30195	10.69805	10.00855	10.70660	40
21	29 12	30 48	29403	99142	30261	69739	00858	70597	39
22	29 4	30 56	29466	99140	30326	69674	00860	70534	38
23	28 56	31 4	29529	99137	30391	69609	00863	70471	37
24	28 48	31 12	29591	99135	30457	69543	00865	70409	36
25	10 28 40	1 31 20	9.29654	9.99132	9.30522	10.69478	10.00868	10.70346	35
26	28 32	31 28	29716	99130	30587	69413	00870	70284	34
27	28 24	31 36	29779	99127	30652	69348	00873	70221	33
28	28 16	31 44	29841	99124	30717	69283	00876	70159	32
29	28 8	31 52	29903	99122	30782	69218	00878	70097	31
30	10 28 0	1 32 0	9.29966	9.99119	9.30846	10.69154	10.00881	10.70034	30
31	27 52	32 8	30028	99117	30911	69089	00883	69972	29
32	27 44	32 16	30090	99114	30975	69025	00886	69910	28
33	27 36	32 24	30151	99112	31040	68960	00888	69849	27
34	27 28	32 32	30213	99109	31104	68896	00891	69787	26
35	10 27 20	1 32 40	9.30275	9.99106	9.31168	10.68832	10.00894	10.69725	25
36	27 12	32 48	30336	99104	31233	68767	00896	69664	24
37	27 4	32 56	30398	99101	31297	68703	00899	69602	23
38	26 56	33 4	30459	99099	31361	68639	00901	69541	22
39	26 48	33 12	30521	99096	31425	68575	00904	69479	21
40	10 26 40	1 33 20	9.30582	9.99093	9.31489	10.68511	10.00907	10.69418	20
41	26 32	33 28	30643	99091	31552	68448	00909	69357	19
42	26 24	33 36	30704	99088	31616	68384	00912	69296	18
43	26 16	33 44	30765	99086	31679	68321	00914	69235	17
44	26 8	33 52	30826	99083	31743	68257	00917	69174	16
45	10 26 0	1 34 0	9.30887	9.99080	9.31806	10.68194	10.00920	10.69113	15
46	25 52	34 8	30947	99078	31870	68130	00922	69053	14
47	25 44	34 16	31008	99075	31933	68067	00925	68992	13
48	25 36	34 24	31068	99072	31996	68004	00928	68932	12
49	25 28	34 32	31129	99070	32059	67941	00930	68871	11
50	10 25 20	1 34 40	9.31189	9.99067	9.32122	10.67878	10.00933	10.68811	10
51	25 12	34 48	31250	99064	32185	67815	00936	68750	9
52	25 4	34 56	31310	99062	32248	67752	00938	68690	8
53	24 56	35 4	31370	99059	32311	67689	00941	68630	7
54	24 48	35 12	31430	99056	32373	67627	00944	68570	6
55	10 24 40	1 35 20	9.31490	9.99054	9.32436	10.67564	10.00946	10.68510	5
56	24 32	35 28	31549	99051	32498	67502	00949	68451	4
57	24 24	35 36	31609	99048	32561	67439	00952	68391	3
58	24 16	35 44	31669	99046	32623	67377	00954	68331	2
59	24 8	35 52	31728	99043	32685	67315	00957	68272	1
60	24 0	36 0	31788	99040	32747	67253	00960	68212	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 24 0	1 36 0	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	60
1	23 52	36 8	31847	99038	32810	67190	00962	68153	59
2	23 44	36 16	31907	99035	32872	67128	00965	68093	58
3	23 36	36 24	31966	99032	32933	67067	00968	68034	57
4	23 28	36 32	32025	99030	32995	67005	00970	67975	56
5	10 23 20	1 36 40	9.32084	9.99027	9.33057	10.66943	10.00973	10.67916	55
6	23 12	36 48	32143	99024	33119	66881	00976	67857	54
7	23 4	36 56	32202	99022	33180	66820	00978	67798	53
8	22 56	37 4	32261	99019	33242	66758	00981	67739	52
9	22 48	37 12	32319	99016	33303	66697	00984	67681	51
10	10 22 40	1 37 20	9.32378	9.99013	9.33365	10.66635	10.00987	10.67622	50
11	22 32	37 28	32437	99011	33426	66574	00989	67563	49
12	22 24	37 36	32495	99008	33487	66513	00992	67505	48
13	22 16	37 44	32553	99005	33548	66452	00995	67447	47
14	22 8	37 52	32612	99002	33609	66391	00998	67388	46
15	10 22 0	1 38 0	9.32670	9.99000	9.33670	10.66330	10.01000	10.67330	45
16	21 52	38 8	32728	98997	33731	66269	01003	67272	44
17	21 44	38 16	32786	98994	33792	66208	01006	67214	43
18	21 36	38 24	32844	98991	33853	66147	01009	67156	42
19	21 28	38 32	32902	98989	33913	66087	01011	67098	41
20	10 21 20	1 38 40	9.32960	9.98986	9.33974	10.66026	10.01014	10.67040	40
21	21 12	38 48	33018	98983	34034	65966	01017	66982	39
22	21 4	38 56	33075	98980	34095	65905	01020	66925	38
23	20 56	39 4	33133	98978	34155	65845	01022	66867	37
24	20 48	39 12	33190	98975	34215	65785	01025	66810	36
25	10 20 40	1 39 20	9.33248	9.98972	9.34276	10.65724	10.01028	10.66752	35
26	20 32	39 28	33305	98969	34336	65664	01031	66695	34
27	20 24	39 36	33362	98967	34396	65604	01033	66638	33
28	20 16	39 44	33420	98964	34456	65544	01036	66580	32
29	20 8	39 52	33477	98961	34516	65484	01039	66523	31
30	10 20 0	1 40 0	9.33534	9.98958	9.34576	10.65424	10.01042	10.66466	30
31	19 52	40 8	33591	98955	34635	65365	01045	66409	29
32	19 44	40 16	33647	98953	34695	65305	01047	66353	28
33	19 36	40 24	33704	98950	34755	65245	01050	66296	27
34	19 28	40 32	33761	98947	34814	65186	01053	66239	26
35	10 19 20	1 40 40	9.33818	9.98944	9.34874	10.65126	10.01056	10.66182	25
36	19 12	40 48	33874	98941	34933	65067	01059	66126	24
37	19 4	40 56	33931	98938	34992	65008	01062	66069	23
38	18 56	41 4	33987	98936	35051	64949	01064	66013	22
39	18 48	41 12	34043	98933	35111	64889	01067	65957	21
40	10 18 40	1 41 20	9.34100	9.98930	9.35170	10.64830	10.01070	10.65900	20
41	18 32	41 28	34156	98927	35229	64771	01073	65844	19
42	18 24	41 36	34212	98924	35288	64712	01076	65788	18
43	18 16	41 44	34268	98921	35347	64653	01079	65732	17
44	18 8	41 52	34324	98919	35405	64595	01081	65676	16
45	10 18 0	1 42 0	9.34380	9.98916	9.35464	10.64536	10.01084	10.65620	15
46	17 52	42 8	34436	98913	35523	64477	01087	65564	14
47	17 44	42 16	34491	98910	35581	64419	01090	65509	13
48	17 36	42 24	34547	98907	35640	64360	01093	65453	12
49	17 28	42 32	34602	98904	35698	64302	01096	65398	11
50	10 17 20	1 42 40	9.34658	9.98901	9.35757	10.64243	10.01099	10.65342	10
51	17 12	42 48	34713	98898	35815	64185	01102	65287	9
52	17 4	42 56	34769	98896	35873	64127	01104	65231	8
53	16 56	43 4	34824	98893	35931	64069	01107	65176	7
54	16 48	43 12	34879	98890	35989	64011	01110	65121	6
55	10 16 40	1 43 20	9.34934	9.98887	9.36047	10.63953	10.01113	10.65066	5
56	16 32	43 28	34989	98884	36105	63895	01116	65011	4
57	16 24	43 36	35044	98881	36163	63837	01119	64956	3
58	16 16	43 44	35099	98878	36221	63779	01122	64901	2
59	16 8	43 52	35154	98875	36279	63721	01125	64846	1
60	16 0	44 0	35209	98872	36336	63664	01128	64791	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 16 0	1 44 0	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	60
1	15 52	44 8	35263	98869	36394	63606	01131	64737	59
2	15 44	44 16	35318	98867	36452	63548	01133	64682	58
3	15 36	44 24	35373	98864	36509	63491	01136	64627	57
4	15 28	44 32	35427	98861	36566	63434	01139	64573	56
5	10 15 20	1 44 40	9.35481	9.98858	9.36624	10.63376	10.01142	10.64519	55
6	15 12	44 48	35536	98855	36681	63319	01145	64464	54
7	15 4	44 56	35590	98852	36738	63262	01148	64410	53
8	14 56	45 4	35644	98849	36795	63205	01151	64356	52
9	14 48	45 12	35698	98846	36852	63148	01154	64302	51
10	10 14 40	1 45 20	9.35752	9.98843	9.36909	10.63091	10.01157	10.64248	50
11	14 32	45 28	35806	98840	36966	63034	01160	64194	49
12	14 24	45 36	35860	98837	37023	62977	01163	64140	48
13	14 16	45 44	35914	98834	37080	62920	01166	64086	47
14	14 8	45 52	35968	98831	37137	62863	01169	64032	46
15	10 14 0	1 46 0	9.36022	9.98828	9.37193	10.62807	10.01172	10.63978	45
16	13 52	46 8	36075	98825	37250	62750	01175	63925	44
17	13 44	46 16	36129	98822	37306	62694	01178	63871	43
18	13 36	46 24	36182	98819	37363	62637	01181	63818	42
19	13 28	46 32	36236	98816	37419	62581	01184	63764	41
20	10 13 20	1 46 40	9.36289	9.98813	9.37476	10.62524	10.01187	10.63711	40
21	13 12	46 48	36342	98810	37532	62468	01190	63658	39
22	13 4	46 56	36395	98807	37588	62412	01193	63605	38
23	12 56	47 4	36449	98804	37644	62356	01196	63551	37
24	12 48	47 12	36502	98801	37700	62300	01199	63498	36
25	10 12 40	1 47 20	9.36555	9.98798	9.37756	10.62244	10.01202	10.63445	35
26	12 32	47 28	36608	98795	37812	62188	01205	63392	34
27	12 24	47 36	36660	98792	37868	62132	01208	63340	33
28	12 16	47 44	36713	98789	37924	62076	01211	63287	32
29	12 8	47 52	36766	98786	37980	62020	01214	63234	31
30	10 12 0	1 48 0	9.36819	9.98783	9.38035	10.61965	10.01217	10.63181	30
31	11 52	48 8	36871	98780	38091	61909	01220	63129	29
32	11 44	48 16	36924	98777	38147	61853	01223	63076	28
33	11 36	48 24	36976	98774	38202	61798	01226	63024	27
34	11 28	48 32	37028	98771	38257	61743	01229	62972	26
35	10 11 20	1 48 40	9.37081	9.98768	9.38313	10.61687	10.01232	10.62919	25
36	11 12	48 48	37133	98765	38368	61632	01235	62867	24
37	11 4	48 56	37185	98762	38423	61577	01238	62815	23
38	10 56	49 4	37237	98759	38479	61521	01241	62763	22
39	10 48	49 12	37289	98756	38534	61466	01244	62711	21
40	10 10 40	1 49 20	9.37341	9.98753	9.38589	10.61411	10.01247	10.62659	20
41	10 32	49 28	37393	98750	38644	61356	01250	62607	19
42	10 24	49 36	37445	98746	38699	61301	01254	62555	18
43	10 16	49 44	37497	98743	38754	61246	01257	62503	17
44	10 8	49 52	37549	98740	38808	61192	01260	62451	16
45	10 10 0	1 50 0	9.37600	9.98737	9.38863	10.61137	10.01263	10.62400	15
46	9 52	50 8	37652	98734	38918	61082	01266	62348	14
47	9 44	50 16	37703	98731	38972	61028	01269	62297	13
48	9 36	50 24	37755	98728	39027	60973	01272	62245	12
49	9 28	50 32	37806	98725	39082	60918	01275	62194	11
50	10 9 20	1 50 40	9.37858	9.98722	9.39136	10.60864	10.01278	10.62142	10
51	9 12	50 48	37909	98719	39190	60810	01281	62091	9
52	9 4	50 56	37960	98715	39245	60755	01285	62040	8
53	8 56	51 4	38011	98712	39299	60701	01288	61989	7
54	8 48	51 12	38062	98709	39353	60647	01291	61938	6
55	10 8 40	1 51 20	9.38113	9.98706	9.39407	10.60593	10.01294	10.61887	5
56	8 32	51 28	38164	98703	39461	60539	01297	61836	4
57	8 24	51 36	38215	98700	39515	60485	01300	61785	3
58	8 16	51 44	38266	98697	39569	60431	01303	61734	2
59	8 8	51 52	38317	98694	39623	60377	01306	61683	1
60	8 0	52 0	38368	98690	39677	60323	01310	61632	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 8 0	1 52 0	9.38368	9.98690	9.39677	10.60323	10.01310	10.61632	60
1	7 52	52 8	38418	98687	39731	60269	01313	61582	59
2	7 44	52 16	38469	98684	39785	60215	01316	61531	58
3	7 36	52 24	38519	98681	39838	60162	01319	61481	57
4	7 28	52 32	38570	98678	39892	60108	01322	61430	56
5	10 7 20	1 52 40	9.38620	9.98675	9.39945	10.60055	10.01325	10.61380	55
6	7 12	52 48	38670	98671	39999	60001	01329	61330	54
7	7 4	52 56	38721	98668	40052	59948	01332	61279	53
8	6 56	53 4	38771	98665	40106	59894	01335	61229	52
9	6 48	53 12	38821	98662	40159	59841	01338	61179	51
10	10 6 40	1 53 20	9.38871	9.98659	9.40212	10.59788	10.01341	10.61129	50
11	6 32	53 28	38921	98656	40266	59734	01344	61079	49
12	6 24	53 36	38971	98652	40319	59681	01348	61029	48
13	6 16	53 44	39021	98649	40372	59628	01351	60979	47
14	6 8	53 52	39071	98646	40425	59575	01354	60929	46
15	10 6 0	1 54 0	9.39121	9.98643	9.40478	10.59522	10.01357	10.60879	45
16	5 52	54 8	39170	98640	40531	59469	01360	60830	44
17	5 44	54 16	39220	98636	40584	59416	01364	60780	43
18	5 36	54 24	39270	98633	40636	59364	01367	60730	42
19	5 28	54 32	39319	98630	40689	59311	01370	60681	41
20	10 5 20	1 54 40	9.39369	9.98627	9.40742	10.59258	10.01373	10.60631	40
21	5 12	54 48	39418	98623	40795	59205	01377	60582	39
22	5 4	54 56	39467	98620	40847	59153	01380	60533	38
23	4 56	55 4	39517	98617	40900	59100	01383	60483	37
24	4 48	55 12	39566	98614	40952	59048	01386	60434	36
25	10 4 40	1 55 20	9.39615	9.98610	9.41005	10.58995	10.01390	10.60385	35
26	4 32	55 28	39664	98607	41057	58943	01393	60336	34
27	4 24	55 36	39713	98604	41109	58891	01396	60287	33
28	4 16	55 44	39762	98601	41161	58839	01399	60238	32
29	4 8	55 52	39811	98597	41214	58786	01403	60189	31
30	10 4 0	1 56 0	9.39860	9.98594	9.41266	10.58734	10.01406	10.60140	30
31	3 52	56 8	39909	98591	41318	58682	01409	60091	29
32	3 44	56 16	39958	98588	41370	58630	01412	60042	28
33	3 36	56 24	40006	98584	41422	58578	01416	59994	27
34	3 28	56 32	40055	98581	41474	58526	01419	59945	26
35	10 3 20	1 56 40	9.40103	9.98578	9.41526	10.58474	10.01422	10.59897	25
36	3 12	56 48	40152	98574	41578	58422	01426	59848	24
37	3 4	56 56	40200	98571	41629	58371	01429	59800	23
38	2 56	57 4	40249	98568	41681	58319	01432	59751	22
39	2 48	57 12	40297	98565	41733	58267	01435	59703	21
40	10 2 40	1 57 20	9.40346	9.98561	9.41784	10.58216	10.01439	10.59654	20
41	2 32	57 28	40394	98558	41836	58164	01442	59606	19
42	2 24	57 36	40442	98555	41887	58113	01445	59558	18
43	2 16	57 44	40490	98551	41939	58061	01449	59510	17
44	2 8	57 52	40538	98548	41990	58010	01452	59462	16
45	10 2 0	1 58 0	9.40586	9.98545	9.42041	10.57959	10.01455	10.59414	15
46	1 52	58 8	40634	98541	42093	57907	01459	59366	14
47	1 44	58 16	40682	98538	42144	57856	01462	59318	13
48	1 36	58 24	40730	98535	42195	57805	01465	59270	12
49	1 28	58 32	40778	98531	42246	57754	01469	59222	11
50	10 1 20	1 58 40	9.40825	9.98528	9.42297	10.57703	10.01472	10.59175	10
51	1 12	58 48	40873	98525	42348	57652	01475	59127	9
52	1 4	58 56	40921	98521	42399	57601	01479	59079	8
53	0 56	59 4	40968	98518	42450	57550	01482	59032	7
54	0 48	59 12	41016	98515	42501	57499	01485	58984	6
55	10 0 40	1 59 20	9.41063	9.98511	9.42552	10.57448	10.01489	10.58937	5
56	0 32	59 28	41111	98508	42603	57397	01492	58889	4
57	0 24	59 36	41158	98505	42653	57347	01495	58842	3
58	0 16	59 44	41205	98501	42704	57296	01499	58795	2
59	0 8	59 52	41252	98498	42755	57245	01502	58748	1
60	0 0	2 0 0	41300	98494	42805	57195	01506	58700	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 0 0	2 0 0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
1	9 59 52	0 8	41347	98491	42856	57144	01509	58653	59
2	59 44	0 16	41394	98488	42906	57094	01512	58606	58
3	59 36	0 24	41441	98484	42957	57043	01516	58559	57
4	59 28	0 32	41488	98481	43007	56993	01519	58512	56
5	9 59 20	2 0 40	9.41535	9.98477	9.43057	10.56943	10.01523	10.58465	55
6	59 12	0 48	41582	98474	43108	56892	01526	58418	54
7	59 4	0 56	41628	98471	43158	56842	01529	58372	53
8	58 56	1 4	41675	98467	43208	56792	01533	58325	52
9	58 48	1 12	41722	98464	43258	56742	01536	58278	51
10	9 58 40	2 1 20	9.41768	9.98460	9.43308	10.56692	10.01540	10.58232	50
11	58 32	1 28	41815	98457	43358	56642	01543	58185	49
12	58 24	1 36	41861	98453	43408	56592	01547	58139	48
13	58 16	1 44	41908	98450	43458	56542	01550	58092	47
14	58 8	1 52	41954	98447	43508	56492	01553	58046	46
15	9 58 0	2 2 0	9.42001	9.98443	9.43558	10.56442	10.01557	10.57999	45
16	57 52	2 8	42047	98440	43607	56393	01560	57953	44
17	57 44	2 16	42093	98436	43657	56343	01564	57907	43
18	57 36	2 24	42140	98433	43707	56293	01567	57860	42
19	57 28	2 32	42186	98429	43756	56244	01571	57814	41
20	9 57 20	2 2 40	9.42232	9.98426	9.43806	10.56194	10.01574	10.57768	40
21	57 12	2 48	42278	98422	43855	56145	01578	57722	39
22	57 4	2 56	42324	98419	43905	56095	01581	57676	38
23	56 56	3 4	42370	98415	43954	56046	01585	57630	37
24	56 48	3 12	42416	98412	44004	55996	01588	57584	36
25	9 56 40	2 3 20	9.42461	9.98409	9.44053	10.55947	10.01591	10.57539	35
26	56 32	3 28	42507	98405	44102	55898	01595	57493	34
27	56 24	3 36	42553	98402	44151	55849	01598	57447	33
28	56 16	3 44	42599	98398	44201	55799	01602	57401	32
29	56 8	3 52	42644	98395	44250	55750	01605	57356	31
30	9 56 0	2 4 0	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
31	55 52	4 8	42735	98388	44348	55652	01612	57265	29
32	55 44	4 16	42781	98384	44397	55603	01616	57219	28
33	55 36	4 24	42826	98381	44446	55554	01619	57174	27
34	55 28	4 32	42872	98377	44495	55505	01623	57128	26
35	9 55 20	2 4 40	9.42917	9.98373	9.44544	10.55456	10.01627	10.57083	25
36	55 12	4 48	42962	98370	44592	55408	01630	57038	24
37	55 4	4 56	43008	98366	44641	55359	01634	56992	23
38	54 56	5 4	43053	98363	44690	55310	01637	56947	22
39	54 48	5 12	43098	98359	44738	55262	01641	56902	21
40	9 54 40	2 5 20	9.43143	9.98356	9.44787	10.55213	10.01644	10.56857	20
41	54 32	5 28	43188	98352	44836	55164	01648	56812	19
42	54 24	5 36	43233	98349	44884	55116	01651	56767	18
43	54 16	5 44	43278	98345	44933	55067	01655	56722	17
44	54 8	5 52	43323	98342	44981	55019	01658	56677	16
45	9 54 0	2 6 0	9.43367	9.98338	9.45029	10.54971	10.01662	10.56633	15
46	53 52	6 8	43412	98334	45078	54922	01666	56588	14
47	53 44	6 16	43457	98331	45126	54874	01669	56543	13
48	53 36	6 24	43502	98327	45174	54826	01673	56498	12
49	53 28	6 32	43546	98324	45222	54778	01676	56454	11
50	9 53 20	2 6 40	9.43591	9.98320	9.45271	10.54729	10.01680	10.56409	10
51	53 12	6 48	43635	98317	45319	54681	01683	56365	9
52	53 4	6 56	43680	98313	45367	54633	01687	56320	8
53	52 56	7 4	43724	98309	45415	54585	01691	56276	7
54	52 48	7 12	43769	98306	45463	54537	01694	56231	6
55	9 52 40	2 7 20	9.43813	9.98302	9.45511	10.54489	10.01698	10.56187	5
56	52 32	7 28	43857	98299	45559	54441	01701	56143	4
57	52 24	7 36	43901	98295	45606	54394	01705	56099	3
58	52 16	7 44	43946	98291	45654	54346	01709	56054	2
59	52 8	7 52	43990	98288	45702	54298	01712	56010	1
60	52 0	8 0	44034	98284	45750	54250	01716	55966	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour A M	Hour P M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	9 52 0	2 8 0	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	60
1	51 52	8 8	44078	98281	45797	54203	01719	55922	59
2	51 44	8 16	44122	98277	45845	54155	01723	55878	58
3	51 36	8 24	44166	98273	45892	54108	01727	55834	57
4	51 28	8 32	44210	98270	45940	54060	01730	55790	56
5	9 51 20	2 8 40	9.44253	9.98266	9.45987	10.54013	10.01734	10.55747	55
6	51 12	8 48	44297	98262	46035	53965	01738	55703	54
7	51 4	8 56	44341	98259	46082	53918	01741	55659	53
8	50 56	9 4	44385	98255	46130	53870	01745	55615	52
9	50 48	9 12	44428	98251	46177	53823	01749	55572	51
10	9 50 40	2 9 20	9.44472	9.98248	9.46224	10.53776	10.01752	10.55528	50
11	50 32	9 28	44516	98244	46271	53729	01756	55484	49
12	50 24	9 36	44559	98240	46319	53681	01760	55441	48
13	50 16	9 44	44602	98237	46366	53634	01763	55398	47
14	50 8	9 52	44646	98233	46413	53587	01767	55354	46
15	9 50 0	2 10 0	9.44689	9.98229	9.46460	10.53540	10.01771	10.55311	45
16	49 52	10 8	44733	98226	46507	53493	01774	55267	44
17	49 44	10 16	44776	98222	46554	53446	01778	55224	43
18	49 36	10 24	44819	98218	46601	53399	01782	55181	42
19	49 28	10 32	44862	98215	46648	53352	01785	55138	41
20	9 49 20	2 10 40	9.44905	9.98211	9.46694	10.53306	10.01789	10.55095	40
21	49 12	10 48	44948	98207	46741	53259	01793	55052	39
22	49 4	10 56	44992	98204	46788	53212	01796	55008	38
23	48 56	11 4	45035	98200	46835	53165	01800	54965	37
24	48 48	11 12	45077	98196	46881	53119	01804	54923	36
25	9 48 40	2 11 20	9.45120	9.98192	9.46928	10.53072	10.01808	10.54880	35
26	48 32	11 28	45163	98189	46975	53025	01811	54837	34
27	48 24	11 36	45206	98185	47021	52979	01815	54794	33
28	48 16	11 44	45249	98181	47068	52932	01819	54751	32
29	48 8	11 52	45292	98177	47114	52886	01823	54708	31
30	9 48 0	2 12 0	9.45334	9.98174	9.47160	10.52840	10.01826	10.54666	30
31	47 52	12 8	45377	98170	47207	52793	01830	54623	29
32	47 44	12 16	45419	98166	47253	52747	01834	54581	28
33	47 36	12 24	45462	98162	47299	52701	01838	54538	27
34	47 28	12 32	45504	98159	47346	52654	01841	54496	26
35	9 47 20	2 12 40	9.45547	9.98155	9.47392	10.52608	10.01845	10.54453	25
36	47 12	12 48	45589	98151	47438	52562	01849	54411	24
37	47 4	12 56	45632	98147	47484	52516	01853	54368	23
38	46 56	13 4	45674	98144	47530	52470	01856	54326	22
39	46 48	13 12	45716	98140	47576	52424	01860	54284	21
40	9 46 40	2 13 20	9.45758	9.98136	9.47622	10.52378	10.01864	10.54242	20
41	46 32	13 28	45801	98132	47668	52332	01868	54199	19
42	46 24	13 36	45843	98129	47714	52286	01871	54157	18
43	46 16	13 44	45885	98125	47760	52240	01875	54115	17
44	46 8	13 52	45927	98121	47806	52194	01879	54073	16
45	9 46 0	2 14 0	9.45969	9.98117	9.47852	10.52148	10.01883	10.54031	15
46	45 52	14 8	46011	98113	47897	52103	01887	53989	14
47	45 44	14 16	46053	98110	47943	52057	01890	53947	13
48	45 36	14 24	46095	98106	47989	52011	01894	53905	12
49	45 28	14 32	46136	98102	48035	51965	01898	53864	11
50	9 45 20	2 14 40	9.46178	9.98098	9.48080	10.51920	10.01902	10.53822	10
51	45 12	14 48	46220	98094	48126	51874	01906	53780	9
52	45 4	14 56	46262	98090	48171	51829	01910	53738	8
53	44 56	15 4	46303	98087	48217	51783	01913	53697	7
54	44 48	15 12	46345	98083	48262	51738	01917	53655	6
55	9 44 40	2 15 20	9.46386	9.98079	9.48307	10.51693	10.01921	10.53614	5
56	44 32	15 28	46428	98075	48353	51647	01925	53572	4
57	44 24	15 36	46469	98071	48398	51602	01929	53531	3
58	44 16	15 44	46511	98067	48443	51557	01933	53489	2
59	44 8	15 52	46552	98063	48489	51511	01937	53448	1
60	44 0	16 0	46594	98060	48534	51466	01940	53406	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 44 0	2 16 0	9.46594	9.98060	9.48534	10.51466	10.01940	10.53406	60
1	43 52	16 8	46635	98056	48579	51421	01944	53365	59
2	43 44	16 16	46676	98052	48624	51376	01948	53324	58
3	43 36	16 24	46717	98048	48669	51331	01952	53283	57
4	43 28	16 32	46758	98044	48714	51286	01956	53242	56
5	9 43 20	2 16 40	9.46800	9.98040	9.48759	10.51241	10.01960	10.53200	55
6	43 12	16 48	46841	98036	48804	51196	01964	53159	54
7	43 4	16 56	46882	98032	48849	51151	01968	53118	53
8	42 56	17 4	46923	98029	48894	51106	01971	53077	52
9	42 48	17 12	46964	98025	48939	51061	01975	53036	51
10	9 42 40	2 17 20	9.47005	9.98021	9.48984	10.51016	10.01979	10.52995	50
11	42 32	17 28	47045	98017	49029	50971	01983	52955	49
12	42 24	17 36	47086	98013	49073	50927	01987	52914	48
13	42 16	17 44	47127	98009	49118	50882	01991	52873	47
14	42 8	17 52	47168	98005	49163	50837	01995	52832	46
15	9 42 0	2 18 0	9.47209	9.98001	9.49207	10.50793	10.01999	10.52791	45
16	41 52	18 8	47249	97997	49252	50748	02003	52751	44
17	41 44	18 16	47290	97993	49296	50704	02007	52710	43
18	41 36	18 24	47330	97989	49341	50659	02011	52670	42
19	41 28	18 32	47371	97986	49385	50615	02014	52629	41
20	9 41 20	2 18 40	9.47411	9.97982	9.49430	10.50570	10.02018	10.52589	40
21	41 12	18 48	47452	97978	49474	50526	02022	52548	39
22	41 4	18 56	47492	97974	49519	50481	02026	52508	38
23	40 56	19 4	47533	97970	49563	50437	02030	52467	37
24	40 48	19 12	47573	97966	49607	50393	02034	52427	36
25	9 40 40	2 19 20	9.47613	9.97962	9.49652	10.50348	10.02038	10.52387	35
26	40 32	19 28	47654	97958	49696	50304	02042	52346	34
27	40 24	19 36	47694	97954	49740	50260	02046	52306	33
28	40 16	19 44	47734	97950	49784	50216	02050	52266	32
29	40 8	19 52	47774	97946	49828	50172	02054	52226	31
30	9 40 0	2 20 0	9.47814	9.97942	9.49872	10.50128	10.02058	10.52186	30
31	39 52	20 8	47854	97938	49916	50084	02062	52146	29
32	39 44	20 16	47894	97934	49960	50040	02066	52106	28
33	39 36	20 24	47934	97930	50004	49996	02070	52066	27
34	39 28	20 32	47974	97926	50048	49952	02074	52026	26
35	9 39 20	2 20 40	9.48014	9.97922	9.50092	10.49908	10.02078	10.51986	25
36	39 12	20 48	48054	97918	50136	49864	02082	51946	24
37	39 4	20 56	48094	97914	50180	49820	02086	51906	23
38	38 56	21 4	48133	97910	50223	49777	02090	51867	22
39	38 48	21 12	48173	97906	50267	49733	02094	51827	21
40	9 38 40	2 21 20	9.48213	9.97902	9.50311	10.49689	10.02098	10.51787	20
41	38 32	21 28	48252	97898	50355	49645	02102	51748	19
42	38 24	21 36	48292	97894	50398	49602	02106	51708	18
43	38 16	21 44	48332	97890	50442	49558	02110	51668	17
44	38 8	21 52	48371	97886	50485	49515	02114	51629	16
45	9 38 0	2 22 0	9.48411	9.97882	9.50529	10.49471	10.02118	10.51589	15
46	37 52	22 8	48450	97878	50572	49428	02122	51550	14
47	37 44	22 16	48490	97874	50616	49384	02126	51510	13
48	37 36	22 24	48529	97870	50659	49341	02130	51471	12
49	37 28	22 32	48568	97866	50703	49297	02134	51432	11
50	9 37 20	2 22 40	9.48607	9.97861	9.50746	10.49254	10.02139	10.51393	10
51	37 12	22 48	48647	97857	50789	49211	02143	51353	9
52	37 4	22 56	48686	97853	50833	49167	02147	51314	8
53	36 56	23 4	48725	97849	50876	49124	02151	51275	7
54	36 48	23 12	48764	97845	50919	49081	02155	51236	6
55	9 36 40	2 23 20	9.48803	9.97841	9.50962	10.49038	10.02159	10.51197	5
56	36 32	23 28	48842	97837	51005	48995	02163	51158	4
57	36 24	23 36	48881	97833	51048	48952	02167	51119	3
58	36 16	23 44	48920	97829	51092	48908	02171	51080	2
59	36 8	23 52	48959	97825	51135	48865	02175	51041	1
60	36 0	24 0	48998	97821	51178	48822	02179	51002	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 36 0	2 24 0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51001	60
1	35 52	24 8	49037	97817	51221	48779	02183	50963	59
2	35 44	24 16	49076	97812	51264	48736	02188	50924	58
3	35 36	24 24	49115	97808	51306	48694	02192	50885	57
4	35 28	24 32	49153	97804	51349	48651	02196	50847	56
5	9 35 20	2 24 40	9.49192	9.97800	9.51392	10.48608	10.02200	10.50808	55
6	35 12	24 48	49231	97796	51435	48565	02204	50769	54
7	35 4	24 56	49269	97792	51478	48522	02208	50731	53
8	34 56	25 4	49308	97788	51520	48480	02212	50692	52
9	34 48	25 12	49347	97784	51563	48437	02216	50653	51
10	9 34 40	2 25 20	9.49385	9.97779	9.51606	10.48394	10.02221	10.50615	50
11	34 32	25 28	49424	97775	51648	48352	02225	50576	49
12	34 24	25 36	49462	97771	51691	48309	02229	50538	48
13	34 16	25 44	49500	97767	51734	48266	02233	50500	47
14	34 8	25 52	49539	97763	51776	48224	02237	50461	46
15	9 34 0	2 26 0	9.49577	9.97759	9.51819	10.48181	10.02241	10.50423	45
16	33 52	26 8	49615	97754	51861	48139	02246	50385	44
17	33 44	26 16	49654	97750	51903	48097	02250	50346	43
18	33 36	26 24	49692	97746	51946	48054	02254	50308	42
19	33 28	26 32	49730	97742	51988	48012	02258	50270	41
20	9 33 20	2 26 40	9.49768	9.97738	9.52031	10.47969	10.02262	10.50232	40
21	33 12	26 48	49806	97734	52073	47927	02266	50194	39
22	33 4	26 56	49844	97729	52115	47885	02271	50156	38
23	32 56	27 4	49882	97725	52157	47843	02275	50118	37
24	32 48	27 12	49920	97721	52200	47800	02279	50080	36
25	9 32 40	2 27 20	9.49958	9.97717	9.52242	10.47758	10.02283	10.50042	35
26	32 32	27 28	49996	97713	52284	47716	02287	50004	34
27	32 24	27 36	50034	97708	52326	47674	02292	49966	33
28	32 16	27 44	50072	97704	52368	47632	02296	49928	32
29	32 8	27 52	50110	97700	52410	47590	02300	49890	31
30	9 32 0	2 28 0	9.50148	9.97696	9.52452	10.47548	10.02304	10.49852	30
31	31 52	28 8	50185	97691	52494	47506	02309	49815	29
32	31 44	28 16	50223	97687	52536	47464	02313	49777	28
33	31 36	28 24	50261	97683	52578	47422	02317	49739	27
34	31 28	28 32	50298	97679	52620	47380	02321	49702	26
35	9 31 20	2 28 40	9.50336	9.97674	9.52661	10.47339	10.02326	10.49664	25
36	31 12	28 48	50374	97670	52703	47297	02330	49626	24
37	31 4	28 56	50411	97666	52745	47255	02334	49589	23
38	30 56	29 4	50449	97662	52787	47213	02338	49551	22
39	30 48	29 12	50486	97657	52829	47171	02343	49514	21
40	9 30 40	2 29 20	9.50523	9.97653	9.52870	10.47130	10.02347	10.49477	20
41	30 32	29 28	50561	97649	52912	47088	02351	49439	19
42	30 24	29 36	50598	97645	52953	47047	02355	49402	18
43	30 16	29 44	50635	97640	52995	47005	02360	49365	17
44	30 8	29 52	50673	97636	53037	46963	02364	49327	16
45	9 30 0	2 30 0	9.50710	9.97632	9.53078	10.46922	10.02368	10.49290	15
46	29 52	30 8	50747	97628	53120	46880	02372	49253	14
47	29 44	30 16	50784	97623	53161	46839	02377	49216	13
48	29 36	30 24	50821	97619	53202	46798	02381	49179	12
49	29 28	30 32	50858	97615	53244	46756	02385	49142	11
50	9 29 20	2 30 40	9.50896	9.97610	9.53285	10.46715	10.02390	10.49104	10
51	29 12	30 48	50933	97606	53327	46673	02394	49067	9
52	29 4	30 56	50970	97602	53368	46632	02398	49030	8
53	28 56	31 4	51007	97597	53409	46591	02403	48993	7
54	28 48	31 12	51043	97593	53450	46550	02407	48957	6
55	9 28 40	2 31 20	9.51080	9.97589	9.53492	10.46508	10.02411	10.48920	5
56	28 32	31 28	51117	97584	53533	46467	02416	48883	4
57	28 24	31 36	51154	97580	53574	46426	02420	48846	3
58	28 16	31 44	51191	97576	53615	46385	02424	48809	2
59	28 8	31 52	51227	97571	53656	46344	02429	48773	1
60	28 0	32 0	51264	97567	53697	46303	02433	48736	0
M	Hour PM.	Hour AM.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	9 28 0	2 32 0	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	60
1	27 52	32 8	51301	97563	53738	46262	02437	48699	59
2	27 44	32 16	51338	97558	53779	46221	02442	48662	58
3	27 36	32 24	51374	97554	53820	46180	02446	48626	57
4	27 28	32 32	51411	97550	53861	46139	02450	48589	56
5	9 27 20	2 32 40	9.51447	9.97545	9.53902	10.46098	10.02455	10.48553	55
6	27 12	32 48	51484	97541	53943	46057	02459	48516	54
7	27 4	32 56	51520	97536	53984	46016	02464	48480	53
8	26 56	33 4	51557	97532	54025	45975	02468	48443	52
9	26 48	33 12	51593	97528	54065	45935	02472	48407	51
10	9 26 40	2 33 20	9.51629	9.97523	9.54106	10.45894	10.02477	10.48371	50
11	26 32	33 28	51666	97519	54147	45853	02481	48334	49
12	26 24	33 36	51702	97515	54187	45813	02485	48298	48
13	26 16	33 44	51738	97510	54228	45772	02490	48262	47
14	26 8	33 52	51774	97506	54269	45731	02494	48226	46
15	9 26 0	2 34 0	9.51811	9.97501	9.54309	10.45691	10.02499	10.48189	45
16	25 52	34 8	51847	97497	54350	45650	02503	48153	44
17	25 44	34 16	51883	97492	54390	45610	02508	48117	43
18	25 36	34 24	51919	97488	54431	45569	02512	48081	42
19	25 28	34 32	51955	97484	54471	45529	02516	48045	41
20	9 25 20	2 34 40	9.51991	9.97479	9.54512	10.45488	10.02521	10.48009	40
21	25 12	34 48	52027	97475	54552	45448	02525	47973	39
22	25 4	34 56	52063	97470	54593	45407	02530	47937	38
23	24 56	35 4	52099	97466	54633	45367	02534	47901	37
24	24 48	35 12	52135	97461	54673	45327	02539	47865	36
25	9 24 40	2 35 20	9.52171	9.97457	9.54714	10.45286	10.02543	10.47829	35
26	24 32	35 28	52207	97453	54754	45246	02547	47793	34
27	24 24	35 36	52242	97448	54794	45206	02552	47758	33
28	24 16	35 44	52278	97444	54835	45165	02556	47722	32
29	24 8	35 52	52314	97439	54875	45125	02561	47686	31
30	9 24 0	2 36 0	9.52350	9.97435	9.54915	10.45085	10.02565	10.47650	30
31	23 52	36 8	52385	97430	54955	45045	02570	47615	29
32	23 44	36 16	52421	97426	54995	45005	02574	47579	28
33	23 36	36 24	52456	97421	55035	44965	02579	47544	27
34	23 28	36 32	52492	97417	55075	44925	02583	47508	26
35	9 23 20	2 36 40	9.52527	9.97412	9.55115	10.44885	10.02588	10.47473	25
36	23 12	36 48	52563	97408	55155	44845	02592	47437	24
37	23 4	36 56	52598	97403	55195	44805	02597	47402	23
38	22 56	37 4	52634	97399	55235	44765	02601	47366	22
39	22 48	37 12	52669	97394	55275	44725	02606	47331	21
40	9 22 40	2 37 20	9.52705	9.97390	9.55315	10.44685	10.02610	10.47295	20
41	22 32	37 28	52740	97385	55355	44645	02615	47260	19
42	22 24	37 36	52775	97381	55395	44605	02619	47225	18
43	22 16	37 44	52811	97376	55434	44566	02624	47189	17
44	22 8	37 52	52846	97372	55474	44526	02628	47154	16
45	9 22 0	2 38 0	9.52881	9.97367	9.55514	10.44486	10.02633	10.47119	15
46	21 52	38 8	52916	97363	55554	44446	02637	47084	14
47	21 44	38 16	52951	97358	55593	44407	02642	47049	13
48	21 36	38 24	52986	97353	55633	44367	02647	47014	12
49	21 28	38 32	53021	97349	55673	44327	02651	46979	11
50	9 21 20	2 38 40	9.53056	9.97344	9.55712	10.44288	10.02656	10.46944	10
51	21 12	38 48	53092	97340	55752	44248	02660	46908	9
52	21 4	38 56	53126	97335	55791	44209	02665	46874	8
53	20 56	39 4	53161	97331	55831	44169	02669	46839	7
54	20 48	39 12	53196	97326	55870	44130	02674	46804	6
55	9 20 40	2 39 20	9.53231	9.97322	9.55910	10.44090	10.02678	10.46769	5
56	20 32	39 28	53266	97317	55949	44051	02683	46734	4
57	20 24	39 36	53301	97312	55989	44011	02688	46699	3
58	20 16	39 44	53336	97308	56028	43972	02692	46664	2
59	20 8	39 52	53370	97303	56067	43933	02697	46630	1
60	20 0	40 0	53405	97299	56107	43893	02701	46595	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	9 20 0	2 40 0	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	60
1	19 52	40 8	53440	97294	56146	43854	02706	46560	59
2	19 44	40 16	53475	97289	56185	43815	02711	46525	58
3	19 36	40 24	53509	97285	56224	43776	02715	46491	57
4	19 28	40 32	53544	97280	56264	43736	02720	46456	56
5	9 19 20	2 40 40	9.53578	9.97276	9.56303	10.43697	10.02724	10.46422	55
6	19 12	40 48	53613	97271	56342	43658	02729	46387	54
7	19 4	40 56	53647	97266	56381	43619	02734	46353	53
8	18 56	41 4	53682	97262	56420	43580	02738	46318	52
9	18 48	41 12	53716	97257	56459	43541	02743	46284	51
10	9 18 40	2 41 20	9.53751	9.97252	9.56498	10.43502	10.02748	10.46249	50
11	18 32	41 28	53785	97248	56537	43463	02752	46215	49
12	18 24	41 36	53819	97243	56576	43424	02757	46181	48
13	18 16	41 44	53854	97238	56615	43385	02762	46146	47
14	18 8	41 52	53888	97234	56654	43346	02766	46112	46
15	9 18 0	2 42 0	9.53922	9.97229	9.56693	10.43307	10.02771	10.46078	45
16	17 52	42 8	53957	97224	56732	43268	02776	46043	44
17	17 44	42 16	53991	97220	56771	43229	02780	46009	43
18	17 36	42 24	54025	97215	56810	43190	02785	45975	42
19	17 28	42 32	54059	97210	56849	43151	02790	45941	41
20	9 17 20	2 42 40	9.54093	9.97206	9.56887	10.43113	10.02794	10.45907	40
21	17 12	42 48	54127	97201	56926	43074	02799	45873	39
22	17 4	42 56	54161	97196	56965	43035	02804	45839	38
23	16 56	43 4	54195	97192	57004	42996	02808	45805	37
24	16 48	43 12	54229	97187	57042	42958	02813	45771	36
25	9 16 40	2 43 20	9.54263	9.97182	9.57081	10.42919	10.02818	10.45737	35
26	16 32	43 28	54297	97178	57120	42880	02822	45703	34
27	16 24	43 36	54331	97173	57158	42842	02827	45669	33
28	16 16	43 44	54365	97168	57197	42803	02832	45635	32
29	16 8	43 52	54399	97163	57235	42765	02837	45601	31
30	9 16 0	2 44 0	9.54433	9.97159	9.57274	10.42726	10.02841	10.45567	30
31	15 52	44 8	54466	97154	57312	42688	02846	45534	29
32	15 44	44 16	54500	97149	57351	42649	02851	45500	28
33	15 36	44 24	54534	97145	57389	42611	02855	45466	27
34	15 28	44 32	54567	97140	57428	42572	02860	45433	26
35	9 15 20	2 44 40	9.54601	9.97135	9.57466	10.42534	10.02865	10.45399	25
36	15 12	44 48	54635	97130	57504	42496	02870	45365	24
37	15 4	44 56	54668	97126	57543	42457	02874	45332	23
38	14 56	45 4	54702	97121	57581	42419	02879	45298	22
39	14 48	45 12	54735	97116	57619	42381	02884	45265	21
40	9 14 40	2 45 20	9.54769	9.97111	9.57658	10.42342	10.02889	10.45231	20
41	14 32	45 28	54802	97107	57696	42304	02893	45198	19
42	14 24	45 36	54836	97102	57734	42266	02898	45164	18
43	14 16	45 44	54869	97097	57772	42228	02903	45131	17
44	14 8	45 52	54903	97092	57810	42190	02908	45097	16
45	9 14 0	2 46 0	9.54936	9.97087	9.57849	10.42151	10.02913	10.45064	15
46	13 52	46 8	54969	97083	57887	42113	02917	45031	14
47	13 44	46 16	55003	97078	57925	42075	02922	44997	13
48	13 36	46 24	55036	97073	57963	42037	02927	44964	12
49	13 28	46 32	55069	97068	58001	41999	02932	44931	11
50	9 13 20	2 46 40	9.55102	9.97063	9.58039	10.41961	10.02937	10.44898	10
51	13 12	46 48	55136	97059	58077	41923	02941	44864	9
52	13 4	46 56	55169	97054	58115	41885	02946	44831	8
53	12 56	47 4	55202	97049	58153	41847	02951	44798	7
54	12 48	47 12	55235	97044	58191	41809	02956	44765	6
55	9 12 40	2 47 20	9.55268	9.97039	9.58229	10.41771	10.02961	10.44732	5
56	12 32	47 28	55301	97035	58267	41733	02965	44699	4
57	12 24	47 36	55334	97030	58304	41696	02970	44666	3
58	12 16	47 44	55367	97025	58342	41658	02975	44633	2
59	12 8	47 52	55400	97020	58380	41620	02980	44600	1
60	12 0	48 0	55433	97015	58418	41582	02985	44567	0
M	Hour P.M	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A M.	Hour P M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 12 0	2 48 0	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
1	11 52	48 8	55466	97010	58455	41545	02990	44534	59
2	11 44	48 16	55499	97005	58493	41507	02995	44501	58
3	11 36	48 24	55532	97001	58531	41469	02999	44468	57
4	11 28	48 32	55564	96996	58569	41431	03004	44436	56
5	9 11 20	2 48 40	9.55597	9.96991	9.58606	10.41394	10.03009	10.44403	55
6	11 12	48 48	55630	96986	58644	41356	03014	44370	54
7	11 4	48 56	55663	96981	58681	41319	03019	44337	53
8	10 56	49 4	55695	96976	58719	41281	03024	44305	52
9	10 48	49 12	55728	96971	58757	41243	03029	44272	51
10	9 10 40	2 49 20	9.55761	9.96966	9.58794	10.41206	10.03034	10.44239	50
11	10 32	49 28	55793	96962	58832	41168	03038	44207	49
12	10 24	49 36	55826	96957	58869	41131	03043	44174	48
13	10 16	49 44	55858	96952	58907	41093	03048	44142	47
14	10 8	49 52	55891	96947	58944	41056	03053	44109	46
15	9 10 0	2 50 0	9.55923	9.96942	9.58981	10.41019	10.03058	10.44077	45
16	9 52	50 8	55956	96937	59019	40981	03063	44044	44
17	9 44	50 16	55988	96932	59056	40944	03068	44012	43
18	9 36	50 24	56021	96927	59094	40906	03073	43979	42
19	9 28	50 32	56053	96922	59131	40869	03078	43947	41
20	9 9 20	2 50 40	9.56085	9.96917	9.59168	10.40832	10.03083	10.43915	40
21	9 12	50 48	56118	96912	59205	40795	03088	43882	39
22	9 4	50 56	56150	96907	59243	40757	03093	43850	38
23	8 56	51 4	56182	96903	59280	40720	03097	43818	37
24	8 48	51 12	56215	96898	59317	40683	03102	43785	36
25	9 8 40	2 51 20	9.56247	9.96893	9.59354	10.40646	10.03107	10.43753	35
26	8 32	51 28	56279	96888	59391	40609	03112	43721	34
27	8 24	51 36	56311	96883	59429	40571	03117	43689	33
28	8 16	51 44	56343	96878	59466	40534	03122	43657	32
29	8 8	51 52	56375	96873	59503	40497	03127	43625	31
30	9 8 0	2 52 0	9.56408	9.96868	9.59540	10.40460	10.03132	10.43592	30
31	7 52	52 8	56440	96863	59577	40423	03137	43560	29
32	7 44	52 16	56472	96858	59614	40386	03142	43528	28
33	7 36	52 24	56504	96853	59651	40349	03147	43496	27
34	7 28	52 32	56536	96848	59688	40312	03152	43464	26
35	9 7 20	2 52 40	9.56568	9.96843	9.59725	10.40275	10.03157	10.43432	25
36	7 12	52 48	56599	96838	59762	40238	03162	43401	24
37	7 4	52 56	56631	96833	59799	40201	03167	43369	23
38	6 56	53 4	56663	96828	59835	40165	03172	43337	22
39	6 48	53 12	56695	96823	59872	40128	03177	43305	21
40	9 6 40	2 53 20	9.56727	9.96818	9.59909	10.40091	10.03182	10.43273	20
41	6 32	53 28	56759	96813	59946	40054	03187	43241	19
42	6 24	53 36	56790	96808	59983	40017	03192	43210	18
43	6 16	53 44	56822	96803	60019	39981	03197	43178	17
44	6 8	53 52	56854	96798	60056	39944	03202	43146	16
45	9 6 0	2 54 0	9.56886	9.96793	9.60093	10.39907	10.03207	10.43114	15
46	5 52	54 8	56917	96788	60130	39870	03212	43083	14
47	5 44	54 16	56949	96783	60166	39834	03217	43051	13
48	5 36	54 24	56980	96778	60203	39797	03222	43020	12
49	5 28	54 32	57012	96772	60240	39760	03228	42988	11
50	9 5 20	2 54 40	9.57044	9.96767	9.60276	10.39724	10.03233	10.42956	10
51	5 12	54 48	57075	96762	60313	39687	03238	42925	9
52	5 4	54 56	57107	96757	60349	39651	03243	42893	8
53	4 56	55 4	57138	96752	60386	39614	03248	42862	7
54	4 48	55 12	57169	96747	60422	39578	03253	42831	6
55	9 4 40	2 55 20	9.57201	9.96742	9.60459	10.39541	10.03258	10.42799	5
56	4 32	55 28	57232	96737	60495	39505	03263	42768	4
57	4 24	55 36	57264	96732	60532	39468	03268	42736	3
58	4 16	55 44	57295	96727	60568	39432	03273	42705	2
59	4 8	55 52	57326	96722	60605	39395	03278	42674	1
60	4 0	56 0	57358	96717	60641	39359	03283	42642	0
M	Hour PM.	Hour AM.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

22 Degs. TABLE XXV. Artificial Sines, Tangents & Secants. 157 Degs.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	9 4 0	2 56 0	9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	60
1	3 52	56 8	57389	96711	60677	39323	.03289	42611	59
2	3 44	56 16	57420	96706	60714	39286	03294	42580	58
3	3 36	56 24	57451	96701	60750	39250	03299	42549	57
4	3 28	56 32	57482	96696	60786	39214	03304	42518	56
5	9 3 20	2 56 40	9.57514	9.96691	9.60823	10.39177	10.03309	10.42486	55
6	3 12	56 48	57545	96686	60859	39141	03314	42455	54
7	3 4	56 56	57576	96681	60895	39105	03319	42424	53
8	2 56	57 4	57607	96676	60931	39069	03324	42393	52
9	2 48	57 12	57638	96670	60967	39033	03330	42362	51
10	9 2 40	2 57 20	9.57669	9.96665	9.61004	10.38996	10.03335	10.42331	50
11	2 32	57 28	57700	96660	61040	38960	03340	42300	49
12	2 24	57 36	57731	96655	61076	38924	03345	42269	48
13	2 16	57 44	57762	96650	61112	38888	03350	42238	47
14	2 8	57 52	57793	96645	61148	38852	03355	42207	46
15	9 2 0	2 58 0	9.57824	9.96640	9.61184	10.38816	10.03360	10.42176	45
16	1 52	58 8	57855	96634	61220	38780	03366	42145	44
17	1 44	58 16	57885	96629	61256	38744	03371	42115	43
18	1 36	58 24	57916	96624	61292	38708	03376	42084	42
19	1 28	58 32	57947	96619	61328	38672	03381	42053	41
20	9 1 20	2 58 40	9.57978	9.96614	9.61364	10.38636	10:03386	10.42022	40
21	1 12	58 48	58008	96608	61400	38600	03392	41992	39
22	1 4	58 56	58039	96603	61436	38564	03397	41961	38
23	0 56	59 4	58070	96598	61472	38528	03402	41930	37
24	0 48	59 12	58101	96593	61508	38492	03407	41899	36
25	9 0 40	2 59 20	9.58131	9.96588	9.61544	10.38456	10.03412	10.41869	35
26	0 32	59 28	58162	96582	61579	38421	03418	41838	34
27	0 24	59 36	58192	96577	61615	38385	03423	41808	33
28	0 16	59 44	58223	96572	61651	38349	03428	41777	32
29	0 8	59 52	58253	96567	61687	38313	03433	41747	31
30	9 0 0	3 0 0	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	30
31	8 59 52	0 8	58314	96556	61758	38242	03444	41686	29
32	59 44	0 16	58345	96551	61794	38206	03449	41655	28
33	59 36	0 24	58375	96546	61830	38170	03454	41625	27
34	59 28	0 32	58406	96541	61865	38135	03459	41594	26
35	8 59 20	3 0 40	9.58436	9.96535	9.61901	10.38099	10.03465	10.41564	25
36	59 12	0 48	58467	96530	61936	38064	03470	41533	24
37	59 4	0 56	58497	96525	61972	38028	03475	41503	23
38	58 56	1 4	58527	96520	62008	37992	03480	41473	22
39	58 48	1 12	58557	96514	62043	37957	03486	41443	21
40	8 58 40	3 1 20	9.58588	9.96509	9.62079	10.37921	10.03491	10.41412	20
41	58 32	1 28	58618	96504	62114	37886	03496	41382	19
42	58 24	1 36	58648	96498	62150	37850	03502	41352	18
43	58 16	1 44	58678	96493	62185	37815	03507	41322	17
44	58 8	1 52	58709	96488	62221	37779	03512	41291	16
45	8 58 0	3 2 0	9.58739	9.96483	9.62256	10.37744	10.03517	10.41261	15
46	57 52	2 8	58769	96477	62292	37708	03523	41231	14
47	57 44	2 16	58799	96472	62327	37673	03528	41201	13
48	57 36	2 24	58829	96467	62362	37638	03533	41171	12
49	57 28	2 32	58859	96461	62398	37602	03539	41141	11
50	8 57 20	3 2 40	9.58889	9.96456	9.62433	10.37567	10.03544	10.41111	10
51	57 12	2 48	58919	96451	62468	37532	03549	41081	9
52	57 4	2 56	58949	96445	62504	37496	03555	41051	8
53	56 56	3 4	58979	96440	62539	37461	03560	41021	7
54	56 48	3 12	59009	96435	62574	37426	03565	40991	6
55	8 56 40	3 3 20	9.59039	9.96429	9.62609	10.37391	10.03571	10.40961	5
56	56 32	3 28	59069	96424	62645	37355	03576	40931	4
57	56 24	3 36	59098	96419	62680	37320	03581	40902	3
58	56 16	3 44	59128	96413	62715	37285	03587	40872	2
59	56 8	3 52	59158	96408	62750	37250	03592	40842	1
60	56 0	4 0	59188	96403	62785	37215	03597	40812	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

112 Degs. 67 Degs.

M.	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 56 0	3 4 0	9.59188	9.96403	9.62785	10.37215	10.03597	10.40812	60
1	55 52	4 8	59218	96397	62820	37180	03603	40782	59
2	55 44	4 16	59247	96392	62855	37145	03608	40753	58
3	55 36	4 24	59277	96387	62890	37110	03613	40723	57
4	55 28	4 32	59307	96381	62926	37074	03619	40693	56
5	8 55 20	3 4 40	9.59336	9.96376	9.62961	10.37039	10.03624	10.40664	55
6	55 12	4 48	59366	96370	62996	37004	03630	40634	54
7	55 4	4 56	59396	96365	63031	36969	03635	40604	53
8	54 56	5 4	59425	96360	63066	36934	03640	40575	52
9	54 48	5 12	59455	96354	63101	36899	03646	40545	51
10	8 54 40	3 5 20	9.59484	9.96349	9.63135	10.36865	10.03651	10.40516	50
11	54 32	5 28	59514	96343	63170	36830	03657	40486	49
12	54 24	5 36	59543	96338	63205	36795	03662	40457	48
13	54 16	5 44	59573	96333	63240	36760	03667	40427	47
14	54 8	5 52	59602	96327	63275	36725	03673	40398	46
15	8 54 0	3 6 0	9.59632	9.96322	9.63310	10.36690	10.03678	10.40368	45
16	53 52	6 8	59661	96316	63345	36655	03684	40339	44
17	53 44	6 16	59690	96311	63379	36621	03689	40310	43
18	53 36	6 24	59720	96305	63414	36586	03695	40280	42
19	53 28	6 32	59749	96300	63449	36551	03700	40251	41
20	8 53 20	3 6 40	9.59778	9.96294	9.63484	10.36516	10.03706	10.40222	40
21	53 12	6 48	59808	96289	63519	36481	03711	40192	39
22	53 4	6 56	59837	96284	63553	36447	03716	40163	38
23	52 56	7 4	59866	96278	63588	36412	03722	40134	37
24	52 48	7 12	59895	96273	63623	36377	03727	40105	36
25	8 52 40	3 7 20	9.59924	9.96267	9.63657	10.36343	10.03733	10.40076	35
26	52 32	7 28	59954	96262	63692	36308	03738	40046	34
27	52 24	7 36	59983	96256	63726	36274	03744	40017	33
28	52 16	7 44	60012	96251	63761	36239	03749	39988	32
29	52 8	7 52	60041	96245	63796	36204	03755	39959	31
30	8 52 0	3 8 0	9.60070	9.96240	9.63830	10.36170	10.03760	10.39930	30
31	51 52	8 8	60099	96234	63865	36135	03766	39901	29
32	51 44	8 16	60128	96229	63899	36101	03771	39872	28
33	51 36	8 24	60157	96223	63934	36066	03777	39843	27
34	51 28	8 32	60186	96218	63968	36032	03782	39814	26
35	8 51 20	3 8 40	9.60215	9.96212	9.64003	10.35997	10.03788	10.39785	25
36	51 12	8 48	60244	96207	64037	35963	03793	39756	24
37	51 4	8 56	60273	96201	64072	35928	03799	39727	23
38	50 56	9 4	60302	96196	64106	35894	03804	39698	22
39	50 48	9 12	60331	96190	64140	35860	03810	39669	21
40	8 50 40	3 9 20	9.60359	9.96185	9.64175	10.35825	10.03815	10.39641	20
41	50 32	9 28	60388	96179	64209	35791	03821	39612	19
42	50 24	9 36	60417	96174	64243	35757	03826	39583	18
43	50 16	9 44	60446	96168	64278	35722	03832	39554	17
44	50 8	9 52	60474	96162	64312	35688	03838	39526	16
45	8 50 0	3 10 0	9.60503	9.96157	9.64346	10.35654	10.03843	10.39497	15
46	49 52	10 8	60532	96151	64381	35619	03849	39468	14
47	49 44	10 16	60561	96146	64415	35585	03854	39439	13
48	49 36	10 24	60589	96140	64449	35551	03860	39411	12
49	49 28	10 32	60618	96135	64483	35517	03865	39382	11
50	8 49 20	3 10 40	9.60646	9.96129	9.64517	10.35483	10.03871	10.39354	10
51	49 12	10 48	60675	96123	64552	35448	03877	39325	9
52	49 4	10 56	60704	96118	64586	35414	03882	39296	8
53	48 56	11 4	60732	96112	64620	35380	03888	39268	7
54	48 48	11 12	60761	96107	64654	35346	03893	39239	6
55	8 48 40	3 11 20	9.60789	9.96101	9.64688	10.35312	10.03899	10.39211	5
56	48 32	11 28	60818	96095	64722	35278	03905	39182	4
57	48 24	11 36	60846	96090	64756	35244	03910	39154	3
58	48 16	11 44	60875	96084	64790	35210	03916	39125	2
59	48 8	11 52	60903	96079	64824	35176	03921	39097	1
60	48 0	12 0	60931	96073	64858	35142	03927	39069	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 48 0	3 12 0	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069	60
1	47 52	12 8	60960	96067	64892	35108	03933	39040	59
2	47 44	12 16	60988	96062	64926	35074	03938	39012	58
3	47 36	12 24	61016	96056	64960	35040	03944	38984	57
4	47 28	12 32	61045	96050	64994	35006	03950	38955	56
5	8 47 20	3 12 40	9.61073	9.96045	9.65028	10.34972	10.03955	10.38927	55
6	47 12	12 48	61101	96039	65062	34938	03961	38899	54
7	47 4	12 56	61129	96034	65096	34904	03966	38871	53
8	46 56	13 4	61158	96028	65130	34870	03972	38842	52
9	46 48	13 12	61186	96022	65164	34836	03978	38814	51
10	8 46 40	3 13 20	9.61214	9.96017	9.65197	10.34803	10.03983	10.38786	50
11	46 32	13 28	61242	96011	65231	34769	03989	38758	49
12	46 24	13 36	61270	96005	65265	34735	03995	38730	48
13	46 16	13 44	61298	96000	65299	34701	04000	38702	47
14	46 8	13 52	61326	95994	65333	34667	04006	38674	46
15	8 46 0	3 14 0	9.61354	9.95988	9.65366	10.34634	10.04012	10.38640	45
16	45 52	14 8	61382	95982	65400	34600	04018	38618	44
17	45 44	14 16	61411	95977	65434	34566	04023	38589	43
18	45 36	14 24	61438	95971	65467	34533	04029	38562	42
19	45 28	14 32	61466	95965	65501	34499	04035	38534	41
20	8 45 20	3 14 40	9.61494	9.95960	9.65535	10.34465	10.04040	10.38506	40
21	45 12	14 48	61522	95954	65568	34432	04046	38478	39
22	45 4	14 56	61550	95948	65602	34398	04052	38450	38
23	44 56	15 4	61578	95942	65636	34364	04058	38422	37
24	44 48	15 12	61606	95937	65669	34331	04063	38394	36
25	8 44 40	3 15 20	9.61634	9.95931	9.65703	10.34297	10.04069	10.38366	35
26	44 32	15 28	61662	95925	65736	34264	04075	38338	34
27	44 24	15 36	61689	95920	65770	34230	04080	38311	33
28	44 16	15 44	61717	95914	65803	34197	04086	38283	32
29	44 8	15 52	61745	95908	65837	34163	04092	38255	31
30	8 44 0	3 16 0	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
31	43 52	16 8	61800	95897	65904	34096	04103	38200	29
32	43 44	16 16	61828	95891	65937	34063	04109	38172	28
33	43 36	16 24	61856	95885	65971	34029	04115	38144	27
34	43 28	16 32	61883	95879	66004	33996	04121	38117	26
35	8 43 20	3 16 40	9.61911	9.95873	9.66038	10.33962	10.04127	10.38089	25
36	43 12	16 48	61939	95868	66071	33929	04132	38061	24
37	43 4	16 56	61966	95862	66104	33896	04138	38034	23
38	42 56	17 4	61994	95856	66138	33862	04144	38006	22
39	42 48	17 12	62021	95850	66171	33829	04150	37979	21
40	8 42 40	3 17 20	9.62049	9.95844	9.66204	10.33796	10.04156	10.37951	20
41	42 32	17 28	62076	95839	66238	33762	04161	37924	19
42	42 24	17 36	62104	95833	66271	33729	04167	37896	18
43	42 16	17 44	62131	95827	66304	33696	04173	37869	17
44	42 8	17 52	62159	95821	66337	33663	04179	37841	16
45	8 42 0	3 18 0	9.62186	9.95815	9.66371	10.33629	10.04185	10.37814	15
46	41 52	18 8	62214	95810	66404	33596	04190	37786	14
47	41 44	18 16	62241	95804	66437	33563	04196	37759	13
48	41 36	18 24	62268	95798	66470	33530	04202	37732	12
49	41 28	18 32	62296	95792	66503	33497	04208	37704	11
50	8 41 20	3 18 40	9.62323	9.95786	9.66537	10.33463	10.04214	10.37677	10
51	41 12	18 48	62350	95780	66570	33430	04220	37650	9
52	41 4	18 56	62377	95775	66603	33397	04225	37623	8
53	40 56	19 4	62405	95769	66636	33364	04231	37595	7
54	40 48	19 12	62432	95763	66669	33331	04237	37568	6
55	8 40 40	3 19 20	9.62459	9.95757	9.66702	10.33298	10.04243	10.37541	5
56	40 32	19 28	62486	95751	66735	33265	04249	37514	4
57	40 24	19 36	62513	95745	66768	33232	04255	37487	3
58	40 16	19 44	62541	95739	66801	33199	04261	37459	2
59	40 8	19 52	62568	95733	66834	33166	04267	37432	1
60	40 0	20 0	62595	95728	66867	33133	04272	37405	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang	Tangent.	Co-sec.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 40 0	3 20 0	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	60
1	39 52	20 8	62622	95722	66900	33100	04278	37378	59
2	39 44	20 16	62649	95716	66933	33067	04284	37351	58
3	39 36	20 24	62676	95710	66966	33034	04290	37324	57
4	39 28	20 32	62703	95704	66999	33001	04296	37297	56
5	8 39 20	3 20 40	9.62730	9.95698	9.67032	10.32968	10.04302	10.37270	55
6	39 12	20 48	62757	95692	67065	32935	04308	37243	54
7	39 4	20 56	62784	95686	67098	32902	04314	37216	53
8	38 56	21 4	62811	95680	67131	32869	04320	37189	52
9	38 48	21 12	62838	95674	67163	32837	04326	37162	51
10	8 38 40	3 21 20	9.62865	9.95668	9.67196	10.32804	10.04332	10.37135	50
11	38 32	21 28	62892	95663	67229	32771	04337	37108	49
12	38 24	21 36	62918	95657	67262	32738	04343	37082	48
13	38 16	21 44	62945	95651	67295	32705	04349	37055	47
14	38 8	21 52	62972	95645	67327	32673	04355	37028	46
15	8 38 0	3 22 0	9.62999	9.95639	9.67360	10.32640	10.04361	10.37001	45
16	37 52	22 8	63026	95633	67393	32607	04367	36974	44
17	37 44	22 16	63052	95627	67426	32574	04373	36948	43
18	37 36	22 24	63079	95621	67458	32542	04379	36921	42
19	37 28	22 32	63106	95615	67491	32509	04385	36894	41
20	8 37 20	3 22 40	9.63133	9.95609	9.67524	10.32476	10.04391	10.36867	40
21	37 12	22 48	63159	95603	67556	32444	04397	36841	39
22	37 4	22 56	63186	95597	67589	32411	04403	36814	38
23	36 56	23 4	63213	95591	67622	32378	04409	36787	37
24	36 48	23 12	63239	95585	67654	32346	04415	36761	36
25	8 36 40	3 23 20	9.63266	9.95579	9.67687	10.32313	10.04421	10.36734	35
26	36 32	23 28	63292	95573	67719	32281	04427	36708	34
27	36 24	23 36	63319	95567	67752	32248	04433	36681	33
28	36 16	23 44	63345	95561	67785	32215	04439	36655	32
29	36 8	23 52	63372	95555	67817	32183	04445	36628	31
30	8 36 0	3 24 0	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30
31	35 52	24 8	63425	95543	67882	32118	04457	36575	29
32	35 44	24 16	63451	95537	67915	32085	04463	36549	28
33	35 36	24 24	63478	95531	67947	32053	04469	36522	27
34	35 28	24 32	63504	95525	67980	32020	04475	36496	26
35	8 35 20	3 24 40	9.63531	9.95519	9.68012	10.31988	10.04481	10.36469	25
36	35 12	24 48	63557	95513	68044	31956	04487	36443	24
37	35 4	24 56	63583	95507	68077	31923	04493	36417	23
38	34 56	25 4	63610	95500	68109	31891	04500	36390	22
39	34 48	25 12	63636	95494	68142	31858	04506	36364	21
40	8 34 40	3 25 20	9.63662	9.95488	9.68174	10.31826	10.04512	10.36338	20
41	34 32	25 28	63689	95482	68206	31794	04518	36311	19
42	34 24	25 36	63715	95476	68239	31761	04524	36285	18
43	34 16	25 44	63741	95470	68271	31729	04530	36259	17
44	34 8	25 52	63767	95464	68303	31697	04536	36233	16
45	8 34 0	3 26 0	9.63794	9.95458	9.68336	10.31664	10.04542	10.36206	15
46	33 52	26 8	63820	95452	68368	31632	04548	36180	14
47	33 44	26 16	63846	95446	68400	31600	04554	36154	13
48	33 36	26 24	63872	95440	68432	31568	04560	36128	12
49	33 28	26 32	63898	95434	68465	31535	04566	36102	11
50	8 33 20	3 26 40	9.63924	9.95427	9.68497	10.31503	10.04573	10.36076	10
51	33 12	26 48	63950	95421	68529	31471	04579	36050	9
52	33 4	26 56	63976	95415	68561	31439	04585	36024	8
53	32 56	27 4	64002	95409	68593	31407	04591	35998	7
54	32 48	27 12	64028	95403	68626	31374	04597	35972	6
55	8 32 40	3 27 20	9.64054	9.95397	9.68658	10.31342	10.04603	10.35946	5
56	32 32	27 28	64080	95391	68690	31310	04609	35920	4
57	32 24	27 36	64106	95384	68722	31278	04616	35894	3
58	32 16	27 44	64132	95378	68754	31246	04622	35868	2
59	32 8	27 52	64158	95372	68786	31214	04628	35842	1
60	32 0	28 0	64184	95366	68818	31182	04634	35816	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 32 0	3 28 0	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	60
1	31 52	28 8	64210	95360	68850	31150	04640	35790	59
2	31 44	28 16	64236	95354	68882	31118	04646	35764	58
3	31 36	28 24	64262	95348	68914	31086	04652	35738	57
4	31 28	28 32	64288	95341	68946	31054	04659	35712	56
5	8 31 20	3 28 40	9.64313	9.95335	9.68978	10.31022	10.04665	10.35687	55
6	31 12	28 48	64339	95329	69010	30990	04671	35661	54
7	31 4	28 56	64365	99323	69042	30958	04677	35635	53
8	30 56	29 4	64391	95317	69074	30926	04683	35609	52
9	30 48	29 12	64417	95310	69106	30894	04690	35583	51
10	8 30 40	3 29 20	9.64442	9.95304	9.69138	10.30862	10.04696	10.35558	50
11	30 32	29 28	64468	95298	69170	30830	04702	35532	49
12	30 24	29 36	64494	95292	69202	30798	04708	35506	48
13	30 16	29 44	64519	95286	69234	30766	04714	35481	47
14	30 8	29 52	64545	95279	69266	30734	04721	35455	46
15	8 30 0	3 30 0	9.64571	9.95273	9.69298	10.30702	10.04727	10.35429	45
16	29 52	30 8	64596	95267	69329	30671	04733	35404	44
17	29 44	30 16	64622	95261	69361	30639	04739	35378	43
18	29 36	30 24	64647	95254	69393	30607	04746	35353	42
19	29 28	30 32	64673	95248	69425	30575	04752	35327	41
20	8 29 20	3 30 40	9.64698	9.95242	9.69457	10.30543	10.04758	10.35302	40
21	29 12	30 48	64724	95236	69488	30512	04764	35276	39
22	29 4	30 56	64749	95229	69520	30480	04771	35251	38
23	28 56	31 4	64775	95223	69552	30448	04777	35225	37
24	28 48	31 12	64800	95217	69584	30416	04783	35200	36
25	8 28 40	3 31 20	9.64826	9.95211	9.69615	10.30385	10.04789	10.35174	35
26	28 32	31 28	64851	95204	69647	30353	04796	35149	34
27	28 24	31 36	64877	95198	69679	30321	04802	35123	33
28	28 16	31 44	64902	95192	69710	30290	04808	35098	32
29	28 8	31 52	64927	95185	69742	30258	04815	35073	31
30	8 28 0	3 32 0	9.64953	9.95179	9.69774	10.30226	10.04821	10.35047	30
31	27 52	32 8	64978	95173	69805	30195	04827	35022	29
32	27 44	32 16	65003	95167	69837	30163	04833	34997	28
33	27 36	32 24	65029	95160	69868	30132	04840	34971	27
34	27 28	32 32	65054	95154	69900	30100	04846	34946	26
35	8 27 20	3 32 40	9.65079	9.95148	9.69932	10.30068	10.04852	10.34921	25
36	27 12	32 48	65104	95141	69963	30037	04859	34896	24
37	27 4	32 56	65130	95135	69995	30005	04865	34870	23
38	26 56	33 4	65155	95129	70026	29974	04871	34845	22
39	26 48	33 12	65180	95122	70058	29942	04878	34820	21
40	8 26 40	3 33 20	9.65205	9.95116	9.70089	10.29911	10.04884	10.34795	20
41	26 32	33 28	65230	95110	70121	29879	04890	34770	19
42	26 24	33 36	65255	95103	70152	29848	04897	34745	18
43	26 16	33 44	65281	95097	70184	29816	04903	34719	17
44	26 8	33 52	65306	95090	70215	29785	04910	34694	16
45	8 26 0	3 34 0	9.65331	9.95084	9.70247	10.29753	10.04916	10.34669	15
46	25 52	34 8	65356	95078	70278	29722	04922	34644	14
47	25 44	34 16	65381	95071	70309	29691	04929	34619	13
48	25 36	34 24	65406	95065	70341	29659	04935	34594	12
49	25 28	34 32	65431	95059	70372	29628	04941	34569	11
50	8 25 20	3 34 40	9.65456	9.95052	9.70404	10.29596	10.04948	10.34544	10
51	25 12	34 48	65481	95046	70435	29565	04954	34519	9
52	25 4	34 56	65506	95039	70466	29534	04961	34494	8
53	24 56	35 4	65531	95033	70498	29502	04967	34469	7
54	24 48	35 12	65556	95027	70529	29471	04973	34444	6
55	8 24 40	3 35 20	9.65580	9.95020	9.70560	10.29440	10.04980	10.34420	5
56	24 32	35 28	65605	95014	70592	29408	04986	34395	4
57	24 24	35 36	65630	95007	70623	29377	04993	34370	3
58	24 16	35 44	65655	95001	70654	29346	04999	34345	2
59	24 8	35 52	65680	94995	70685	29315	05005	34320	1
60	24 0	36 0	65705	94988	70717	29283	05012	34295	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 24 0	3 36 0	9.65705	9.94988	9.70717	10.29283	10.05012	10.34295	60
1	23 52	36 8	65729	94982	70748	29252	05018	34271	59
2	23 44	36 16	65754	94975	70779	29221	05025	34246	58
3	23 36	36 24	65779	94969	70810	29190	05031	34221	57
4	23 28	36 32	65804	94962	70841	29159	05038	34196	56
5	8 23 20	3 36 40	9.65828	9.94956	9.70873	10.29127	10.05044	10.34172	55
6	23 12	36 48	65853	94949	70904	29096	05051	34147	54
7	23 4	36 56	65878	94943	70935	29065	05057	34122	53
8	22 56	37 4	65902	94936	70966	29034	05064	34098	52
9	22 48	37 12	65927	94930	70997	29003	05070	34073	51
10	8 22 40	3 37 20	9.65952	9.94923	9.71028	10.28972	10.05077	10.34048	50
11	22 32	37 28	65976	94917	71059	28941	05083	34024	49
12	22 24	37 36	66001	94911	71090	28910	05089	33999	48
13	22 16	37 44	66025	94904	71121	28879	05096	33975	47
14	22 8	37 52	66050	94898	71153	28847	05102	33950	46
15	8 22 0	3 38 0	9.66075	9.94891	9.71184	10.28816	10.05109	10.33925	45
16	21 52	38 8	66099	94885	71215	28785	05115	33901	44
17	21 44	38 16	66124	94878	71246	28754	05122	33876	43
18	21 36	38 24	66148	94871	71277	28723	05129	33852	42
19	21 28	38 32	66173	94865	71308	28692	05135	33827	41
20	8 21 20	3 38 40	9.66197	9.94858	9.71339	10.28661	10.05142	10.33803	40
21	21 12	38 48	66221	94852	71370	28630	05148	33779	39
22	21 4	38 56	66246	94845	71401	28599	05155	33754	38
23	20 56	39 4	66270	94839	71431	28569	05161	33730	37
24	20 48	39 12	66295	94832	71462	28538	05168	33705	36
25	8 20 40	3 39 20	9.66319	9.94826	9.71493	10.28507	10.05174	10.33681	35
26	20 32	39 28	66343	94819	71524	28476	05181	33657	34
27	20 24	39 36	66368	94813	71555	28445	05187	33632	33
28	20 16	39 44	66392	94806	71586	28414	05194	33608	32
29	20 8	39 52	66416	94799	71617	28383	05201	33584	31
30	8 20 0	3 40 0	9.66441	9.94793	9.71648	10.28352	10.05207	10.33559	30
31	19 52	40 8	66465	94786	71679	28321	05214	33535	29
32	19 44	40 16	66489	94780	71709	28291	05220	33511	28
33	19 36	40 24	66513	94773	71740	28260	05227	33487	27
34	19 28	40 32	66537	94767	71771	28229	05233	33463	26
35	8 19 20	3 40 40	9.66562	9.94760	9.71802	10.28198	10.05240	10.33438	25
36	19 12	40 48	66586	94753	71833	28167	05247	33414	24
37	19 4	40 56	66610	94747	71863	28137	05253	33390	23
38	18 56	41 4	66634	94740	71894	28106	05260	33366	22
39	18 48	41 12	66658	94734	71925	28075	05266	33342	21
40	8 18 40	3 41 20	9.66682	9.94727	9.71955	10.28045	10.05273	10.33318	20
41	18 32	41 28	66706	94720	71986	28014	05280	33294	19
42	18 24	41 36	66731	94714	72017	27983	05286	33269	18
43	18 16	41 44	66755	94707	72048	27952	05293	33245	17
44	18 8	41 52	66779	94700	72078	27922	05300	33221	16
45	8 18 0	3 42 0	9.66803	9.94694	9.72109	10.27891	10.05306	10.33197	15
46	17 52	42 8	66827	94687	72140	27860	05313	33173	14
47	17 44	42 16	66851	94680	72170	27830	05320	33149	13
48	17 36	42 24	66875	94674	72201	27799	05326	33125	12
49	17 28	42 32	66899	94667	72231	27769	05333	33101	11
50	8 17 20	3 42 40	9.66922	9.94660	9.72262	10.27738	10.05340	10.33078	10
51	17 12	42 48	66946	94654	72293	27707	05346	33054	9
52	17 4	42 56	66970	94647	72323	27677	05353	33030	8
53	16 56	43 4	66994	94640	72354	27646	05360	33006	7
54	16 48	43 12	67018	94634	72384	27616	05366	32982	6
55	8 16 40	3 43 20	9.67042	9.94627	9.72415	10.27585	10.05373	10.32958	5
56	16 32	43 28	67066	94620	72445	27555	05380	32934	4
57	16 24	43 36	67090	94614	72476	27524	05386	32910	3
58	16 16	43 44	67113	94607	72506	27494	05393	32887	2
59	16 8	43 52	67137	94600	72537	27463	05400	32863	1
60	16 0	44 0	67161	94593	72567	27433	05407	32839	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 16 0	3 44 0	9.67161	9.94593	9.72567	10.27433	10.05407	10.32839	60
1	15 52	44 8	67185	94587	72598	27402	05413	32815	59
2	15 44	44 16	67208	94580	72628	27372	05420	32792	58
3	15 36	44 24	67232	94573	72659	27341	05427	32768	57
4	15 28	44 32	67256	94567	72689	27311	05433	32744	56
5	8 15 20	3 44 40	9.67280	9.94560	9.72720	10.27280	10.05440	10.32720	55
6	15 12	44 48	67303	94553	72750	27250	05447	32697	54
7	15 4	44 56	67327	94546	72780	27220	05454	32673	53
8	14 56	45 4	67350	94540	72811	27189	05460	32650	52
9	14 48	45 12	67374	94533	72841	27159	05467	32626	51
10	8 14 40	3 45 20	9.67398	9.94526	9.72872	10.27128	10.05474	10.32602	50
11	14 32	45 28	67421	94519	72902	27098	05481	32579	49
12	14 24	45 36	67445	94513	72932	27068	05487	32555	48
13	14 16	45 44	67468	94506	72963	27037	05494	32532	47
14	14 8	45 52	67492	94499	72993	27007	05501	32508	46
15	8 14 0	3 46 0	9.67515	9.94492	9.73023	10.26977	10.05508	10.32485	45
16	13 52	46 8	67539	94485	73054	26946	05515	32461	44
17	13 44	46 16	67562	94479	73084	26916	05521	32438	43
18	13 36	46 24	67586	94472	73114	26886	05528	32414	42
19	13 28	46 32	67609	94465	73144	26856	05535	32391	41
20	8 13 20	3 46 40	9.67633	9.94458	9.73175	10.26825	10.05542	10.32367	40
21	13 12	46 48	67656	94451	73205	26795	05549	32344	39
22	13 4	46 56	67680	94445	73235	26765	05555	32320	38
23	12 56	47 4	67703	94438	73265	26735	05562	32297	37
24	12 48	47 12	67726	94431	73295	26705	05569	32274	36
25	8 12 40	3 47 20	9.67750	9.94424	9.73326	10.26674	10.05576	10.32250	35
26	12 32	47 28	67773	94417	73356	26644	05583	32227	34
27	12 24	47 36	67796	94410	73386	26614	05590	32204	33
28	12 16	47 44	67820	94404	73416	26584	05596	32180	32
29	12 8	47 52	67843	94397	73446	26554	05603	32157	31
30	8 12 0	3 48 0	9.67866	9.94390	9.73476	10.26524	10.05610	10.32134	30
31	11 52	48 8	67890	94383	73507	26493	05617	32110	29
32	11 44	48 16	67913	94376	73537	26463	05624	32087	28
33	11 36	48 24	67936	94369	73567	26433	05631	32064	27
34	11 28	48 32	67959	94362	73597	26403	05638	32041	26
35	8 11 20	3 48 40	9.67982	9.94355	9.73627	10.26373	10.05645	10.32018	25
36	11 12	48 48	68006	94349	73657	26343	05651	31994	24
37	11 4	48 56	68029	94342	73687	26313	05658	31971	23
38	10 56	49 4	68052	94335	73717	26283	05665	31948	22
39	10 48	49 12	68075	94328	73747	26253	05672	31925	21
40	8 10 40	3 49 20	9.68098	9.94321	9.73777	10.26223	10.05679	10.31902	20
41	10 32	49 28	68121	94314	73807	26193	05686	31879	19
42	10 24	49 36	68144	94307	73837	26163	05693	31856	18
43	10 16	49 44	68167	94300	73867	26133	05700	31833	17
44	10 8	49 52	68190	94293	73897	26103	05707	31810	16
45	8 10 0	3 50 0	9.68213	9.94286	9.73927	10.26073	10.05714	10.31787	15
46	9 52	50 8	68237	94279	73957	26043	05721	31763	14
47	9 44	50 16	68260	94273	73987	26013	05727	31740	13
48	9 36	50 24	68283	94266	74017	25983	05734	31717	12
49	9 28	50 32	68305	94259	74047	25953	05741	31695	11
50	8 9 20	3 50 40	9.68328	9.94252	9.74077	10.25923	10.05748	10.31672	10
51	9 12	50 48	68351	94245	74107	25893	05755	31649	9
52	9 4	50 56	68374	94238	74137	25863	05762	31626	8
53	8 56	51 4	68397	94231	74166	25834	05769	31603	7
54	8 48	51 12	68420	94224	74196	25804	05776	31580	6
55	8 8 40	3 51 20	9.68443	9.94217	9.74226	10.25774	10.05783	10.31557	5
56	8 32	51 28	68466	94210	74256	25744	05790	31534	4
57	8 24	51 36	68489	94203	74286	25714	05797	31511	3
58	8 16	51 44	68512	94196	74316	25684	05804	31488	2
59	8 8	51 52	68534	94189	74345	25655	05811	31466	1
60	8 0	52 0	68557	94182	74375	25625	05818	31443	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 8 0	3 52 0	9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	60
1	7 52	52 8	68580	94175	74405	25595	05825	31420	59
2	7 44	52 16	68603	94168	74435	25565	05832	31397	58
3	7 36	52 24	68625	94161	74465	25535	05839	31375	57
4	7 28	52 32	68648	94154	74494	25506	05846	31352	56
5	8 7 20	3 52 40	9.68671	9.94147	9.74524	10.25476	10.05853	10.31329	55
6	7 12	52 48	68694	94140	74554	25446	05860	31306	54
7	7 4	52 56	68716	94133	74583	25417	05867	31284	53
8	6 56	53 4	68739	94126	74613	25387	05874	31261	52
9	6 48	53 12	68762	94119	74643	25357	05881	31238	51
10	8 6 40	3 53 20	9.68784	9.94112	9.74673	10.25327	10.05888	10.31216	50
11	6 32	53 28	68807	94105	74702	25298	05895	31193	49
12	6 24	53 36	68829	94098	74732	25268	05902	31171	48
13	6 16	53 44	68852	94090	74762	25238	05910	31148	47
14	6 8	53 52	68875	94083	74791	25209	05917	31125	46
15	8 6 0	3 54 0	9.68897	9.94076	9.74821	10.25179	10.05924	10.31103	45
16	5 52	54 8	68920	94069	74851	25149	05931	31080	44
17	5 44	54 16	68942	94062	74880	25120	05938	31058	43
18	5 36	54 24	68965	94055	74910	25090	05945	31035	42
19	5 28	54 32	68987	94048	74939	25061	05952	31013	41
20	8 5 20	3 54 40	9.69010	9.94041	9.74969	10.25031	10.05959	10.30990	40
21	5 12	54 48	69032	94034	74998	25002	05966	30968	39
22	5 4	54 56	69055	94027	75028	24972	05973	30945	38
23	4 56	55 4	69077	94020	75058	24942	05980	30923	37
24	4 48	55 12	69100	94012	75087	24913	05988	30900	36
25	8 4 40	3 55 20	9.69122	9.94005	9.75117	10.24883	10.05995	10.30878	35
26	4 32	55 28	69144	93998	75146	24854	06002	30856	34
27	4 24	55 36	69167	93991	75176	24824	06009	30833	33
28	4 16	55 44	69189	939[illegible]	75205	24795	06016	30811	32
29	4 8	55 52	69212	93977	75235	24765	06023	30788	31
30	8 4 0	3 56 0	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
31	3 52	56 8	69256	93963	75294	24706	06037	30744	29
32	3 44	56 16	69279	93955	75323	24677	06045	30721	28
33	3 36	56 24	69301	93948	75353	24647	06052	30699	27
34	3 28	56 32	69323	93941	75382	24618	06059	30677	26
35	8 3 20	3 56 40	9.69345	9.93934	9.75411	10.24589	10.06066	10.30655	25
36	3 12	56 48	69368	93927	75441	24559	06073	30632	24
37	3 4	56 56	69390	93920	75470	24530	06080	30610	23
38	2 56	57 4	69412	93912	75500	24500	06088	30588	22
39	2 48	57 12	69434	93905	75529	24471	06095	30566	21
40	8 2 40	3 57 20	9.69456	9.93898	9.75558	10.24442	10.06102	10.30544	20
41	2 32	57 28	69479	93891	75588	24412	06109	30521	19
42	2 24	57 36	69501	93884	75617	24383	06116	30499	18
43	2 16	57 44	69523	93876	75647	24353	06124	30477	17
44	2 8	57 52	69545	93869	75676	24324	06131	30455	16
45	8 2 0	3 58 0	9.69567	9.93862	9.75705	10.24295	10.06138	10.30433	15
46	1 52	58 8	69589	93855	75735	24265	06145	30411	14
47	1 44	58 16	69611	93847	75764	24236	06153	30389	13
48	1 36	58 24	69633	93840	75793	24207	06160	30367	12
49	1 28	58 32	69655	93833	75822	24178	06167	30345	11
50	8 1 20	3 58 40	9.69677	9.93826	9.75852	10.24148	10.06174	10.30323	10
51	1 12	58 48	69699	93819	75881	24119	06181	30301	9
52	1 4	58 56	69721	93811	75910	24090	06189	30279	8
53	0 56	59 4	69743	93804	75939	24061	06196	30257	7
54	0 48	59 12	69765	93797	75969	24031	06203	30235	6
55	8 0 40	3 59 20	9.69787	9.93789	9.75998	10.24002	10.06211	10.30213	5
56	0 32	59 28	69809	93782	76027	23973	06218	30191	4
57	0 24	59 36	69831	93775	76056	23944	06225	30169	3
58	0 16	59 44	69853	93768	76086	23914	06232	30147	2
59	0 8	59 52	69875	93760	76115	23885	06240	30125	1
60	0 0	4 0 0	69897	93753	76144	23856	06247	30103	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour AM	Hour P M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 0 0	4 0 0	9.69897	9.93753	9.76144	10.23856	10.06247	10.30103	60
1	7 59 52	0 8	69919	93746	76173	23827	06254	30081	59
2	59 44	0 16	69941	93738	76202	23798	06262	30059	58
3	59 36	0 24	69963	93731	76231	23769	06269	30037	57
4	59 28	0 32	69984	93724	76261	23739	06276	30016	56
5	7 59 20	4 0 40	9.70006	9.93717	9.76290	10.23710	10.06283	10.29994	55
6	59 12	0 48	70028	93709	76319	23681	06291	29972	54
7	59 4	0 56	70050	93702	76348	23652	06298	29950	53
8	58 56	1 4	70072	93695	76377	23623	06305	29928	52
9	58 48	1 12	70093	93687	76406	23594	06313	29907	51
10	7 58 40	4 1 20	9.70115	9.93680	9.76435	10.23565	10.06320	10.29885	50
11	58 32	1 28	70137	93673	76464	23536	06327	29863	49
12	58 24	1 36	70159	93665	76493	23507	06335	29841	48
13	58 16	1 44	70180	93658	76522	23478	06342	29820	47
14	58 8	1 52	70202	93650	76551	23449	06350	29798	46
15	7 58 0	4 2 0	9.70224	9.93643	9.76580	10.23420	10.06357	10.29776	45
16	57 52	2 8	70245	93636	76609	23391	06364	29755	44
17	57 44	2 16	70267	93628	76639	23361	06372	29733	43
18	57 36	2 24	70288	93621	76668	23332	06379	29712	42
19	57 28	2 32	70310	93614	76697	23303	06386	29690	41
20	7 57 20	4 2 40	9.70332	9.93606	9.76725	10.23275	10.06394	10.29668	40
21	57 12	2 48	70353	93599	76754	23246	06401	29647	39
22	57 4	2 56	70375	93591	76783	23217	06409	29625	38
23	56 56	3 4	70396	93584	76812	23188	06416	29604	37
24	56 48	3 12	70418	93577	76841	23159	06423	29582	36
25	7 56 40	4 3 20	9.70439	9.93569	9.76870	10.23130	10.06431	10.29561	35
26	56 32	3 28	70461	93562	76899	23101	06438	29539	34
27	56 24	3 36	70482	93554	76928	23072	06446	29518	33
28	56 16	3 44	70504	93547	76957	23043	06453	29496	32
29	56 8	3 52	70525	93539	76986	23014	06461	29475	31
30	7 56 0	7 4 0	9.70547	9.93532	9.77015	10.22985	10.06468	10.29453	30
31	55 52	4 8	70568	93525	77044	22956	06475	29432	29
32	55 44	4 16	70590	93517	77073	22927	06483	29410	28
33	55 36	4 24	70611	93510	77101	22899	06490	29389	27
34	55 28	4 32	70633	93502	77130	22870	06498	29367	26
35	7 55 20	4 4 40	9.70654	9.93495	9.77159	10.22841	10.06505	10.29346	25
36	55 12	4 48	70675	93487	77188	22812	06513	29325	24
37	55 4	4 56	70697	93480	77217	22783	06520	29303	23
38	54 56	5 4	70718	93472	77246	22754	06528	29282	22
39	54 48	5 12	70739	93465	77274	22726	06535	29261	21
40	7 54 40	4 5 20	9.70761	9.93457	9.77303	10.22697	10.06543	10.29239	20
41	54 32	5 28	70782	93450	77332	22668	06550	29218	19
42	54 24	5 36	70803	93442	77361	22639	06558	29197	18
43	54 16	5 44	70824	93435	77390	22610	06565	29176	17
44	54 8	5 52	70846	93427	77418	22582	06573	29154	16
45	7 54 0	4 6 0	9.70867	9.93420	9.77447	10.22553	10.06580	10.29[illegible]33	15
46	53 52	6 8	70888	93412	77476	22524	06588	29112	14
47	53 44	6 16	70909	93405	77505	22495	06595	29091	13
48	53 36	6 24	70931	93397	77533	22467	06603	29069	12
49	53 28	6 32	70952	93390	77562	22438	06610	29048	11
50	7 53 20	4 6 40	9.70973	9.93382	9.77591	10.22409	10.06618	10.29027	10
51	53 12	6 48	70994	93375	77619	22381	06625	29006	9
52	53 4	6 56	71015	93367	77648	22352	06633	28985	8
53	52 56	7 4	71036	93360	77677	22323	06640	28964	7
54	52 48	7 12	71058	93352	77706	22294	06648	2894[illegible]	6
55	7 52 40	4 7 20	9.71079	9.93344	9.77734	10.22266	10.06656	10.2[illegible]	5
56	52 32	7 28	71100	93337	77763	22237	06663	[illegible]	4
57	52 24	7 36	71121	93329	77791	22209	06671	[illegible]	3
58	52 16	7 44	71142	93322	77820	22180	06678	[illegible]	2
59	52 8	7 52	71163	93314	77849	22151	06686	28837	1
60	52 0	8 0	71184	93307	77877	22123	06693	28816	0
M	Hour P M	Hour A M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M	Hour P.M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M.
0	7 52 0	4 8 0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
1	51 52	8 8	71205	93299	77906	22094	06701	28795	59
2	51 44	8 16	71226	93291	77935	22065	06709	28774	58
3	51 36	8 24	71247	93284	77963	22037	06716	28753	57
4	51 28	8 32	71268	93276	77992	22008	06724	28732	56
5	7 51 20	4 8 40	9.71289	9.93269	9.78020	10.21980	10.06731	10.28711	55
6	51 12	8 48	71310	93261	78049	21951	06739	28690	54
7	51 4	8 56	71331	93253	78077	21923	06747	28669	53
8	50 56	9 4	71352	93246	78106	21894	06754	28648	52
9	50 48	9 12	71373	93238	78135	21865	06762	28627	51
10	7 50 40	4 9 20	9.71393	9.93230	9.78163	10.21837	10.06770	10.28607	50
11	50 32	9 28	71414	93223	78192	21808	06777	28586	49
12	50 24	9 36	71435	93215	78220	21780	06785	28565	48
13	50 16	9 44	71456	93207	78249	21751	06793	28544	47
14	50 8	9 52	71477	93200	78277	21723	06800	28523	46
15	7 50 0	4 10 0	9.71498	9.93192	9.78306	10.21694	10.06808	10.28502	45
16	49 52	10 8	71519	93184	78334	21666	06816	28481	44
17	49 44	10 16	71539	93177	78363	21637	06823	28461	43
18	49 36	10 24	71560	93169	78391	21609	06831	28440	42
19	49 28	10 32	71581	93161	78419	21581	06839	28419	41
20	7 49 20	4 10 40	9.71602	9.93154	9.78448	10.21552	10.06846	10.28398	40
21	49 12	10 48	71622	93146	78476	21524	06854	28378	39
22	49 4	10 56	71643	93138	78505	21495	06862	28357	38
23	48 56	11 4	71664	93131	78533	21467	06869	28336	37
24	48 48	11 12	71685	93123	78562	21438	06877	28315	36
25	7 48 40	4 11 20	9.71705	9.93115	9.78590	10.21410	10.06885	10.28295	35
26	48 32	11 28	71726	93108	78618	21382	06892	28274	34
27	48 24	11 36	71747	93100	78647	21353	06900	28253	33
28	48 16	11 44	71767	93092	78675	21325	06908	28233	32
29	48 8	11 52	71788	93084	78704	21296	06916	28212	31
30	7 48 0	4 12 0	9.71809	9.93077	9.78732	10.21268	10.06923	10.28191	30
31	47 52	12 8	71829	93069	78760	21240	06931	28171	29
32	47 44	12 16	71850	93061	78789	21211	06939	28150	28
33	47 36	12 24	71870	93053	78817	21183	06947	28130	27
34	47 28	12 32	71891	93046	78845	21155	06954	28109	26
35	7 47 20	4 12 40	9.71911	9.93038	9.78874	10.21126	10.06962	10.28089	25
36	47 12	12 48	71932	93030	78902	21098	06970	28068	24
37	47 4	12 56	71952	93022	78930	21070	06978	28048	23
38	46 56	13 4	71973	93014	78959	21041	06986	28027	22
39	46 48	13 12	71994	93007	78987	21013	06993	28006	21
40	7 46 40	4 13 20	9.72014	9.92999	9.79015	10.20985	10.07001	10.27986	20
41	46 32	13 28	72034	92991	79043	20957	07009	27966	19
42	46 24	13 36	72055	92983	79072	20928	07017	27945	18
43	46 16	13 44	72075	92976	79100	20900	07024	27925	17
44	46 8	13 52	72096	92968	79128	20872	07032	27904	16
45	7 46 0	4 14 0	9.72116	9.92960	9.79156	10.20844	10.07040	10.27884	15
46	45 52	14 8	72137	92952	79185	20815	07048	27863	14
47	45 44	14 16	72157	92944	79213	20787	07056	27843	13
48	45 36	14 24	72177	92936	79241	20759	07064	27823	12
49	45 28	14 32	72198	92929	79269	20731	07071	27802	11
50	7 45 20	4 14 40	9.72218	9.92921	9.79297	10.20703	10.07079	10.27782	10
51	45 12	14 48	72238	92913	79326	20674	07087	27762	9
52	45 4	14 56	72259	92905	79354	20646	07095	27741	8
53	44 56	15 4	72279	92897	79382	20618	07103	27721	7
54	44 48	15 12	72299	92889	79410	20590	07111	27701	6
55	7 44 40	4 15 20	9.72320	9.92881	9.79438	10.20562	10.07119	10.27680	5
56	44 32	15 28	72340	92874	79466	20534	07126	27660	4
57	44 24	15 36	72360	92866	79495	20505	07134	27640	3
58	44 16	15 44	72381	92858	79523	20477	07142	27619	2
59	44 8	15 52	72401	92850	79551	20449	07150	27599	1
60	44 0	16 0	72421	92842	79579	20421	07158	27579	0
M	Hour P.M	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M	Hour P.M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 44 0	4 16 0	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	60
1	43 52	16 8	72441	92834	79607	20393	07166	27559	59
2	43 44	16 16	72461	92826	79635	20365	07174	27539	58
3	43 36	16 24	72482	92818	79663	20337	07182	27518	57
4	43 28	16 32	72502	92810	79691	20309	07190	27498	56
5	7 43 20	4 16 40	9.72522	9.92803	9.79719	10.20281	10.07197	10.27478	55
6	43 12	16 48	72542	92795	79747	20253	07205	27458	54
7	43 4	16 56	72562	92787	79776	20224	07213	27438	53
8	42 56	17 4	72582	92779	79804	20196	07221	27418	52
9	42 48	17 12	72602	92771	79832	20168	07229	27398	51
10	7 42 40	4 17 20	9.72622	9.92763	9.79860	10.20140	10.07237	10.27378	50
11	42 32	17 28	72643	92755	79888	20112	07245	27357	49
12	42 24	17 36	72663	92747	79916	20084	07253	27337	48
13	42 16	17 44	72683	92739	79944	20056	07261	27317	47
14	42 8	17 52	72703	92731	79972	20028	07269	27297	46
15	7 42 0	4 18 0	9.72723	9.92723	9.80000	10.20000	10.07277	10.27277	45
16	41 52	18 8	72743	92715	80028	19972	07285	27257	44
17	41 44	18 16	72763	92707	80056	19944	07293	27237	43
18	41 36	18 24	72783	92699	80084	19916	07301	27217	42
19	41 28	18 32	72803	92691	80112	19888	07309	27197	41
20	7 41 20	4 18 40	9.72823	9.92683	9.80140	10.19860	10.07317	10.27177	40
21	41 12	18 48	72843	92675	80168	19832	07325	27157	39
22	41 4	18 56	72863	92667	80195	19805	07333	27137	38
23	40 56	19 4	72883	92659	80223	19777	07341	27117	37
24	40 48	19 12	72902	92651	80251	19749	07349	27098	36
25	7 40 40	4 19 20	9.72922	9.92643	9.80279	10.19721	10.07357	10.27078	35
26	40 32	19 28	72942	92635	80307	19693	07365	27058	34
27	40 24	19 36	72962	92627	80335	19665	07373	27038	33
28	40 16	19 44	72982	92619	80363	19637	07381	27018	32
29	40 8	19 52	73002	92611	80391	19609	07389	26998	31
30	7 40 0	4 20 0	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
31	39 52	20 8	73041	92595	80447	19553	07405	26959	29
32	39 44	20 16	73061	92587	80474	19526	07413	26939	28
33	39 36	20 24	73081	92579	80502	19498	07421	26919	27
34	39 28	20 32	73101	92571	80530	19470	07429	26899	26
35	7 39 20	4 20 40	9.73121	9.92563	9.80558	10.19442	10.07437	10.26879	25
36	39 12	20 48	73140	92555	80586	19414	07445	26860	24
37	39 4	20 56	73160	92546	80614	19386	07454	26840	23
38	38 56	21 4	73180	92538	80642	19358	07462	26820	22
39	38 48	21 12	73200	92530	80669	19331	07470	26800	21
40	7 38 40	4 21 20	9.73219	9.92522	9.80697	10.19303	10.07478	10.26781	20
41	38 32	21 28	73239	92514	80725	19275	07486	26761	19
42	38 24	21 36	73259	92506	80753	19247	07494	26741	18
43	38 16	21 44	73278	92498	80781	19219	07502	26722	17
44	38 8	21 52	73298	92490	80808	19192	07510	26702	16
45	7 38 0	4 22 0	9.73318	9.92482	9.80836	10.19164	10.07518	10.26682	15
46	37 52	22 8	73337	92473	80864	19136	07527	26663	14
47	37 44	22 16	73357	92465	80892	19108	07535	26643	13
48	37 36	22 24	73377	92457	80919	19081	07543	26623	12
49	37 28	22 32	73396	92449	80947	19053	07551	26604	11
50	7 37 20	4 22 40	9.73416	9.92441	9.80975	10.19025	10.07559	10.26584	10
51	37 12	22 48	73435	92433	81003	18997	07567	26565	9
52	37 4	22 56	73455	92425	81030	18970	07575	26545	8
53	36 56	23 4	73474	92416	81058	18942	07584	26526	7
54	36 48	23 12	73494	92408	81086	18914	07592	26506	6
55	7 36 40	4 23 20	9.73513	9.92400	9.81113	10.18887	10.07600	10.26487	5
56	36 32	23 28	73533	92392	81141	18859	07608	26467	4
57	36 24	23 36	73552	92384	81169	18831	07616	26448	3
58	36 16	23 44	73572	92376	81196	18804	07624	26428	2
59	36 8	23 52	73591	92367	81224	18776	07633	26409	1
60	36 0	24 0	73611	92359	81252	18748	07641	26389	0
M	Hour P.M	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 36 0	4 24 0	9.73611	9.92359	9.81252	10.18748	10.07641	10.26389	60
1	35 52	24 8	73630	92351	81279	18721	07649	26370	59
2	35 44	24 16	73650	92343	81307	18693	07657	26350	58
3	35 36	24 24	73669	92335	81335	18665	07665	26331	57
4	35 28	24 32	73689	92326	81362	18638	07674	26311	56
5	7 35 20	4 24 40	9.73708	9.92318	9.81390	10.18610	10.07682	10.26292	55
6	35 12	24 48	73727	92310	81418	18582	07690	26273	54
7	35 4	24 56	73747	92302	81445	18555	07698	26253	53
8	34 56	25 4	73766	92293	81473	18527	07707	26234	52
9	34 48	25 12	73785	92285	81500	18500	07715	26215	51
10	7 34 40	4 25 20	9.73805	9.92277	9.81528	10.18472	10.07723	10.26195	50
11	34 32	25 28	73824	92269	81556	18444	07731	26176	49
12	34 24	25 36	73843	92260	81583	18417	07740	26157	48
13	34 16	25 44	73863	92252	81611	18389	07748	26137	47
14	34 8	25 52	73882	92244	81638	18362	07756	26118	46
15	7 34 0	4 26 0	9.73901	9.92235	9.81666	10.18334	10.07765	10.26099	45
16	33 52	26 8	73921	92227	81693	18307	07773	26079	44
17	33 44	26 16	73940	92219	81721	18279	07781	26060	43
18	33 36	26 24	73959	92211	81748	18252	07789	26041	42
19	33 28	26 32	73978	92202	81776	18224	07798	26022	41
20	7 33 20	4 26 40	9.73997	9.92194	9.81803	10.18197	10.07806	10.26003	40
21	33 12	26 48	74017	92186	81831	18169	07814	25983	39
22	33 4	26 56	74036	92177	81858	18142	07823	25964	38
23	32 56	27 4	74055	92169	81886	18114	07831	25945	37
24	32 48	27 12	74074	92161	81913	18087	07839	25926	36
25	7 32 40	4 27 20	9.74093	9.92152	9.81941	10.18059	10.07848	10.25907	35
26	32 32	27 28	74113	92144	81968	18032	07856	25887	34
27	32 24	27 36	74132	92136	81996	18004	07864	25868	33
28	32 16	27 44	74151	92127	82023	17977	07873	25849	32
29	32 8	27 52	74170	92119	82051	17949	07881	25830	31
30	7 32 0	4 28 0	9.74189	9.92111	9.82078	10.17922	10.07889	10.25811	30
31	31 52	28 8	74208	92102	82106	17894	07898	25792	29
32	31 44	28 16	74227	92094	82133	17867	07906	25773	28
33	31 36	28 24	74246	92086	82161	17839	07914	25754	27
34	31 28	28 32	74265	92077	82188	17812	07923	25735	26
35	7 31 20	4 28 40	9.74284	9.92069	9.82215	10.17785	10.07931	10.25716	25
36	31 12	28 48	74303	92060	82243	17757	07940	25697	24
37	31 4	28 56	74322	92052	82270	17730	07948	25678	23
38	30 56	29 4	74341	92044	82298	17702	07956	25659	22
39	30 48	29 12	74360	92035	82325	17675	07965	25640	21
40	7 30 40	4 29 20	9.74379	9.92027	9.82352	10.17648	10.07973	10.25621	20
41	30 32	29 28	74398	92018	82380	17620	07982	25602	19
42	30 24	29 36	74417	92010	82407	17593	07990	25583	18
43	30 16	29 44	74436	92002	82435	17565	07998	25564	17
44	30 8	29 52	74455	91993	82462	17538	08007	25545	16
45	7 30 0	4 30 0	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	15
46	29 52	30 8	74493	91976	82517	17483	08024	25507	14
47	29 44	30 16	74512	91968	82544	17456	08032	25488	13
48	29 36	30 24	74531	91959	82571	17429	08041	25469	12
49	29 28	30 32	74549	91951	82599	17401	08049	25451	11
50	7 29 20	4 30 40	9.74568	9.91942	9.82626	10.17374	10.08058	10.25432	10
51	29 12	30 48	74587	91934	82653	17347	08066	25413	9
52	29 4	30 56	74606	91925	82681	17319	08075	25394	8
53	28 56	31 4	74625	91917	82708	17292	08083	25375	7
54	28 48	31 12	74644	91908	82735	17265	08092	25356	6
55	7 28 40	4 31 20	9.74662	9.91900	9.82762	10.17238	10.08100	10.25338	5
56	28 32	31 28	74681	91891	82790	17210	08109	25319	4
57	28 24	31 36	74700	91883	82817	17183	08117	25300	3
58	28 16	31 44	74719	91874	82844	17156	08126	25281	2
59	28 8	31 52	74737	91866	82871	17129	08134	25263	1
60	28 0	32 0	74756	91857	82899	17101	08143	25244	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour A.M	Hour P.M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 28 0	4 32 0	9.74756	9.91857	9.82899	10.17101	10.08143	10.25244	60
1	27 52	32 8	74775	91849	82926	17074	08151	25225	59
2	27 44	32 16	74794	91840	82953	17047	08160	25206	58
3	27 36	32 24	74812	91832	82980	17020	08168	25188	57
4	27 28	32 32	74831	91823	83008	16992	08177	25169	56
5	7 27 20	4 32 40	9.74850	9.91815	9.83035	10.16965	10.08185	10.25150	55
6	27 12	32 48	74868	91806	83062	16938	08194	25132	54
7	27 4	32 56	74887	91798	83089	16911	08202	25113	53
8	26 56	33 4	74906	91789	83117	16883	08211	25094	52
9	26 48	33 12	74924	91781	83144	16856	08219	25076	51
10	7 26 40	4 33 20	9.74943	9.91772	9.83171	10.16829	10.08228	10.25057	50
11	26 32	33 28	74961	91763	83198	16802	08237	25039	49
12	26 24	33 36	74980	91755	83225	16775	08245	25020	48
13	26 16	33 44	74999	91746	83252	16748	08254	25001	47
14	26 8	33 52	75017	91738	83280	16720	08262	24983	46
15	7 26 0	4 34 0	9.75036	9.91729	9.83307	10.16693	10.08271	10.24964	45
16	25 52	34 8	75054	91720	83334	16666	08280	24946	44
17	25 44	34 16	75073	91712	83361	16639	08288	24927	43
18	25 36	34 24	75091	91703	83388	16612	08297	24909	42
19	25 28	34 32	75110	91695	83415	16585	08305	24890	41
20	7 25 20	4 34 40	9.75128	9.91686	9.83442	10.16558	10.08314	10.24872	40
21	25 12	34 48	75147	91677	83470	16530	08323	24853	39
22	25 4	34 56	75165	91669	83497	16503	08331	24835	38
23	24 56	35 4	75184	91660	83524	16476	08340	24816	37
24	24 48	35 12	75202	91651	83551	16449	08349	24798	36
25	7 24 40	4 35 20	9.75221	9.91643	9.83578	10.16422	10.08357	10.24779	35
26	24 32	35 28	75239	91634	83605	16395	08366	24761	34
27	24 24	35 36	75258	91625	83632	16368	08375	24742	33
28	24 16	35 44	75276	91617	83659	16341	08383	24724	32
29	24 8	35 52	75294	91608	83686	16314	08392	24706	31
30	7 24 0	4 36 0	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
31	23 52	36 8	75331	91591	83740	16260	08409	24669	29
32	23 44	36 16	75350	91582	83768	16232	08418	24650	28
33	23 36	36 24	75368	91573	83795	16205	08427	24632	27
34	23 28	36 32	75386	91565	83822	16178	08435	24614	26
35	7 23 20	4 36 40	9.75405	9.91556	9.83849	10.16151	10.08444	10.24595	25
36	23 12	36 48	75423	91547	83876	16124	08453	24577	24
37	23 4	36 56	75441	91538	83903	16097	08462	24559	23
38	22 56	37 4	75459	91530	83930	16070	08470	24541	22
39	22 48	37 12	75478	91521	83957	16043	08479	24522	21
40	7 22 40	4 37 20	9.75496	9.91512	9.83984	10.16016	10.08488	10.24504	20
41	22 32	37 28	75514	91504	84011	15989	08496	24486	19
42	22 24	37 36	75533	91495	84038	15962	08505	24467	18
43	22 16	37 44	75551	91486	84065	15935	08514	24449	17
44	22 8	37 52	75569	91477	84092	15908	08523	24431	16
45	7 22 0	4 38 0	9.75587	9.91469	9.84119	10.15881	10.08531	10.24413	15
46	21 52	38 8	75605	91460	84146	15854	08540	24395	14
47	21 44	38 16	75624	91451	84173	15827	08549	24376	13
48	21 36	38 24	75642	91442	84200	15800	08558	24358	12
49	21 28	38 32	75660	91433	84227	15773	08567	24340	11
50	7 21 20	4 38 40	9.75678	9.91425	9.84254	10.15746	10.08575	10.24322	10
51	21 12	38 48	75696	91416	84280	15720	08584	24304	9
52	21 4	38 56	75714	91407	84307	15693	08593	24286	8
53	20 56	39 4	75733	91398	84334	15666	08602	24267	7
54	20 48	39 12	75751	91389	84361	15639	08611	24249	6
55	7 20 40	4 39 20	9.75769	9.91381	9.84388	10.15612	10.08619	10.24231	5
56	20 32	39 28	75787	91372	84415	15585	08628	24213	4
57	20 24	39 36	75805	91363	84442	15558	08637	24195	3
58	20 16	39 44	75823	91354	84469	15531	08646	24177	2
59	20 8	39 52	75841	91345	84496	15504	08655	24159	1
60	20 0	40 0	75859	91336	84523	15477	08664	24141	0
M	Hour P.M	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 20 0	4 40 0	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	60
1	19 52	40 8	75877	91328	84550	15450	08672	24123	59
2	19 44	40 16	75895	91319	84576	15424	08681	24105	58
3	19 36	40 24	75913	91310	84603	15397	08690	24087	57
4	19 28	40 32	75931	91301	84630	15370	08699	24069	56
5	7 19 20	4 40 40	9.75949	9.91292	9.84657	10.15343	10.08708	10.24051	55
6	19 12	40 48	75967	91283	84684	15316	08717	24033	54
7	19 4	40 56	75985	91274	84711	15289	08726	24015	53
8	18 56	41 4	76003	91266	84738	15262	08734	23997	52
9	18 48	41 12	76021	91257	84764	15236	08743	23979	51
10	7 18 40	4 41 20	9.76039	9.91248	9.84791	10.15209	10.08752	10.23961	50
11	18 32	41 28	76057	91239	84818	15182	08761	23943	49
12	18 24	41 36	76075	91230	84845	15155	08770	23925	48
13	18 16	41 44	76093	91221	84872	15128	08779	23907	47
14	18 8	41 52	76111	91212	84899	15101	08788	23889	46
15	7 18 0	4 42 0	9.76129	9.91203	9.84925	10.15075	10.08797	10.23871	45
16	17 52	42 8	76146	91194	84952	15048	08806	23854	44
17	17 44	42 16	76164	91185	84979	15021	08815	23836	43
18	17 36	42 24	76182	91176	85006	14994	08824	23818	42
19	17 28	42 32	76200	91167	85033	14967	08833	23800	41
20	7 17 20	4 42 40	9.76218	9.91158	9.85059	10.14941	10.08842	10.23782	40
21	17 12	42 48	76236	91149	85086	14914	08851	23764	39
22	17 4	42 56	76253	91141	85113	14887	08859	23747	38
23	16 56	43 4	76271	91132	85140	14860	08868	23729	37
24	16 48	43 12	76289	91123	85166	14834	08877	23711	36
25	7 16 40	4 43 20	9.76307	9.91114	9.85193	10.14807	10.08886	10.23693	35
26	16 32	43 28	76324	91105	85220	14780	08895	23676	34
27	16 24	43 36	76342	91096	85247	14753	08904	23658	33
28	16 16	43 44	76360	91087	85273	14727	08913	23640	32
29	16 8	43 52	76378	91078	85300	14700	08922	23622	31
30	7 16 0	4 44 0	9.76395	9.91069	9.85327	10.14673	10.08931	10.23605	30
31	15 52	44 8	76413	91060	85354	14646	08940	23587	29
32	15 44	44 16	76431	91051	85380	14620	08949	23569	28
33	15 36	44 24	76448	91042	85407	14593	08958	23552	27
34	15 28	44 32	76466	91033	85434	14566	08967	23534	26
35	7 15 20	4 44 40	9.76484	9.91023	9.85460	10.14540	10.08977	10.23516	25
36	15 12	44 48	76501	91014	85487	14513	08986	23499	24
37	15 4	44 56	76519	91005	85514	14486	08995	23481	23
38	14 56	45 4	76537	90996	85540	14460	09004	23463	22
39	14 48	45 12	76554	90987	85567	14433	09013	23446	21
40	7 14 40	4 45 20	9.76572	9.90978	9.85594	10.14406	10.09022	10.23428	20
41	14 32	45 28	76590	90969	85620	14380	09031	23410	19
42	14 24	45 36	76607	90960	85647	14353	09040	23393	18
43	14 16	45 44	76625	90951	85674	14326	09049	23375	17
44	14 8	45 52	76642	90942	85700	14300	09058	23358	16
45	7 14 0	4 46 0	9.76660	9.90933	9.85727	10.14273	10.09067	10.23340	15
46	13 52	46 8	76677	90924	85754	14246	09076	23323	14
47	13 44	46 16	76695	90915	85780	14220	09085	23305	13
48	13 36	46 24	76712	90906	85807	14193	09094	23288	12
49	13 28	46 32	76730	90896	85834	14166	09104	23270	11
50	7 13 20	4 46 40	9.76747	9.90887	9.85860	10.14140	10.09113	10.23253	10
51	13 12	46 48	76765	90878	85887	14113	09122	23235	9
52	13 4	46 56	76782	90869	85913	14087	09131	23218	8
53	12 56	47 4	76800	90860	85940	14060	09140	23200	7
54	12 48	47 12	76817	90851	85967	14033	09149	23183	6
55	7 12 40	4 47 20	9.76835	9.90842	9.85993	10.14007	10.09158	10.23165	5
56	12 32	47 28	76852	90832	86020	13980	09168	23148	4
57	12 24	47 36	76870	90823	86046	13954	09177	23130	3
58	12 16	47 44	76887	90814	86073	13927	09186	23113	2
59	12 8	47 52	76904	90805	86100	13900	09195	23096	1
60	12 0	48 0	76922	90796	86126	13874	09204	23078	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 12 0	4 48 0	9.76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
1	11 52	48 8	76939	90787	86153	13847	09213	23061	59
2	11 44	48 16	76957	90777	86179	13821	09223	23043	58
3	11 36	48 24	76974	90768	86206	13794	09232	23026	57
4	11 28	48 32	76991	90759	86232	13768	09241	23009	56
5	7 11 20	4 48 40	9.77009	9.90750	9.86259	10.13741	10.09250	10.22991	55
6	11 12	48 48	77026	90741	86285	13715	09259	22974	54
7	11 4	48 56	77043	90731	86312	13688	09269	22957	53
8	10 56	49 4	77061	90722	86338	13662	09278	22939	52
9	10 48	49 12	77078	90713	86365	13635	09287	22922	51
10	7 10 40	4 49 20	9.77095	9.90704	9.86392	10.13608	10.09296	10.22905	50
11	10 32	49 28	77112	90694	86418	13582	09306	22888	49
12	10 24	49 36	77130	90685	86445	13555	09315	22870	48
13	10 16	49 44	77147	90676	86471	13529	09324	22853	47
14	10 8	49 52	77164	90667	86498	13502	09333	22836	46
15	7 10 0	4 50 0	9.77181	9.90657	9.86524	10.13476	10.09343	10.22819	45
16	9 52	50 8	77199	90648	86551	13449	09352	22801	44
17	9 44	50 16	77216	90639	86577	13423	09361	22784	43
18	9 36	50 24	77233	90630	86603	13397	09370	22767	42
19	9 28	50 32	77250	90620	86630	13370	09380	22750	41
20	7 9 20	4 50 40	9.77268	9.90611	9.86656	10.13344	10.09389	10.22732	40
21	9 12	50 48	77285	90602	86683	13317	09398	22715	39
22	9 4	50 56	77302	90592	86709	13291	09408	22698	38
23	8 56	51 4	77319	90583	86736	13264	09417	22681	37
24	8 48	51 12	77336	90574	86762	13238	09426	22664	36
25	7 8 40	4 51 20	9.77353	9.90565	9.86789	10.13211	10.09435	10.22647	35
26	8 32	51 28	77370	90555	86815	13185	09445	22630	34
27	8 24	51 36	77387	90546	86842	13158	09454	22613	33
28	8 16	51 44	77405	90537	86868	13132	09463	22595	32
29	8 8	51 52	77422	90527	86894	13106	09473	22578	31
30	7 8 0	4 52 0	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
31	7 52	52 8	77456	90509	86947	13053	09491	22544	29
32	7 44	52 16	77473	90499	86974	13026	09501	22527	28
33	7 36	52 24	77490	90490	87000	13000	09510	22510	27
34	7 28	52 32	77507	90480	87027	12973	09520	22493	26
35	7 7 20	4 52 40	9.77524	9.90471	9.87053	10.12947	10.09529	10.22476	25
36	7 12	52 48	77541	90462	87079	12921	09538	22459	24
37	7 4	52 56	77558	90452	87106	12894	09548	22442	23
38	6 56	53 4	77575	90443	87132	12868	09557	22425	22
39	6 48	53 12	77592	90434	87158	12842	09566	22408	21
40	7 6 40	4 53 20	9.77609	9.90424	9.87185	10.12815	10.09576	10.22391	20
41	6 32	53 28	77626	90415	87211	12789	09585	22374	19
42	6 24	53 36	77643	90405	87238	12762	09595	22357	18
43	6 16	53 44	77660	90396	87264	12736	09604	22340	17
44	6 8	53 52	77677	90386	87290	12710	09614	22323	16
45	7 6 0	4 54 0	9.77694	9.90377	9.87317	10.12683	10.09623	10.22306	15
46	5 52	54 8	77711	90368	87343	12657	09632	22289	14
47	5 44	54 16	77728	90358	87369	12631	09642	22272	13
48	5 36	54 24	77744	90349	87396	12604	09651	22256	12
49	5 28	54 32	77761	90339	87422	12578	09661	22239	11
50	7 5 20	4 54 40	9.77778	9.90330	9.87448	10.12552	10.09670	10.22222	10
51	5 12	54 48	77795	90320	87475	12525	09680	22205	9
52	5 4	54 56	77812	90311	87501	12499	09689	22188	8
53	4 56	55 4	77829	90301	87527	12473	09699	22171	7
54	4 48	55 12	77846	90292	87554	12446	09708	22154	6
55	7 4 40	4 55 20	9.77862	9.90282	9.87580	10.12420	10.09718	10.22138	5
56	4 32	55 28	77879	90273	87606	12394	09727	22121	4
57	4 24	55 36	77896	90263	87633	12367	09737	22104	3
58	4 16	55 44	77913	90254	87659	12341	09746	22087	2
59	4 8	55 52	77930	90244	87685	12315	09756	22070	1
60	4 0	56 0	77946	90235	87711	12289	09765	22054	0
M	Hour PM	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 4 0	4 56 0	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	60
1	3 52	56 8	77963	90225	87738	12262	09775	22037	59
2	3 44	56 16	77980	90216	87764	12236	09784	22020	58
3	3 36	56 24	77997	90206	87790	12210	09794	22003	57
4	3 28	56 32	78013	90197	87817	12183	09803	21987	56
5	7 3 20	4 56 40	9.78030	9.90187	9.87843	10.12157	10.09813	10.21970	55
6	3 12	56 48	78047	90178	87869	12131	09822	21953	54
7	3 4	56 56	78063	90168	87895	12105	09832	21937	53
8	2 56	57 4	78080	90159	87922	12078	09841	21920	52
9	2 48	57 12	78097	90149	87948	12052	09851	21903	51
10	7 2 40	4 57 20	9.78113	9.90139	9.87974	10.12026	10.09861	10.21887	50
11	2 32	57 28	78130	90130	88000	12000	09870	21870	49
12	2 24	57 36	78147	90120	88027	11973	09880	21853	48
13	2 16	57 44	78163	90111	88053	11947	09889	21837	47
14	2 8	57 52	78180	90101	88079	11921	09899	21820	46
15	7 2 0	4 58 0	9.78197	9.90091	9.88105	10.11895	10.09909	10.21803	45
16	1 52	58 8	78213	90082	88131	11869	09918	21787	44
17	1 44	58 16	78230	90072	88158	11842	09928	21770	43
18	1 36	58 24	78246	90063	88184	11816	09937	21754	42
19	1 28	58 32	78263	90053	88210	11790	09947	21737	41
20	7 1 20	4 58 40	9.78280	9.90043	9.88236	10.11764	10.09957	10.21720	40
21	1 12	58 48	78296	90034	88262	11738	09966	21704	39
22	1 4	58 56	78313	90024	88289	11711	09976	21687	38
23	0 56	59 4	78329	90014	88315	11685	09986	21671	37
24	0 48	59 12	78346	90005	88341	11659	09995	21654	36
25	7 0 40	4 59 20	9.78362	9.89995	9.88367	10.11633	10.10005	10.21638	35
26	0 32	59 28	78379	89985	88393	11607	10015	21621	34
27	0 24	59 36	78395	89976	88420	11580	10024	21605	33
28	0 16	59 44	78412	89966	88446	11554	10034	21588	32
29	0 8	59 52	78428	89956	88472	11528	10044	21572	31
30	7 0 0	5 0 0	9.78445	9.89947	9.88498	10.11502	10.10053	10.21555	30
31	6 59 52	0 8	78461	89937	88524	11476	10063	21539	29
32	59 44	0 16	78478	89927	88550	11450	10073	21522	28
33	59 36	0 24	78494	89918	88577	11423	10082	21506	27
34	59 28	0 32	78510	89908	88603	11397	10092	21490	26
35	6 59 20	5 0 40	9.78527	9.89898	9.88629	10.11371	10.10102	10.21473	25
36	59 12	0 48	78543	89888	88655	11345	10112	21457	24
37	59 4	0 56	78560	89879	88681	11319	10121	21440	23
38	58 56	1 4	78576	89869	88707	11293	10131	21424	22
39	58 48	1 12	78592	89859	88733	11267	10141	21408	21
40	6 58 40	5 1 20	9.78609	9.89849	9.88759	10.11241	10.10151	10.21391	20
41	58 32	1 28	78625	89840	88786	11214	10160	21375	19
42	58 24	1 36	78642	89830	88812	11188	10170	21358	18
43	58 16	1 44	78658	89820	88838	11162	10180	21342	17
44	58 8	1 52	78674	89810	88864	11136	10190	21326	16
45	6 58 0	5 2 0	9.78691	9.89801	9.88890	10.11110	10.10199	10.21309	15
46	57 52	2 8	78707	89791	88916	11084	10209	21293	14
47	57 44	2 16	78723	89781	88942	11058	10219	21277	13
48	57 36	2 24	78739	89771	88968	11032	10229	21261	12
49	57 28	2 32	78756	89761	88994	11006	10239	21244	11
50	6 57 20	5 2 40	9.78772	9.89752	9.89020	10.10980	10.10248	10.21228	10
51	57 12	2 48	78788	89742	89046	10954	10258	21212	9
52	57 4	2 56	78805	89732	89073	10927	10268	21195	8
53	56 56	3 4	78821	89722	89099	10901	10278	21179	7
54	56 48	3 12	78837	89712	89125	10875	10288	21163	6
55	6 56 40	5 3 20	9.78853	9.89702	9.89151	10.10849	10.10298	10.21147	5
56	56 32	3 28	78869	89693	89177	10823	10307	21131	4
57	56 24	3 36	78886	89683	89203	10797	10317	21114	3
58	56 16	3 44	78902	89673	89229	10771	10327	21098	2
59	56 8	3 52	78918	89663	89255	10745	10337	21082	1
60	56 0	4 0	78934	89653	89281	10719	10347	21066	0
M	Hour P.M	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M.	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M.
0	0 56 0	5 4 0	9.78934	9.89653	9.89281	10.10719	10.10347	10.21066	60
1	55 52	4 8	78950	89643	89307	10693	10357	21050	59
2	55 44	4 16	7896	89633	89333	10667	10367	21033	58
3	55 36	4 24	78983	89624	89359	10641	10376	21017	57
4	55 28	4 32	78999	89614	89385	10615	10386	21001	56
5	6 55 20	5 4 40	9.79015	9.89604	9.89411	10.10589	10.10396	10.20985	55
6	55 12	4 48	79031	89594	89437	10563	10406	20969	54
7	55 4	4 56	79047	89584	89463	10537	10416	20953	53
8	54 56	5 4	79063	89574	89489	10511	10426	20937	52
9	54 48	5 12	79079	89564	89515	10485	10436	20921	51
10	6 54 40	5 5 20	9.79095	9.89554	9.89541	10.10459	10.10446	10.20905	50
11	54 32	5 28	79111	89544	89567	10433	10456	20889	49
12	54 24	5 36	79128	89534	89593	10407	10466	20872	48
13	54 16	5 44	79144	89524	89619	10381	10476	20856	47
14	54 8	5 52	79160	89514	89645	10355	10486	20840	46
15	6 54 0	5 6 0	9.79176	9.89504	9.89671	10.10329	10.10496	10.20824	45
16	53 52	6 8	79192	89495	89697	10303	10505	20808	44
17	53 44	6 16	79208	89485	89723	10277	10515	20792	43
18	53 36	6 24	79224	89475	89749	10251	10525	20776	42
19	53 28	6 32	79240	89465	89775	10225	10535	20760	41
20	6 53 20	5 6 40	9.79256	9.89455	9.89801	10.10199	10.10545	10.20744	40
21	53 12	6 48	79272	89445	89827	10173	10555	20728	39
22	53 4	6 56	79288	89435	89853	10147	10565	20712	38
23	52 56	7 4	79304	89425	89879	10121	10575	20696	37
24	52 48	7 12	79319	89415	89905	10095	10585	20681	36
25	6 52 40	5 7 20	9.79335	9.89405	9.89931	10.10069	10.10595	10.20665	35
26	52 32	7 28	79351	89395	89957	10043	10605	20649	34
27	52 24	7 36	79367	89385	89983	10017	10615	20633	33
28	52 16	7 44	79383	89375	90009	09991	10625	20617	32
29	52 8	7 52	79399	89364	90035	09965	10636	20601	31
30	6 52 0	5 8 0	9.79415	9.89354	9.90061	10.09939	10.10646	10.20585	30
31	51 52	8 8	79431	89344	90086	09914	10656	20569	29
32	51 44	8 16	79447	89334	90112	09888	10666	20553	28
33	51 36	8 24	79463	89324	90138	09862	10676	20537	27
34	51 28	8 32	79478	89314	90164	09836	10686	20522	26
35	6 51 20	5 8 40	9.79494	9.89304	9.90190	10.09810	10.10696	10.20506	25
36	51 12	8 48	79510	89294	90216	09784	10706	20490	24
37	51 4	8 56	79526	89284	90242	09758	10716	20474	23
38	50 56	9 4	79542	89274	90268	09732	10726	20458	22
39	50 48	9 12	79558	89264	90294	09706	10736	20442	21
40	6 50 40	5 9 20	9.79573	9.89254	9.90320	10.09680	10.10746	10.20427	20
41	50 32	9 28	79589	89244	90346	09654	10756	20411	19
42	50 24	9 36	79605	89233	90371	09629	10767	20395	18
43	50 16	9 44	79621	89223	90397	09603	10777	20379	17
44	50 8	9 52	79636	89213	90423	09577	10787	20364	16
45	6 50 0	5 10 0	9.79652	9.89203	9.90449	10.09551	10.10797	10.20348	15
46	49 52	10 8	79668	89193	90475	09525	10807	20332	14
47	49 44	10 16	79684	89183	90501	09499	10817	20316	13
48	49 36	10 24	79699	89173	90527	09473	10827	20301	12
49	49 28	10 32	79715	89162	90553	09447	10838	20285	11
50	6 49 20	5 10 40	9.79731	9.89152	9.90578	10.09422	10.10848	10.20269	10
51	49 12	10 48	79746	89142	90604	09396	10858	20254	9
52	49 4	10 56	79762	89132	90630	09370	10868	20238	8
53	48 56	11 4	79778	89122	90656	09344	10878	20222	7
54	48 48	11 12	79793	89112	90682	09318	10888	20207	6
55	6 48 40	5 11 20	9.79809	9.89101	9.90708	10.09292	10.10899	10.20191	5
56	48 32	11 28	79825	89091	90734	09266	10909	20175	4
57	48 24	11 36	79840	89081	90759	09241	10919	20160	3
58	48 16	11 44	79856	89071	90785	09215	10929	20144	2
59	48 8	11 52	79872	89060	90811	09189	10940	20128	1
60	48 0	12 0	79887	89050	90837	09163	10950	20113	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 48 0	5 12 0	9.79887	9.89050	9.90837	10.09163	10.10950	10.20113	60
1	47 52	12 8	79903	89040	90863	09137	10960	20097	59
2	47 44	12 16	79918	89030	90889	09111	10970	20082	58
3	47 36	12 24	79934	89020	90914	09086	10980	20066	57
4	47 28	12 32	79950	89009	90940	09060	10991	20050	56
5	6 47 20	5 12 40	9.79965	9.88999	9.90966	10.09034	10.11001	10.20035	55
6	47 12	12 48	79981	88989	90992	09008	11011	20019	54
7	47 4	12 56	79996	88978	91018	08982	11022	20004	53
8	46 56	13 4	80012	88968	91043	08957	11032	19988	52
9	46 48	13 12	80027	88958	91069	08931	11042	19973	51
10	6 46 40	5 13 20	9.80043	9.88948	9.91095	10.08905	10.11052	10.19957	50
11	46 32	13 28	80058	88937	91121	08879	11063	19942	49
12	46 24	13 36	80074	88927	91147	08853	11073	19926	48
13	46 16	13 44	80089	88917	91172	08828	11083	19911	47
14	46 8	13 52	80105	88906	91198	08802	11094	19895	46
15	6 46 0	5 14 0	9.80120	9.88896	9.91224	10.08776	10.11104	10.19880	45
16	45 52	14 8	80136	88886	91250	08750	11114	19864	44
17	45 44	14 16	80151	88875	91276	08724	11125	19849	43
18	45 36	14 24	80166	88865	91301	08699	11135	19834	42
19	45 28	14 32	80182	88855	91327	08673	11145	19818	41
20	6 45 20	5 14 40	9.80197	9.88844	9.91353	10.08647	10.11156	10.19803	40
21	45 12	14 48	80213	88834	91379	08621	11166	19787	39
22	45 4	14 56	80228	88824	91404	08596	11176	19772	38
23	44 56	15 4	80244	88813	91430	08570	11187	19756	37
24	44 48	15 12	80259	88803	91456	08544	11197	19741	36
25	6 44 40	5 15 20	9.80274	9.88793	9.91482	10.08518	10.11207	10.19726	35
26	44 32	15 28	80290	88782	91507	08493	11218	19710	34
27	44 24	15 36	80305	88772	91533	08467	11228	19695	33
28	44 16	15 44	80320	88761	91559	08441	11239	19680	32
29	44 8	15 52	80336	88751	91585	08415	11249	19664	31
30	6 44 0	5 16 0	9.80351	9.88741	9.91610	10.08390	10.11259	10.19649	30
31	43 52	16 8	80366	88730	91636	08364	11270	19634	29
32	43 44	16 16	80382	88720	91662	08338	11280	19618	28
33	43 36	16 24	80397	88709	91688	08312	11291	19603	27
34	43 28	16 32	80412	88699	91713	08287	11301	19588	26
35	6 43 20	5 16 40	9.80428	9.88688	9.91739	10.08261	10.11312	10.19572	25
36	43 12	16 48	80443	88678	91765	08235	11322	19557	24
37	43 4	16 56	80458	88668	91791	08209	11332	19542	23
38	42 56	17 4	80473	88657	91816	08184	11343	19527	22
39	42 48	17 12	80489	88647	91842	08158	11353	19511	21
40	6 42 40	5 17 20	9.80504	9.88636	9.91868	10.08132	10.11364	10.19496	20
41	42 32	17 28	80519	88626	91893	08107	11374	19481	19
42	42 24	17 36	80534	88615	91919	08081	11385	19466	18
43	42 16	17 44	80550	88605	91945	08055	11395	19450	17
44	42 8	17 52	80565	88594	91971	08029	11406	19435	16
45	6 42 0	5 18 0	9.80580	9.88584	9.91996	10.08004	10.11416	10.19420	15
46	41 52	18 8	80595	88573	92022	07978	11427	19405	14
47	41 44	18 16	80610	88563	92048	07952	11437	19390	13
48	41 36	18 24	80625	88552	92073	07927	11448	19375	12
49	41 28	18 32	80641	88542	92099	07901	11458	19359	11
50	6 41 20	5 18 40	9.80656	9.88531	9.92125	10.07875	10.11469	10.19344	10
51	41 12	18 48	80671	88521	92150	07850	11479	19329	9
52	41 4	18 56	80686	88510	92176	07824	11490	19314	8
53	40 56	19 4	80701	88499	92202	07798	11501	19299	7
54	40 48	19 12	80716	88489	92227	07773	11511	19284	6
55	6 40 40	5 19 20	9.80731	9.88478	9.92253	10.07747	10.11522	10.19269	5
56	40 32	19 28	80746	88468	92279	07721	11532	19254	4
57	40 24	19 36	80762	88457	92304	07696	11543	19238	3
58	40 16	19 44	80777	88447	92330	07670	11553	19223	2
59	40 8	19 52	80792	88436	92356	07644	11564	19208	1
60	40 0	20 0	80807	88425	92381	07619	11575	19193	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A M	Hour P M	Sine.	Co-fine.	Tangent.	Co-tang.	Secant.	Co-fecant.	M
0	6 40 0	5 20 0	9.80807	9.88425	9.92381	10.07619	10.11575	10.19193	60
1	39 52	20 8	80822	88415	92407	07593	11585	19178	59
2	39 44	20 16	80837	88404	92433	07567	11596	19163	58
3	39 36	20 24	80852	88394	92458	07542	11606	19148	57
4	39 28	20 32	80867	88383	92484	07516	11617	19133	56
5	6 39 20	5 20 40	9.80882	9.88372	9.92510	10.07490	10.11628	10.19118	55
6	39 12	20 48	80897	88362	92535	07465	11638	19103	54
7	39 4	20 56	80912	88351	92561	07439	11649	19088	53
8	38 56	21 4	80927	88340	92587	07413	11660	19073	52
9	38 48	21 12	80942	88330	92612	07388	11670	19058	51
10	6 38 40	5 21 20	9.80957	9.88319	9.92638	10.07362	10.11681	10.19043	50
11	38 32	21 28	80972	88308	92663	07337	11692	19028	49
12	38 24	21 36	80987	88298	92689	07311	11702	19013	48
13	38 16	21 44	81002	88287	92715	07285	11713	18998	47
14	38 8	21 52	81017	88276	92740	07260	11724	18983	46
15	6 38 0	5 22 0	9.81032	9.88266	9.92766	10.07234	10.11734	10.18968	45
16	37 52	22 8	81047	88255	92792	07208	11745	18953	44
17	37 44	22 16	81061	88244	92817	07183	11756	18939	43
18	37 36	22 24	81076	88234	92843	07157	11766	18924	42
19	37 28	22 32	81091	88223	92868	07132	11777	18909	41
20	6 37 20	5 22 40	9.81106	9.88212	9.92894	10.07106	10.11788	10.18894	40
21	37 12	22 48	81121	88201	92920	07080	11799	18879	39
22	37 4	22 56	81136	88191	92945	07055	11809	18864	38
23	36 56	23 4	81151	88180	92971	07029	11820	18849	37
24	36 48	23 12	81166	88169	92996	07004	11831	18834	36
25	6 36 40	5 23 20	9.81180	9.88158	9.93022	10.06978	10.11842	10.18820	35
26	36 32	23 28	81195	88148	93048	06952	11852	18805	34
27	36 24	23 36	81210	88137	93073	06927	11863	18790	33
28	36 16	23 44	81225	88126	93099	06901	11874	18775	32
29	36 8	23 52	81240	88115	93124	06876	11885	18760	31
30	6 36 0	5 24 0	9.81254	9.88105	9.93150	10.06850	10.11895	10.18746	30
31	35 52	24 8	81269	88094	93175	06825	11906	18731	29
32	35 44	24 16	81284	88083	93201	06799	11917	18716	28
33	35 36	24 24	81299	88072	93227	06773	11928	18701	27
34	35 28	24 32	81314	88061	93252	06748	11939	18686	26
35	6 35 20	5 24 40	9.81328	9.88051	9.93278	10.06722	10.11949	10.18672	25
36	35 12	24 48	81343	88040	93303	06697	11960	18657	24
37	35 4	24 56	81358	88029	93329	06671	11971	18642	23
38	34 56	25 4	81372	88018	93354	06646	11982	18628	22
39	34 48	25 12	81387	88007	93380	06620	11993	18613	21
40	6 34 40	5 25 20	9.81402	9.87996	9.93406	10.06594	10.12004	10.18598	20
41	34 32	25 28	81417	87985	93431	06569	12015	18583	19
42	34 24	25 36	81431	87975	93457	06543	12025	18569	18
43	34 16	25 44	81446	87964	93482	06518	12036	18554	17
44	34 8	25 52	81461	87953	93508	06492	12047	18539	16
45	6 34 0	5 26 0	9.81475	9.87942	9.93533	10.06467	10.12058	10.18525	15
46	33 52	26 8	81490	87931	93559	06441	12069	18510	14
47	33 44	26 16	81505	87920	93584	06416	12080	18495	13
48	33 36	26 24	81519	87909	93610	06390	12091	18481	12
49	33 28	26 32	81534	87898	93636	06364	12102	18466	11
50	6 33 20	5 26 40	9.81549	9.87887	9.93661	10.06339	10.12113	10.18451	10
51	33 12	26 48	81563	87877	93687	06313	12123	18437	9
52	33 4	26 56	81578	87866	93712	06288	12134	18422	8
53	32 56	27 4	81592	87855	93738	06262	12145	18408	7
54	32 48	27 12	81607	87844	93763	06237	12156	18393	6
55	6 32 40	5 27 20	9.81622	9.87833	9.93789	10.06211	10.12167	10.18378	5
56	32 32	27 28	81636	87822	93814	06186	12178	18364	4
57	32 24	27 36	81651	87811	93840	06160	12189	18349	3
58	32 16	27 44	81665	87800	93865	06135	12200	18335	2
59	32 8	27 52	81680	87789	93891	06109	12211	18320	1
60	32 0	28 0	81694	87778	93916	06084	12222	18306	0
M	Hour P M	Hour A M	Co-fine.	Sine.	Co-tang.	Tangent.	Co-fecant	Secant.	M

M	Hour A.M	Hour P.M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 32 0	5 28 0	9.81694	9.87778	9.93916	10.06084	10.12222	10.18306	60
1	31 52	28 8	81709	87767	93942	06058	12233	18291	59
2	31 44	28 16	81723	87756	93967	06033	12244	18277	58
3	31 36	28 24	81738	87745	93993	06007	12255	18262	57
4	31 28	28 32	81752	87734	94018	05982	12266	18248	56
5	6 31 20	5 28 40	9.81767	9.87723	9.94044	10.05956	10.12277	10.18233	55
6	31 12	28 48	81781	87712	94069	05931	12288	18219	54
7	31 4	28 56	81796	87701	94095	05905	12299	18204	53
8	30 56	29 4	81810	87690	94120	05880	12310	18190	52
9	30 48	29 12	81825	87679	94146	05854	12321	18175	51
10	6 30 40	5 29 20	9.81839	9.87668	9.94171	10.05829	10.12332	10.18161	50
11	30 32	29 28	81854	87657	94197	05803	12343	18146	49
12	30 24	29 36	81868	87646	94222	05778	12354	18132	48
13	30 16	29 44	81882	87635	94248	05752	12365	18118	47
14	30 8	29 52	81897	87624	94273	05727	12376	18103	46
15	6 30 0	5 30 0	9.81911	9.87613	9.94299	10.05701	10.12387	10.18089	45
16	29 52	30 8	81926	87601	94324	05676	12399	18074	44
17	29 44	30 16	81940	87590	94350	05650	12410	18060	43
18	29 36	30 24	81955	87579	94375	05625	12421	18045	42
19	29 28	30 32	81969	87568	94401	05599	12432	18031	41
20	6 29 20	5 30 40	9.81983	9.87557	9.94426	10.05574	10.12443	10.18017	40
21	29 12	30 48	81998	87546	94452	05548	12454	18002	39
22	29 4	30 56	82012	87535	94477	05523	12465	17988	38
23	28 56	31 4	82026	87524	94503	05497	12476	17974	37
24	28 48	31 12	82041	87513	94528	05472	12487	17959	36
25	6 28 40	5 31 20	9.82055	9.87501	9.94554	10.05446	10.12499	10.17945	35
26	28 32	31 28	82069	87490	94579	05421	12510	17931	34
27	28 24	31 36	82084	87479	94604	05396	12521	17916	33
28	28 16	31 44	82098	87468	94630	05370	12532	17902	32
29	28 8	31 52	82112	87457	94655	05345	12543	17888	31
30	6 28 0	5 32 0	9.82126	9.87446	9.94681	10.05319	10.12554	10.17874	30
31	27 52	32 8	82141	87434	94706	05294	12566	17859	29
32	27 44	32 16	82155	87423	94732	05268	12577	17845	28
33	27 36	32 24	82169	87412	94757	05243	12588	17831	27
34	27 28	32 32	82184	87401	94783	05217	12599	17816	26
35	6 27 20	5 32 40	9.82198	9.87390	9.94808	10.05192	10.12610	10.17802	25
36	27 12	32 48	82212	87378	94834	05166	12622	17788	24
37	27 4	32 56	82226	87367	94859	05141	12633	17774	23
38	26 56	33 4	82240	87356	94884	05116	12644	17760	22
39	26 48	33 12	82255	87345	94910	05090	12655	17745	21
40	6 26 40	5 33 20	9.82269	9.87334	9.94935	10.05065	10.12666	10.17731	20
41	26 32	33 28	82283	87322	94961	05039	12678	17717	19
42	26 24	33 36	82297	87311	94986	05014	12689	17703	18
43	26 16	33 44	82311	87300	95012	04988	12700	17689	17
44	26 8	33 52	82326	87288	95037	04963	12712	17674	16
45	6 26 0	5 34 0	9.82340	9.87277	9.95062	10.04938	10.12723	10.17660	15
46	25 52	34 8	82354	87266	95088	04912	12734	17646	14
47	25 44	34 16	82368	87255	95113	04887	12745	17632	13
48	25 36	34 24	82382	87243	95139	04861	12757	17618	12
49	25 28	34 32	82396	87232	95164	04836	12768	17604	11
50	6 25 20	5 34 40	9.82410	9.87221	9.95190	10.04810	10.12779	10.17590	10
51	25 12	34 48	82424	87209	95215	04785	12791	17576	9
52	25 4	34 56	82439	87198	95240	04760	12802	17561	8
53	24 56	35 4	82453	87187	95266	04734	12813	17547	7
54	24 48	35 12	82467	87175	95291	04709	12825	17533	6
55	6 24 40	5 35 20	9.82481	9.87164	9.95317	10.04683	10.12836	10.17519	5
56	24 32	35 28	82495	87153	95342	04658	12847	17505	4
57	24 24	35 36	82509	87141	95368	04632	12859	17491	3
58	24 16	35 44	82523	87130	95393	04607	12870	17477	2
59	24 8	35 52	82537	87119	95418	04582	12881	17463	1
60	24 0	36 0	82551	87107	95444	04556	12893	17449	0
M	Hour P.M	Hour A.M	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 24 0	5 36 0	9.82551	9.87107	9.95444	10.04556	10.12893	10.17449	60
1	23 52	36 8	82565	87096	95469	04531	12904	17435	59
2	23 44	36 16	82579	87085	95495	04505	12915	17421	58
3	23 36	36 24	82593	87073	95520	04480	12927	17407	57
4	23 28	36 32	82607	87062	95545	04455	12938	17393	56
5	6 23 20	5 36 40	9.82621	9.87050	9.95571	10.04429	10.12950	10.17379	55
6	23 12	36 48	82635	87039	95596	04404	12961	17365	54
7	23 4	36 56	82649	87028	95622	04378	12972	17351	53
8	22 56	37 4	82663	87016	95647	04353	12984	17337	52
9	22 48	37 12	82677	87005	95672	04328	12995	17323	51
10	6 22 40	5 37 20	9.82691	9.86993	9.95698	10.04302	10.13007	10.17309	50
11	22 32	37 28	82705	86982	95723	04277	13018	17295	49
12	22 24	37 36	82719	86970	95748	04252	13030	17281	48
13	22 16	37 44	82733	86959	95774	04226	13041	17267	47
14	22 8	37 52	82747	86947	95799	04201	13053	17253	46
15	6 22 0	5 38 0	9.82761	9.86936	9.95825	10.04175	10.13064	10.17239	45
16	21 52	38 8	82775	86924	95850	04150	13076	17225	44
17	21 44	38 16	82788	86913	95875	04125	13087	17212	43
18	21 36	38 24	82802	86902	95901	04099	13098	17198	42
19	21 28	38 32	82816	86890	95926	04074	13110	17184	41
20	6 21 20	5 38 40	9.82830	9.86879	9.95952	10.04048	10.13121	10.17170	40
21	21 12	38 48	82844	86867	95977	04023	13133	17156	39
22	21 4	38 56	82858	86855	96002	03998	13145	17142	38
23	20 56	39 4	82872	86844	96028	03972	13156	17128	37
24	20 48	39 12	82885	86832	96053	03947	13168	17115	36
25	6 20 40	5 39 20	9.82899	9.86821	9.96078	10.03922	10.13179	10.17101	35
26	20 32	39 28	82913	86809	96104	03896	13191	17087	34
27	20 24	39 36	82927	86798	96129	03871	13202	17073	33
28	20 16	39 44	82941	86786	96155	03845	13214	17059	32
29	20 8	39 52	82955	86775	96180	03820	13225	17045	31
30	6 20 0	5 40 0	9.82968	9.86763	9.96205	10.03795	10.13237	10.17032	30
31	19 52	40 8	82982	86752	96231	03769	13248	17018	29
32	19 44	40 16	82996	86740	96256	03744	13260	17004	28
33	19 36	40 24	83010	86728	96281	03719	13272	16990	27
34	19 28	40 32	83023	86717	96307	03693	13283	16977	26
35	6 19 20	5 40 40	9.83037	9.86705	9.96332	10.03668	10.13295	10.16963	25
36	19 12	40 48	83051	86694	96357	03643	13306	16949	24
37	19 4	40 56	83065	86682	96383	03617	13318	16935	23
38	18 56	41 4	83078	86670	96408	03592	13330	16922	22
39	18 48	41 12	83092	86659	96433	03567	13341	16908	21
40	6 18 40	5 41 20	9.83106	9.86647	9.96459	10.03541	10.13353	10.16894	20
41	18 32	41 28	83120	86635	96484	03516	13365	16880	19
42	18 24	41 36	83133	86624	96510	03490	13376	16867	18
43	18 16	41 44	83147	86612	96535	03465	13388	16853	17
44	18 8	41 52	83161	86600	96560	03440	13400	16839	16
45	6 18 0	5 42 0	9.83174	9.86589	9.96586	10.03414	10.13411	10.16826	15
46	17 52	42 8	83188	86577	96611	03389	13423	16812	14
47	17 44	42 16	83202	86565	96636	03364	13435	16798	13
48	17 36	42 24	83215	86554	96662	03338	13446	16785	12
49	17 28	42 32	83229	86542	96687	03313	13458	16771	11
50	6 17 20	5 42 40	9.83242	9.86530	9.96712	10.03288	10.13470	10.16758	10
51	17 12	42 48	83256	86518	96738	03262	13482	16744	9
52	17 4	42 56	83270	86507	96763	03237	13493	16730	8
53	16 56	43 4	83283	86495	96788	03212	13505	16717	7
54	16 48	43 12	83297	86483	96814	03186	13517	16703	6
55	6 16 40	5 43 20	9.83310	9.86472	9.96839	10.03161	10.13528	10.16690	5
56	16 32	43 28	83324	86460	96864	03136	13540	16676	4
57	16 24	43 36	83338	86448	96890	03110	13552	16662	3
58	16 16	43 44	83351	86436	96915	03085	13564	16649	2
59	16 8	43 52	83365	86425	96940	03060	13575	16635	1
60	16 0	44 0	83378	86413	96966	03034	13587	16622	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 16 0	5 44 0	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622	60
1	15 52	44 8	83392	86401	96991	03009	13599	16608	59
2	15 44	44 16	83405	86389	97016	02984	13611	16595	58
3	15 36	44 24	83419	86377	97042	02958	13623	16581	57
4	15 28	44 32	83432	86366	97067	02933	13634	16568	56
5	6 15 20	5 44 40	9.83446	9.86354	9.97092	10.02908	10.13646	10.16554	55
6	15 12	44 48	83459	86342	97118	02882	13658	16541	54
7	15 4	44 56	83473	86330	97143	02857	13670	16527	53
8	14 56	45 4	83486	86318	97168	02832	13682	16514	52
9	14 48	45 12	83500	86306	97193	02807	13694	16500	51
10	6 14 40	5 45 20	9.83513	9.86295	9.97219	10.02781	10.13705	10.16487	50
11	14 32	45 28	83527	86283	97244	02756	13717	16473	49
12	14 24	45 36	83540	86271	97269	02731	13729	16460	48
13	14 16	45 44	83554	86259	97295	02705	13741	16446	47
14	14 8	45 52	83567	86247	97320	02680	13753	16433	46
15	6 14 0	5 46 0	9.83581	9.86235	9.97345	10.02655	10.13765	10.16419	45
16	13 52	46 8	83594	86223	97371	02629	13777	16406	44
17	13 44	46 16	83608	86211	97396	02604	13789	16392	43
18	13 36	46 24	83621	86200	97421	02579	13800	16379	42
19	13 28	46 32	83634	86188	97447	02553	13812	16366	41
20	6 13 20	5 46 40	9.83648	9.86176	9.97472	10.02528	10.13824	10.16352	40
21	13 12	46 48	83661	86164	97497	02503	13836	16339	39
22	13 4	46 56	83674	86152	97523	02477	13848	16326	38
23	12 56	47 4	83688	86140	97548	02452	13860	16312	37
24	12 48	47 12	83701	86128	97573	02427	13872	16299	36
25	6 12 40	5 47 20	9.83715	9.86116	9.97598	10.02402	10.13884	10.16285	35
26	12 32	47 28	83728	86104	97624	02376	13896	16272	34
27	12 24	47 36	83741	86092	97649	02351	13908	16259	33
28	12 16	47 44	83755	86080	97674	02326	13920	16245	32
29	12 8	47 52	83768	86068	97700	02300	13932	16232	31
30	6 12 0	5 48 0	9.83781	9.86056	9.97725	10.02275	10.13944	10.16219	30
31	11 52	48 8	83795	86044	97750	02250	13956	16205	29
32	11 44	48 16	83808	86032	97776	02224	13968	16192	28
33	11 36	48 24	83821	86020	97801	02199	13980	16179	27
34	11 28	48 32	83834	86008	97826	02174	13992	16166	26
35	6 11 20	5 48 40	9.83848	9.85996	9.97851	10.02149	10.14004	10.16152	25
36	11 12	48 48	83861	85984	97877	02123	14016	16139	24
37	11 4	48 56	83874	85972	97902	02098	14028	16126	23
38	10 56	49 4	83887	85960	97927	02073	14040	16113	22
39	10 48	49 12	83901	85948	97953	02047	14052	16099	21
40	6 10 40	5 49 20	9.83914	9.85936	9.97978	10.02022	10.14064	10.16086	20
41	10 32	49 28	83927	85924	98003	01997	14076	16073	19
42	10 24	49 36	83940	85912	98029	01971	14088	16060	18
43	10 16	49 44	83954	85900	98054	01946	14100	16046	17
44	10 8	49 52	83967	85888	98079	01921	14112	16033	16
45	6 10 0	5 50 0	9.83980	9.85876	9.98104	10.01896	10.14124	10.16020	15
46	9 52	50 8	83993	85864	98130	01870	14136	16007	14
47	9 44	50 16	84006	85851	98155	01845	14149	15994	13
48	9 36	50 24	84020	85839	98180	01820	14161	15980	12
49	9 28	50 32	84033	85827	98206	01794	14173	15967	11
50	6 9 20	5 50 40	9.84046	9.85815	9.98231	10.01769	10.14185	10.15954	10
51	9 12	50 48	84059	85803	98256	01744	14197	15941	9
52	9 4	50 56	84072	85791	98281	01719	14209	15928	8
53	8 56	51 4	84085	85779	98307	01693	14221	15915	7
54	8 48	51 12	84098	85766	98332	01668	14234	15902	6
55	6 8 40	5 51 20	9.84112	9.85754	9.98357	10.01643	10.14246	10.15888	5
56	8 32	51 28	84125	85742	98383	01617	14258	15875	4
57	8 24	51 36	84138	85730	98408	01592	14270	15862	3
58	8 16	51 44	84151	85718	98433	01567	14282	15849	2
59	8 8	51 52	84164	85706	98458	01542	14294	15836	1
60	8 0	52 0	84177	85693	98484	01516	14307	15823	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M	Hour AM	Hour PM	Sine.	Co-sine.	Tangent	Co-tang.	Secant.	Co-secant.	M
0	6 8 0	5 52 0	9. 84177	9. 85693	9. 98484	10. 01516	10. 14307	10. 15823	60
1	7 52	52 8	84190	85681	98509	01491	14319	15810	59
2	7 44	52 16	84203	85669	98534	01466	14331	15797	58
3	7 36	52 24	84216	85657	98560	01440	14343	15784	57
4	7 28	52 32	84229	85645	98585	01415	14355	15771	56
5	6 7 20	5 52 40	9. 84242	9. 85632	9. 98610	10. 01390	10. 14368	10. 15758	55
6	7 12	52 48	84255	85620	98635	01365	14380	15745	54
7	7 4	52 56	84269	85608	98661	01339	14392	15731	53
8	6 56	53 4	84282	85596	98686	01314	14404	15718	52
9	6 48	53 12	84295	85583	98711	01289	14417	15705	51
10	6 6 40	5 53 20	9. 84308	9. 85571	9. 98737	10. 01263	10. 14429	10. 15692	50
11	6 32	53 28	84321	85559	98762	01238	14441	15679	49
12	6 24	53 36	84334	85547	98787	01213	14453	15666	48
13	6 16	53 44	84347	85534	98812	01188	14466	15653	47
14	6 8	53 52	84360	85522	98838	01162	14478	15640	46
15	6 6 0	5 54 0	9. 84373	9. 85510	9. 98863	10. 01137	10. 14490	10. 15627	45
16	5 52	54 8	84385	85497	98888	01112	14503	15615	44
17	5 44	54 16	84398	85485	98913	01087	14515	15602	43
18	5 36	54 24	84411	85473	98939	01061	14527	15589	42
19	5 28	54 32	84424	85460	98964	01036	14540	15576	41
20	6 5 20	5 54 40	9. 84437	9. 85448	9. 98989	10. 01011	10. 14552	10. 15563	40
21	5 12	54 48	84450	85436	99015	00985	14564	15550	39
22	5 4	54 56	84463	85423	99040	00960	14577	15537	38
23	4 56	55 4	84476	85411	99065	00935	14589	15524	37
24	4 48	55 12	84489	85399	99090	00910	14601	15511	36
25	6 4 40	5 55 20	9. 84502	9. 85386	9. 99116	10. 00884	10. 14014	10. 15498	35
26	4 32	55 28	84515	85374	99141	00859	14626	15485	34
27	4 24	55 36	84528	85361	99166	00834	14639	15472	33
28	4 16	55 44	84540	85349	99191	00809	14651	15460	32
29	4 8	55 52	84553	85337	99217	00783	14663	15447	31
30	6 4 0	5 56 0	9. 84566	9. 85324	9. 99242	10. 00758	10. 14676	10. 15434	30
31	3 52	56 8	84579	85312	99267	00733	14688	15421	29
32	3 44	56 16	84592	85299	99293	00707	14701	15408	28
33	3 36	56 24	84605	85287	99318	00682	14713	15395	27
34	3 28	56 32	84618	85274	99343	00657	14726	15382	26
35	6 3 20	5 56 40	9. 84630	9. 85262	9. 99368	10. 00632	10. 14738	10. 15370	25
36	3 12	56 48	84643	85250	99394	00606	14750	15357	24
37	3 4	56 56	84656	85237	99419	00581	14763	15344	23
38	2 56	57 4	84669	85225	99444	00556	14775	15331	22
39	2 48	57 12	84682	85212	99469	00531	14788	15318	21
40	6 2 40	5 57 20	9. 84694	9. 85200	9. 99495	10. 00505	10. 14800	10. 15306	20
41	2 32	57 28	84707	85187	99520	00480	14813	15293	19
42	2 24	57 36	84720	85175	99545	00455	14825	15280	18
43	2 16	57 44	84733	85162	99570	00430	14838	15267	17
44	2 8	57 52	84745	85150	99596	00404	14850	15255	16
45	6 2 0	5 58 0	9. 84758	9. 85137	9. 99621	10. 00379	10. 14863	10. 15242	15
46	1 52	58 8	84771	85125	99646	00354	14875	15229	14
47	1 44	58 16	84784	85112	99672	00328	14888	15216	13
48	1 36	58 24	84796	85100	99697	00303	14900	15204	12
49	1 28	58 32	84809	85087	99722	00278	14913	15191	11
50	6 1 20	5 58 40	9. 84822	9. 85074	9. 99747	10. 00253	10. 14926	10. 15178	10
51	1 12	58 48	84835	85062	99773	00227	14938	15165	9
52	1 4	58 56	84847	85049	99798	00202	14951	15153	8
53	0 56	59 4	84860	85037	99823	00177	14963	15140	7
54	0 48	59 12	84873	85024	99848	00152	14976	15127	6
55	6 0 40	5 59 20	9. 84885	9. 85012	9. 99874	10. 00126	10. 14988	10. 15115	5
56	0 32	59 28	84898	84999	99899	00101	15001	15102	4
57	0 24	59 36	84911	84986	99924	00076	15014	15089	3
58	0 16	59 44	84923	84974	99949	00051	15026	15077	2
59	0 8	59 52	84936	84961	99975	00025	15039	15064	1
60	0 0	6 0 0	84949	84949	10.00000	00000	15051	15051	0
M	Hour PM	Hour AM	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

TABLE XXVI. For reducing the Time of the Moon's Passage over the Meridian of Greenwich to the Time of its Passage over any other Meridian.

The numbers taken from this Table are to be added to the Time at Greenwich in West Longitude, but subtracted in East.

Daily variation of the Moon's passing the Meridian.

Ship's Long.	40	42	44	46	48	50	52	54	56	58	60	62	64	66	Ship's Long.
°	'	'	'	'	'	'	'	'	'	'	'	'	'	'	°
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
10	1	1	1	1	1	1	1	1	2	2	2	2	2	2	10
15	2	2	2	2	2	2	2	2	2	2	2	3	3	3	15
20	2	2	2	3	3	3	3	3	3	3	3	3	4	4	20
25	3	3	3	3	3	3	4	4	4	4	4	4	4	5	25
30	3	3	4	4	4	4	4	4	5	5	5	5	5	5	30
35	4	4	4	4	5	5	5	5	5	6	6	6	6	6	35
40	4	5	5	5	5	6	6	6	6	6	7	7	7	7	40
45	5	5	5	6	6	6	6	7	7	7	7	8	8	8	45
50	6	6	6	6	7	7	7	7	8	8	8	9	9	9	50
55	6	6	7	7	7	8	8	8	9	9	9	9	10	10	55
60	7	7	7	8	8	8	9	9	9	10	10	10	11	11	60
65	7	8	8	8	9	9	9	10	10	10	11	11	12	12	65
70	8	8	9	9	9	10	10	10	11	11	12	12	12	13	70
75	8	9	9	10	10	10	11	11	12	12	12	13	13	14	75
80	9	9	10	10	11	11	12	12	12	13	13	14	14	15	80
85	9	10	10	11	11	12	12	13	13	14	14	15	15	16	85
90	10	10	11	11	12	12	13	13	14	14	15	15	16	16	90
95	11	11	12	12	13	13	14	14	15	15	16	16	17	17	95
100	11	12	12	13	13	14	14	15	16	16	17	17	18	18	100
105	12	12	13	13	14	15	15	16	16	17	17	18	19	19	105
110	12	13	13	14	15	15	16	16	17	18	18	19	20	20	110
115	13	13	14	15	15	16	17	17	18	19	19	20	20	21	115
120	13	14	15	15	16	17	17	18	19	19	20	21	21	22	120
125	14	15	15	16	17	17	18	19	19	20	21	22	22	23	125
130	14	15	16	17	17	18	19	19	20	21	22	22	23	24	130
135	15	16	16	17	18	19	19	20	21	22	22	23	24	25	135
140	16	16	17	18	19	19	20	21	22	23	23	24	25	26	140
145	16	17	18	19	19	20	21	22	23	23	24	25	26	27	145
150	17	17	18	19	20	21	22	22	23	24	25	26	27	27	150
155	17	18	19	20	21	22	22	23	24	25	26	27	28	28	155
160	18	19	20	20	21	22	23	24	25	26	27	28	28	29	160
165	18	19	20	21	22	23	24	25	26	27	27	28	29	30	165
170	19	20	21	22	23	24	25	25	26	27	28	29	30	31	170
175	19	20	21	22	23	24	25	26	27	28	29	30	31	32	175
180	20	21	22	23	24	25	26	27	28	29	30	31	32	33	180
	40'	42'	44	46'	48'	50'	52'	54'	56'	58'	60'	62'	64'	66'	

TABLE XXVII. Correction of moon's altitude for Parallax & Refraction.

☽ alt Deg.	Corr. Min.	☽ alt Deg	Corr. Min.
10	51	51	35
11	52	52	35
12	52	53	34
13	52	54	33
14	52	55	32
15	52	56	32
16	52	57	31
17	52	58	30
18	52	59	29
19	52	60	28
20	51		
21	51	61	27
22	51	62	26
23	51	63	26
24	50	64	25
25	50	65	24
26	50	66	23
27	49	67	22
28	49	68	21
29	49	69	20
30	48	70	19
31	48	71	18
32	47	72	17
33	47	73	17
34	46	74	16
35	46	75	15
36	45	76	14
37	45	77	13
38	44	78	12
39	44	79	11
40	43	80	10
41	42	81	9
42	42	82	8
43	41	83	7
44	40	84	6
45	40	85	5
46	39	86	4
47	38	87	3
48	38	88	2
49	37	89	1
50	36	90	0

TABLE XXVIII. For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours.													Time from Noon.
	0° 5'	0° 10'	0° 15'	0° 20'	0° 25'	0° 30'	0° 35'	0° 40'	0° 45'	0° 50'	0° 55'	1° 0'	1° 5'	
0h 0'	0'	0'	0'	0	0	0'	0'	0'	0'	0'	0'	0'	0° 0'	12h 0'
0 12	0	0	0	0	0	0	1	1	1	1	1	1	0 1	12 12
0 24	0	0	0	1	1	1	1	1	1	2	2	2	0 2	12 24
0 36	0	0	1	1	1	1	2	2	2	2	3	3	0 3	12 36
0 48	0	1	1	1	2	2	2	3	3	3	4	4	0 4	12 48
1 0	0	1	1	2	2	2	3	3	4	4	5	5	0 5	13 0
1 12	0	1	1	2	2	3	3	4	4	5	5	6	0 6	13 12
1 24	1	1	2	2	3	3	4	5	5	6	6	7	0 8	13 24
1 36	1	1	2	3	3	4	5	5	6	7	7	8	0 9	13 36
1 48	1	1	2	3	4	4	5	6	7	7	8	9	0 10	13 48
2 0	1	2	2	3	4	5	6	7	7	8	9	10	0 11	14 0
2 12	1	2	3	4	5	5	6	7	8	9	10	11	0 12	14 12
2 24	1	2	3	4	5	6	7	8	9	10	11	12	0 13	14 24
2 36	1	2	3	4	5	6	8	9	10	11	12	13	0 14	14 36
2 48	1	2	3	5	6	7	8	9	10	12	13	14	0 15	14 48
3 0	1	2	4	5	6	7	9	10	11	12	14	15	0 16	15 0
3 12	1	3	4	5	7	8	9	11	12	13	15	16	0 17	15 12
3 24	1	3	4	6	7	8	10	11	13	14	16	17	0 18	15 24
3 36	1	3	4	6	7	9	10	12	13	15	16	18	0 19	15 36
3 48	2	3	5	6	8	9	11	13	14	16	17	19	0 21	15 48
4 0	2	3	5	7	8	10	12	13	15	17	18	20	0 22	16 0
4 12	2	3	5	7	9	10	12	14	10	17	19	21	0 23	16 12
4 24	2	4	5	7	9	11	13	15	16	18	20	22	0 24	16 24
4 36	2	4	6	8	10	11	13	15	17	19	21	23	0 25	16 36
4 48	2	4	6	8	10	12	14	16	18	20	22	24	0 26	16 48
5 0	2	4	6	8	10	12	15	17	19	21	23	25	0 27	17 0
5 12	2	4	6	9	11	13	15	17	19	22	24	26	0 28	17 12
5 24	2	4	7	9	11	13	16	18	20	22	25	27	0 29	17 24
5 36	2	5	7	9	12	14	16	19	21	23	26	28	0 30	17 36
5 48	2	5	7	10	12	14	17	19	22	24	27	29	0 31	17 48
6 0	2	5	7	10	12	15	17	20	22	25	27	30	0 32	18 0
6 12	3	5	8	10	13	15	18	21	23	26	28	31	0 34	18 12
6 24	3	5	8	11	13	16	19	21	24	27	29	32	0 35	18 24
6 36	3	5	8	11	14	16	19	22	25	27	30	33	0 36	18 36
6 48	3	6	8	11	14	17	20	23	25	28	31	34	0 37	18 48
7 0	3	6	9	12	15	17	20	23	26	29	32	35	0 38	19 0
7 12	3	6	9	12	15	18	21	24	27	30	33	36	0 39	19 12
7 24	3	6	9	12	15	18	22	25	28	31	34	37	0 40	19 24
7 36	3	6	9	13	16	19	22	25	28	32	35	38	0 41	19 36
7 48	3	6	10	13	16	19	23	26	29	32	36	39	0 42	19 48
8 0	3	7	10	13	17	20	23	27	30	33	37	40	0 43	20 0
8 12	3	7	10	14	17	20	24	27	31	34	38	41	0 44	20 12
8 24	3	7	10	14	17	21	24	28	31	35	38	42	0 45	20 24
8 36	4	7	11	14	18	21	25	29	32	36	39	43	0 47	20 36
8 48	4	7	11	15	18	22	26	29	33	37	40	44	0 48	20 48
9 0	4	7	11	15	19	22	26	30	34	37	41	45	0 49	21 0
9 12	4	8	11	15	19	23	27	31	34	38	42	46	0 50	21 12
9 24	4	8	12	16	20	23	27	31	35	39	43	47	0 51	21 24
9 36	4	8	12	16	20	24	28	32	36	40	44	48	0 52	21 36
9 48	4	8	12	16	20	24	29	33	37	41	45	49	0 53	21 48
10 0	4	8	12	17	21	25	29	33	37	42	46	50	0 54	22 0
10 12	4	8	13	17	21	25	30	34	38	42	47	51	0 55	22 12
10 24	4	9	13	17	22	26	30	35	39	43	48	52	0 56	22 24
10 36	4	9	13	18	22	26	31	35	40	44	49	53	0 57	22 36
10 48	4	9	13	18	22	27	31	36	40	45	49	54	0 58	22 48
11 0	5	9	14	18	23	27	32	37	41	46	50	55	1 0	23 0
11 12	5	9	14	19	23	28	33	37	42	47	51	56	1 1	23 12
11 24	5	9	14	19	24	28	33	38	43	47	52	57	1 2	23 24
11 36	5	10	14	19	24	29	34	39	43	48	53	58	1 3	23 36
11 48	5	10	15	20	25	29	34	39	44	49	54	59	1 4	23 48
12 0	5	10	15	20	25	30	35	40	45	50	55	60	1 5	24 0

TABLE XXVIII. For reducing the Moon's Declination as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other Time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours. ° ' 1 10	° ' 1 15	° ' 1 20	° ' 1 25	° ' 1 30	° ' 1 35	° ' 1 40	° ' 1 45	° ' 1 50	° ' 1 55	Time from Noon.
0h 0	0° 0'	0° 0'	0° 0'	0° 0'	0° 0'	0° 0'	0° 0'	0° 0'	0° 0'	0° 0'	12h 0
0 12	0 1	0 1	0 1	0 1	0 1	0 2	0 2	0 2	0 2	0 2	12 12
0 24	0 2	0 2	0 3	0 3	0 3	0 3	0 3	0 3	0 4	0 4	12 24
0 36	0 3	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 6	12 36
0 48	0 5	0 5	0 5	0 6	0 6	0 6	0 7	0 7	0 7	0 8	12 48
1 0	0 6	0 6	0 7	0 7	0 7	0 8	0 8	0 9	0 9	0 10	13 0
1 12	0 7	0 7	0 8	0 8	0 9	0 9	0 10	0 10	0 11	0 11	13 12
1 24	0 8	0 9	0 9	0 10	0 10	0 11	0 12	0 12	0 13	0 13	13 24
1 36	0 9	0 10	0 11	0 11	0 12	0 13	0 13	0 14	0 15	0 15	13 36
1 48	0 10	0 11	0 12	0 13	0 13	0 14	0 15	0 16	0 16	0 17	13 48
2 0	0 12	0 12	0 13	0 14	0 15	0 16	0 17	0 17	0 18	0 19	14 0
2 12	0 13	0 14	0 15	0 16	0 16	0 17	0 18	0 19	0 20	0 21	14 12
2 24	0 14	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 22	0 23	14 24
2 36	0 15	0 16	0 17	0 18	0 19	0 21	0 22	0 23	0 24	0 25	14 36
2 48	0 16	0 17	0 19	0 20	0 21	0 22	0 23	0 24	0 26	0 27	14 48
3 0	0 17	0 19	0 20	0 21	0 22	0 24	0 25	0 26	0 27	0 29	15 0
3 12	0 19	0 20	0 21	0 23	0 24	0 25	0 27	0 28	0 29	0 31	15 12
3 24	0 20	0 21	0 23	0 24	0 25	0 27	0 28	0 30	0 31	0 33	15 24
3 36	0 21	0 22	0 24	0 25	0 27	0 28	0 30	0 31	0 33	0 34	15 36
3 48	0 22	0 24	0 25	0 27	0 28	0 30	0 32	0 33	0 35	0 36	15 48
4 0	0 23	0 25	0 27	0 28	0 30	0 32	0 33	0 35	0 37	0 38	16 0
4 12	0 24	0 26	0 28	0 30	0 31	0 33	0 35	0 37	0 38	0 40	16 12
4 24	0 26	0 27	0 29	0 31	0 33	0 35	0 37	0 38	0 40	0 42	16 24
4 36	0 27	0 29	0 31	0 33	0 34	0 36	0 38	0 40	0 42	0 44	16 36
4 48	0 28	0 30	0 32	0 34	0 36	0 38	0 40	0 42	0 44	0 46	16 48
5 0	0 29	0 31	0 33	0 35	0 37	0 40	0 42	0 44	0 46	0 48	17 0
5 12	0 30	0 32	0 35	0 37	0 39	0 41	0 43	0 45	0 48	0 50	17 12
5 24	0 31	0 34	0 36	0 38	0 40	0 43	0 45	0 47	0 49	0 52	17 24
5 36	0 33	0 35	0 37	0 40	0 42	0 44	0 47	0 49	0 51	0 54	17 36
5 48	0 34	0 36	0 39	0 41	0 43	0 46	0 48	0 51	0 53	0 56	17 48
6 0	0 35	0 37	0 40	0 42	0 45	0 47	0 50	0 52	0 55	0 57	18 0
6 12	0 36	0 39	0 41	0 44	0 46	0 49	0 52	0 54	0 57	0 59	18 12
6 24	0 37	0 40	0 43	0 45	0 48	0 51	0 53	0 56	0 59	1 1	18 24
6 36	0 38	0 41	0 44	0 47	0 49	0 52	0 55	0 58	1 0	1 3	18 36
6 48	0 40	0 42	0 45	0 48	0 51	0 54	0 57	0 59	1 2	1 5	18 48
7 0	0 41	0 44	0 47	0 50	0 52	0 55	0 58	1 1	1 4	1 7	19 0
7 12	0 42	0 45	0 48	0 51	0 54	0 57	1 0	1 3	1 6	1 9	19 12
7 24	0 43	0 46	0 49	0 52	0 55	0 59	1 2	1 5	1 8	1 11	19 24
7 36	0 44	0 47	0 51	0 54	0 57	1 0	1 3	1 6	1 10	1 13	19 36
7 48	0 45	0 49	0 52	0 55	0 58	1 2	1 5	1 8	1 11	1 15	19 48
8 0	0 47	0 50	0 53	0 57	1 0	1 3	1 7	1 10	1 13	1 17	20 0
8 12	0 48	0 51	0 55	0 58	1 1	1 5	1 8	1 12	1 15	1 19	20 12
8 24	0 49	0 52	0 56	0 59	1 3	1 6	1 10	1 13	1 17	1 20	20 24
8 36	0 50	0 54	0 57	1 1	1 4	1 8	1 12	1 15	1 19	1 22	20 36
8 48	0 51	0 55	0 59	1 2	1 6	1 10	1 13	1 17	1 21	1 24	20 48
9 0	0 52	0 56	1 0	1 4	1 7	1 11	1 15	1 19	1 22	1 26	21 0
9 12	0 54	0 57	1 1	1 5	1 9	1 13	1 17	1 20	1 24	1 28	21 12
9 24	0 55	0 59	1 3	1 7	1 10	1 14	1 18	1 22	1 26	1 30	21 24
9 36	0 56	1 0	1 4	1 8	1 12	1 16	1 20	1 24	1 28	1 32	21 36
9 48	0 57	1 1	1 5	1 9	1 13	1 18	1 22	1 26	1 30	1 34	21 48
10 0	0 58	1 2	1 7	1 11	1 15	1 19	1 23	1 27	1 32	1 36	22 0
10 12	0 59	1 4	1 8	1 12	1 16	1 21	1 25	1 29	1 33	1 38	22 12
10 24	1 1	1 5	1 9	1 14	1 18	1 22	1 27	1 31	1 35	1 40	22 24
10 36	1 2	1 6	1 11	1 15	1 19	1 24	1 28	1 33	1 37	1 42	22 36
10 48	1 3	1 7	1 12	1 16	1 21	1 25	1 30	1 34	1 39	1 43	22 48
11 0	1 4	1 9	1 13	1 18	1 22	1 27	1 32	1 36	1 41	1 45	23 0
11 12	1 5	1 10	1 15	1 19	1 24	1 29	1 33	1 38	1 43	1 47	23 12
11 24	1 6	1 11	1 16	1 21	1 25	1 30	1 35	1 40	1 44	1 49	23 24
11 36	1 8	1 12	1 17	1 22	1 27	1 32	1 37	1 41	1 46	1 51	23 36
11 48	1 9	1 14	1 19	1 24	1 28	1 33	1 38	1 43	1 48	1 53	23 48
12 0	1 10	1 15	1 20	1 25	1 30	1 35	1 40	1 45	1 50	1 55	24 0

TABLE XXVIII. For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other Time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours. ° ′ 2 0	° ′ 2 5	° ′ 2 10	° ′ 2 15	° ′ 2 20	° ′ 2 25	° ′ 2 30	° ′ 2 35	° ′ 2 40	° ′ 2 45	° ′ 2 50	Time from Noon.
0h ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	12h ′0
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 3	0 3	0 3	0 3	12 12
0 24	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 5	0 5	0 6	12 24
0 36	0 6	0 6	0 6	0 7	0 7	0 7	0 7	0 8	0 8	0 8	0 8	12 36
0 48	0 8	0 8	0 9	0 9	0 9	0 10	0 10	0 10	0 11	0 11	0 11	12 48
1 0	0 10	0 10	0 11	0 11	0 12	0 12	0 12	0 13	0 13	0 14	0 14	13 0
1 12	0 12	0 12	0 13	0 13	0 14	0 14	0 15	0 15	0 16	0 16	0 17	13 12
1 24	0 14	0 15	0 15	0 16	0 16	0 17	0 17	0 18	0 19	0 19	0 20	13 24
1 36	0 16	0 17	0 17	0 18	0 19	0 19	0 20	0 21	0 21	0 22	0 23	13 36
1 48	0 18	0 19	0 19	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 25	13 48
2 0	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 26	0 27	0 27	0 28	14 0
2 12	0 22	0 23	0 24	0 25	0 26	0 27	0 27	0 28	0 29	0 30	0 31	14 12
2 24	0 24	0 25	0 26	0 27	0 28	0 29	0 30	0 31	0 32	0 33	0 34	14 24
2 36	0 26	0 27	0 28	0 29	0 30	0 31	0 32	0 34	0 35	0 36	0 37	14 36
2 48	0 28	0 29	0 30	0 31	0 33	0 34	0 35	0 36	0 37	0 38	0 40	14 48
3 0	0 30	0 31	0 32	0 34	0 35	0 36	0 37	0 39	0 40	0 41	0 42	15 0
3 12	0 32	0 33	0 35	0 36	0 37	0 39	0 40	0 41	0 43	0 44	0 45	15 12
3 24	0 34	0 35	0 37	0 38	0 40	0 41	0 42	0 44	0 45	0 47	0 48	15 24
3 36	0 36	0 37	0 39	0 40	0 42	0 43	0 45	0 46	0 48	0 49	0 51	15 36
3 48	0 38	0 40	0 41	0 43	0 44	0 46	0 47	0 49	0 51	0 52	0 54	15 48
4 0	0 40	0 42	0 43	0 45	0 47	0 48	0 50	0 52	0 53	0 55	0 57	16 0
4 12	0 42	0 44	0 45	0 47	0 49	0 51	0 52	0 54	0 56	0 58	0 59	16 12
4 24	0 44	0 46	0 48	0 49	0 51	0 53	0 55	0 57	0 59	1 0	1 2	16 24
4 36	0 46	0 48	0 50	0 52	0 54	0 56	0 57	0 59	1 1	1 3	1 5	16 36
4 48	0 48	0 50	0 52	0 54	0 56	0 58	1 0	1 2	1 4	1 6	1 8	16 48
5 0	0 50	0 52	0 54	0 56	0 58	1 0	1 2	1 5	1 7	1 9	1 11	17 0
5 12	0 52	0 54	0 56	0 58	1 1	1 3	1 5	1 7	1 9	1 11	1 14	17 12
5 24	0 54	0 56	0 58	1 1	1 3	1 5	1 7	1 10	1 12	1 14	1 16	17 24
5 36	0 56	0 58	1 1	1 3	1 5	1 8	1 10	1 12	1 15	1 17	1 19	17 36
5 48	0 58	1 0	1 3	1 5	1 8	1 10	1 12	1 15	1 17	1 20	1 22	17 48
6 0	1 0	1 2	1 5	1 7	1 10	1 12	1 15	1 17	1 20	1 22	1 25	18 0
6 12	1 2	1 5	1 7	1 10	1 12	1 15	1 17	1 20	1 23	1 25	1 28	18 12
6 24	1 4	1 7	1 9	1 12	1 15	1 17	1 20	1 23	1 25	1 28	1 31	18 24
6 36	1 6	1 9	1 11	1 14	1 17	1 20	1 23	1 25	1 28	1 31	1 33	18 36
6 48	1 8	1 11	1 14	1 16	1 19	1 22	1 25	1 28	1 31	1 33	1 36	18 48
7 0	1 10	1 13	1 16	1 19	1 22	1 25	1 27	1 30	1 33	1 36	1 39	19 0
7 12	1 12	1 15	1 18	1 21	1 24	1 27	1 30	1 33	1 36	1 39	1 42	19 12
7 24	1 14	1 17	1 20	1 23	1 26	1 29	1 32	1 36	1 39	1 42	1 45	19 24
7 36	1 16	1 19	1 22	1 25	1 29	1 32	1 35	1 38	1 41	1 44	1 48	19 36
7 48	1 18	1 21	1 24	1 28	1 31	1 34	1 37	1 41	1 44	1 47	1 50	19 48
8 0	1 20	1 23	1 27	1 30	1 33	1 37	1 40	1 43	1 47	1 50	1 53	20 0
8 12	1 22	1 25	1 29	1 32	1 36	1 39	1 42	1 46	1 49	1 53	1 56	20 12
8 24	1 24	1 27	1 31	1 34	1 38	1 41	1 45	1 48	1 52	1 55	1 59	20 24
8 36	1 26	1 30	1 33	1 37	1 40	1 44	1 47	1 51	1 55	1 58	2 2	20 36
8 48	1 28	1 32	1 35	1 39	1 43	1 46	1 50	1 54	1 57	2 1	2 5	20 48
9 0	1 30	1 34	1 37	1 41	1 45	1 49	1 52	1 56	2 0	2 4	2 7	21 0
9 12	1 32	1 36	1 40	1 43	1 47	1 51	1 55	1 59	2 3	2 6	2 10	21 12
9 24	1 34	1 38	1 42	1 46	1 50	1 54	1 57	2 1	2 5	2 9	2 13	21 24
9 36	1 36	1 40	1 44	1 48	1 52	1 56	2 0	2 4	2 8	2 12	2 16	21 36
9 48	1 38	1 42	1 46	1 50	1 54	1 58	2 2	2 7	2 11	2 15	2 19	21 48
10 0	1 40	1 44	1 48	1 52	1 57	2 1	2 5	2 9	2 13	2 17	2 22	22 0
10 12	1 42	1 46	1 50	1 55	1 59	2 3	2 7	2 12	2 16	2 20	2 24	22 12
10 24	1 44	1 48	1 53	1 57	2 1	2 6	2 10	2 14	2 19	2 23	2 27	22 24
10 36	1 46	1 50	1 55	1 59	2 4	2 8	2 12	2 17	2 21	2 26	2 30	22 36
10 48	1 48	1 52	1 57	2 1	2 6	2 10	2 15	2 19	2 24	2 28	2 33	22 48
11 0	1 50	1 55	1 59	2 4	2 8	2 13	2 17	2 22	2 27	2 31	2 36	23 0
11 12	1 52	1 57	2 1	2 6	2 11	2 15	2 20	2 25	2 29	2 34	2 39	23 12
11 24	1 54	1 59	2 3	2 8	2 13	2 18	2 22	2 27	2 32	2 37	2 41	23 24
11 36	1 56	2 1	2 6	2 10	2 15	2 20	2 25	2 30	2 35	2 39	2 44	23 36
11 48	1 58	2 3	2 8	2 13	2 18	2 23	2 27	2 32	2 37	2 42	2 47	23 48
12 0	2 0	2 5	2 10	2 15	2 20	2 25	2 30	2 35	2 40	2 45	2 50	24 0

TABLE XXVIII. For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other Time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours.											Time from Noon.
	° ′ 2 55	° ′ 3 0	° ′ 3 5	° ′ 3 10	° ′ 3 15	° ′ 3 20	° ′ 3 25	° ′ 3 30	° ′ 3 35	° ′ 3 40	° ′ 3 45	
0h ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	0° ′0	12h ′0
0 12	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 4	0 4	0 4	12 12
0 24	0 6	0 6	0 6	0 6	0 6	0 7	0 7	0 7	0 7	0 7	0 7	12 24
0 36	0 9	0 9	0 9	0 9	0 10	0 10	0 10	0 10	0 11	0 11	0 11	12 36
0 48	0 12	0 12	0 12	0 13	0 13	0 13	0 14	0 14	0 14	0 15	0 15	12 48
1 0	0 15	0 15	0 15	0 16	0 16	0 17	0 17	0 17	0 18	0 18	0 19	13 0
1 12	0 17	0 18	0 18	0 19	0 19	0 20	0 20	0 21	0 21	0 22	0 22	13 12
1 24	0 20	0 21	0 22	0 22	0 23	0 23	0 24	0 24	0 25	0 26	0 26	13 24
1 36	0 23	0 24	0 25	0 25	0 26	0 27	0 27	0 28	0 29	0 29	0 30	13 36
1 48	0 26	0 27	0 28	0 28	0 29	0 30	0 31	0 31	0 32	0 33	0 34	13 48
2 0	0 29	0 30	0 31	0 32	0 32	0 33	0 34	0 35	0 36	0 37	0 37	14 0
2 12	0 32	0 33	0 34	0 35	0 36	0 37	0 38	0 38	0 39	0 40	0 41	14 12
2 24	0 35	0 36	0 37	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	14 24
2 36	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	0 47	0 48	0 49	14 36
2 48	0 41	0 42	0 43	0 44	0 45	0 47	0 48	0 49	0 50	0 51	0 52	14 48
3 0	0 44	0 45	0 46	0 47	0 49	0 50	0 51	0 52	0 54	0 55	0 56	15 0
3 12	0 47	0 48	0 49	0 51	0 52	0 53	0 55	0 56	0 57	0 59	1 0	15 12
3 24	0 50	0 51	0 52	0 54	0 55	0 57	0 58	0 59	1 1	1 2	1 4	15 24
3 36	0 52	0 54	0 55	0 57	0 58	1 0	1 1	1 3	1 4	1 6	1 7	15 36
3 48	0 55	0 57	0 59	1 0	1 2	1 3	1 5	1 6	1 8	1 10	1 11	15 48
4 0	0 58	1 0	1 2	1 3	1 5	1 7	1 8	1 10	1 12	1 13	1 15	16 0
4 12	1 1	1 3	1 5	1 6	1 8	1 10	1 12	1 13	1 15	1 17	1 19	16 12
4 24	1 4	1 6	1 8	1 10	1 11	1 13	1 15	1 17	1 19	1 21	1 22	16 24
4 36	1 7	1 9	1 11	1 13	1 15	1 17	1 19	1 20	1 22	1 24	1 26	16 36
4 48	1 10	1 12	1 14	1 16	1 18	1 20	1 22	1 24	1 26	1 28	1 30	16 48
5 0	1 13	1 15	1 17	1 19	1 21	1 23	1 25	1 27	1 30	1 32	1 34	17 0
5 12	1 16	1 18	1 20	1 22	1 24	1 27	1 29	1 31	1 33	1 35	1 37	17 12
5 24	1 19	1 21	1 23	1 25	1 28	1 30	1 32	1 34	1 37	1 39	1 41	17 24
5 36	1 22	1 24	1 26	1 29	1 31	1 33	1 36	1 38	1 40	1 43	1 45	17 36
5 48	1 25	1 27	1 29	1 32	1 34	1 37	1 39	1 41	1 44	1 46	1 49	17 48
6 0	1 27	1 30	1 32	1 35	1 37	1 40	1 42	1 45	1 47	1 50	1 52	18 0
6 12	1 30	1 33	1 36	1 38	1 41	1 43	1 46	1 48	1 51	1 54	1 56	18 12
6 24	1 33	1 36	1 39	1 41	1 44	1 47	1 49	1 52	1 55	1 57	2 0	18 24
6 36	1 36	1 39	1 42	1 44	1 47	1 50	1 53	1 55	1 58	2 1	2 4	18 36
6 48	1 39	1 42	1 45	1 48	1 50	1 53	1 56	1 59	2 2	2 5	2 7	18 48
7 0	1 42	1 45	1 48	1 51	1 54	1 57	2 0	2 2	2 5	2 8	2 11	19 0
7 12	1 45	1 48	1 51	1 54	1 57	2 0	2 3	2 6	2 9	2 12	2 15	19 12
7 24	1 48	1 51	1 54	1 57	2 0	2 3	2 6	2 9	2 13	2 16	2 19	19 24
7 36	1 51	1 54	1 57	2 0	2 3	2 7	2 10	2 13	2 16	2 19	2 22	19 36
7 48	1 54	1 57	2 0	2 3	2 7	2 10	2 13	2 16	2 20	2 23	2 26	19 48
8 0	1 57	2 0	2 3	2 7	2 10	2 13	2 17	2 20	2 23	2 27	2 30	20 0
8 12	2 0	2 3	2 6	2 10	2 13	2 17	2 20	2 23	2 27	2 30	2 34	20 12
8 24	2 2	2 6	2 9	2 13	2 16	2 20	2 23	2 27	2 30	2 34	2 37	20 24
8 36	2 5	2 9	2 13	2 16	2 20	2 23	2 27	2 30	2 34	2 38	2 41	20 36
8 48	2 8	2 12	2 16	2 19	2 23	2 27	2 30	2 34	2 38	2 41	2 45	20 48
9 0	2 11	2 15	2 19	2 22	2 26	2 30	2 34	2 37	2 41	2 45	2 49	21 0
9 12	2 14	2 18	2 22	2 26	2 29	2 33	2 37	2 41	2 45	2 49	2 52	21 12
9 24	2 17	2 21	2 25	2 29	2 33	2 37	2 41	2 44	2 48	2 52	2 56	21 24
9 36	2 20	2 24	2 28	2 32	2 36	2 40	2 44	2 48	2 52	2 56	3 0	21 36
9 48	2 23	2 27	2 31	2 35	2 39	2 43	2 47	2 51	2 56	3 0	3 4	21 48
10 0	2 26	2 30	2 34	2 38	2 42	2 47	2 51	2 55	2 59	3 3	3 7	22 0
10 12	2 29	2 33	2 37	2 41	2 46	2 50	2 54	2 58	3 3	3 7	3 11	22 12
10 24	2 32	2 36	2 40	2 45	2 49	2 53	2 58	3 2	3 6	3 11	3 15	22 24
10 36	2 35	2 39	2 43	2 48	2 52	2 57	3 1	3 5	3 10	3 14	3 19	22 36
10 48	2 37	2 42	2 46	2 51	2 55	3 0	3 4	3 9	3 13	3 18	3 22	22 48
11 0	2 40	2 45	2 50	2 54	2 59	3 3	3 8	3 12	3 17	3 22	3 26	23 0
11 12	2 43	2 48	2 53	2 57	3 2	3 7	3 11	3 16	3 21	3 25	3 30	23 12
11 24	2 46	2 51	2 56	3 0	3 5	3 10	3 15	3 19	3 24	3 29	3 34	23 24
11 36	2 49	2 54	2 59	3 4	3 8	3 13	3 18	3 23	3 28	3 33	3 37	23 36
11 48	2 52	2 57	3 2	3 7	3 12	3 17	3 22	3 26	3 31	3 36	3 41	23 48
12 0	2 55	3 0	3 5	3 10	3 15	3 20	3 25	3 30	3 35	3 40	3 45	24 0

TABLE XXIX. For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other Time under any other Meridian.

Time from Noon.	3' 30''	3' 32''	3' 34''	3' 36''	3' 38''	3' 40''	3' 42''	3' 44''	3' 46''	Ship's Long.
	Daily Variation of the Sun's Right Ascension in Time.									
0h 0'	0' 0''	0' 0''	0' 0''	0' 0''	0' 0''	0' 0''	0' 0''	0' 0''	0' 0''	0°
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	3
0 24	0 3	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	6
0 36	0 5	0 5	0 5	0 5	0 5	0 5	0 6	0 6	0 6	9
0 48	0 7	0 7	0 7	0 7	0 7	0 7	0 7	0 7	0 8	12
1 0	0 9	0 9	0 9	0 9	0 9	0 9	0 9	0 9	0 9	15
1 12	0 10	0 11	0 11	0 11	0 11	0 11	0 11	0 11	0 11	18
1 24	0 12	0 12	0 12	0 13	0 13	0 13	0 13	0 13	0 13	21
1 36	0 14	0 14	0 14	0 14	0 15	0 15	0 15	0 15	0 15	24
1 48	0 16	0 16	0 16	0 16	0 16	0 16	0 17	0 17	0 17	27
2 0	0 17	0 18	0 18	0 18	0 18	0 18	0 18	0 19	0 19	30
2 12	0 19	0 19	0 20	0 20	0 20	0 20	0 20	0 21	0 21	33
2 24	0 21	0 21	0 21	0 22	0 22	0 22	0 22	0 22	0 23	36
2 36	0 23	0 23	0 23	0 23	0 24	0 24	0 24	0 24	0 24	39
2 48	0 24	0 25	0 25	0 25	0 25	0 26	0 26	0 26	0 26	42
3 0	0 26	0 26	0 27	0 27	0 27	0 27	0 28	0 28	0 28	45
3 12	0 28	0 28	0 29	0 29	0 29	0 29	0 30	0 30	0 30	48
3 24	0 30	0 30	0 30	0 31	0 31	0 31	0 31	0 32	0 32	51
3 36	0 31	0 32	0 32	0 32	0 33	0 33	0 33	0 34	0 34	54
3 48	0 33	0 34	0 34	0 34	0 35	0 35	0 35	0 35	0 36	57
4 0	0 35	0 35	0 36	0 36	0 36	0 37	0 37	0 37	0 38	60
4 12	0 37	0 37	0 37	0 38	0 38	0 38	0 39	0 39	0 40	63
4 24	0 38	0 39	0 39	0 40	0 40	0 40	0 41	0 41	0 41	66
4 36	0 40	0 41	0 41	0 41	0 42	0 42	0 43	0 43	0 43	69
4 48	0 42	0 42	0 43	0 43	0 44	0 44	0 44	0 45	0 45	72
5 0	0 44	0 44	0 45	0 45	0 45	0 46	0 46	0 47	0 47	75
5 12	0 45	0 46	0 46	0 47	0 47	0 48	0 48	0 49	0 49	78
5 24	0 47	0 48	0 48	0 49	0 49	0 49	0 50	0 50	0 51	81
5 36	0 49	0 49	0 50	0 50	0 51	0 51	0 52	0 52	0 53	84
5 48	0 51	0 51	0 52	0 52	0 53	0 53	0 54	0 54	0 55	87
6 0	0 52	0 53	0 53	0 54	0 54	0 55	0 55	0 56	0 56	90
6 12	0 54	0 55	0 55	0 56	0 56	0 57	0 57	0 58	0 58	93
6 24	0 56	0 57	0 57	0 58	0 58	0 59	0 59	1 0	1 0	96
6 36	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 2	1 2	99
6 48	0 59	1 0	1 1	1 1	1 2	1 2	1 3	1 3	1 4	102
7 0	1 1	1 2	1 2	1 3	1 4	1 4	1 5	1 5	1 6	105
7 12	1 3	1 4	1 4	1 5	1 5	1 6	1 7	1 7	1 8	108
7 24	1 5	1 5	1 6	1 7	1 7	1 8	1 8	1 9	1 10	111
7 36	1 6	1 7	1 8	1 8	1 9	1 10	1 10	1 11	1 12	114
7 48	1 8	1 9	1 10	1 10	1 11	1 11	1 12	1 13	1 13	117
8 0	1 10	1 11	1 11	1 12	1 13	1 13	1 14	1 15	1 15	120
8 12	1 12	1 12	1 13	1 14	1 14	1 15	1 16	1 17	1 17	123
8 24	1 13	1 14	1 15	1 16	1 16	1 17	1 18	1 18	1 19	126
8 36	1 15	1 16	1 17	1 17	1 18	1 19	1 20	1 20	1 21	129
8 48	1 17	1 18	1 18	1 19	1 20	1 21	1 21	1 22	1 23	132
9 0	1 19	1 19	1 20	1 21	1 22	1 22	1 23	1 24	1 25	135
9 12	1 20	1 21	1 22	1 23	1 24	1 24	1 25	1 26	1 27	138
9 24	1 22	1 23	1 24	1 25	1 25	1 26	1 27	1 28	1 29	141
9 36	1 24	1 25	1 26	1 26	1 27	1 28	1 29	1 30	1 30	144
9 48	1 26	1 27	1 27	1 28	1 29	1 30	1 31	1 31	1 32	147
10 0	1 27	1 28	1 29	1 30	1 31	1 32	1 32	1 33	1 34	150
10 12	1 29	1 30	1 31	1 32	1 33	1 33	1 34	1 35	1 36	153
10 24	1 31	1 32	1 33	1 34	1 34	1 35	1 36	1 37	1 38	156
10 36	1 33	1 34	1 35	1 35	1 36	1 37	1 38	1 39	1 40	159
10 48	1 34	1 35	1 36	1 37	1 38	1 39	1 40	1 41	1 42	162
11 0	1 36	1 37	1 38	1 39	1 40	1 41	1 42	1 43	1 44	165
11 12	1 38	1 39	1 40	1 41	1 42	1 43	1 44	1 45	1 45	168
11 24	1 40	1 41	1 42	1 43	1 44	1 44	1 45	1 46	1 47	171
11 36	1 41	1 42	1 43	1 44	1 45	1 46	1 47	1 48	1 49	174
11 48	1 43	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	177
12 0	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	180
	3' 30''	3' 32''	3' 34''	3' 36''	3' 38''	3' 40''	3' 42''	3' 44''	3' 46''	

TABLE XXIX. For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other Time under any other Meridian.

Time from Noon.	Daily Variation of the Sun's Right Ascension in Time. 3'	48"	3'	50"	3'	52"	3'	54"	3'	56"	3'	58"	4'	0"	4'	2"	4'	4"	4'	6"	Ships Long.
h '	'	"	'	"	'	"	'	"	'	"	'	"	'	"	'	"	'	"	'	"	°
0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0 12	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	3
0 24	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	6
0 36	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	0	6	9
0 48	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	0	8	12
1 0	0	9	0	10	0	10	0	10	0	10	0	10	0	10	0	10	0	10	0	10	15
1 12	0	11	0	11	0	12	0	12	0	12	0	12	0	12	0	12	0	12	0	12	18
1 24	0	13	0	13	0	14	0	14	0	14	0	14	0	14	0	14	0	14	0	14	21
1 36	0	15	0	15	0	15	0	16	0	16	0	16	0	16	0	16	0	16	0	16	24
1 48	0	17	0	17	0	17	0	18	0	18	0	18	0	18	0	18	0	18	0	18	27
2 0	0	19	0	19	0	19	0	19	0	20	0	20	0	20	0	20	0	20	0	20	30
2 12	0	21	0	21	0	21	0	21	0	22	0	22	0	22	0	22	0	22	0	23	33
2 24	0	23	0	23	0	23	0	23	0	24	0	24	0	24	0	24	0	24	0	25	36
2 36	0	25	0	25	0	25	0	25	0	26	0	26	0	26	0	26	0	26	0	27	39
2 48	0	27	0	27	0	27	0	27	0	28	0	28	0	28	0	28	0	28	0	29	42
3 0	0	28	0	29	0	29	0	29	0	29	0	30	0	30	0	30	0	30	0	31	45
3 12	0	30	0	31	0	31	0	31	0	31	0	32	0	32	0	32	0	33	0	33	48
3 24	0	32	0	33	0	33	0	33	0	33	0	34	0	34	0	34	0	35	0	35	51
3 36	0	34	0	34	0	35	0	35	0	35	0	36	0	36	0	36	0	37	0	37	54
3 48	0	36	0	36	0	37	0	37	0	37	0	38	0	38	0	38	0	39	0	39	57
4 0	0	38	0	38	0	39	0	39	0	39	0	40	0	40	0	40	0	41	0	41	60
4 12	0	40	0	40	0	41	0	41	0	41	0	42	0	42	0	42	0	43	0	43	63
4 24	0	42	0	42	0	43	0	43	0	43	0	44	0	44	0	44	0	45	0	45	66
4 36	0	44	0	44	0	44	0	45	0	45	0	46	0	46	0	46	0	47	0	47	69
4 48	0	46	0	46	0	46	0	47	0	47	0	48	0	48	0	48	0	49	0	49	72
5 0	0	47	0	48	0	48	0	49	0	49	0	50	0	50	0	50	0	51	0	51	75
5 12	0	49	0	50	0	50	0	51	0	51	0	52	0	52	0	52	0	53	0	53	78
5 24	0	51	0	52	0	52	0	53	0	53	0	54	0	54	0	54	0	55	0	55	81
5 36	0	53	0	54	0	54	0	55	0	55	0	56	0	56	0	56	0	57	0	57	84
5 48	0	55	0	56	0	56	0	57	0	57	0	58	0	58	0	58	0	59	0	59	87
6 0	0	57	0	57	0	58	0	58	0	59	0	59	1	0	1	0	1	1	1	1	90
6 12	0	59	0	59	1	0	1	0	1	1	1	1	1	2	1	3	1	3	1	4	93
6 24	1	1	1	1	1	2	1	2	1	3	1	3	1	4	1	5	1	5	1	6	96
6 36	1	3	1	3	1	4	1	4	1	5	1	5	1	6	1	7	1	7	1	8	99
6 48	1	5	1	5	1	6	1	6	1	7	1	7	1	8	1	9	1	9	1	10	102
7 0	1	6	1	7	1	8	1	8	1	9	1	9	1	10	1	11	1	11	1	12	105
7 12	1	8	1	9	1	10	1	10	1	11	1	11	1	12	1	13	1	13	1	14	108
7 24	1	10	1	11	1	12	1	12	1	13	1	13	1	14	1	15	1	15	1	16	111
7 36	1	12	1	13	1	13	1	14	1	15	1	15	1	16	1	17	1	17	1	18	114
7 48	1	14	1	15	1	15	1	16	1	17	1	17	1	18	1	19	1	19	1	20	117
8 0	1	16	1	17	1	17	1	18	1	19	1	19	1	20	1	21	1	21	1	22	120
8 12	1	18	1	19	1	19	1	20	1	21	1	21	1	22	1	23	1	23	1	24	123
8 24	1	20	1	20	1	21	1	22	1	23	1	23	1	24	1	25	1	25	1	26	126
8 36	1	22	1	22	1	23	1	24	1	25	1	25	1	26	1	27	1	27	1	28	129
8 48	1	24	1	24	1	25	1	26	1	27	1	27	1	28	1	29	1	29	1	30	132
9 0	1	25	1	26	1	27	1	28	1	28	1	29	1	30	1	31	1	31	1	32	135
9 12	1	27	1	28	1	29	1	30	1	30	1	31	1	32	1	33	1	34	1	34	138
9 24	1	29	1	30	1	31	1	32	1	32	1	33	1	34	1	35	1	36	1	36	141
9 36	1	31	1	32	1	33	1	34	1	34	1	35	1	36	1	37	1	38	1	38	144
9 48	1	33	1	34	1	35	1	36	1	36	1	37	1	38	1	39	1	40	1	40	147
10 0	1	35	1	36	1	37	1	37	1	38	1	39	1	40	1	41	1	42	1	42	150
10 12	1	37	1	38	1	39	1	39	1	40	1	41	1	42	1	43	1	44	1	45	153
10 24	1	39	1	40	1	41	1	41	1	42	1	43	1	44	1	45	1	46	1	47	156
10 36	1	41	1	42	1	42	1	43	1	44	1	45	1	46	1	47	1	48	1	49	159
10 48	1	43	1	43	1	44	1	45	1	46	1	47	1	48	1	49	1	50	1	51	162
11 0	1	44	1	45	1	46	1	47	1	48	1	49	1	50	1	51	1	52	1	53	165
11 12	1	46	1	47	1	48	1	49	1	50	1	51	1	52	1	53	1	54	1	55	168
11 24	1	48	1	49	1	50	1	51	1	52	1	53	1	54	1	55	1	56	1	57	171
11 36	1	50	1	51	1	52	1	53	1	54	1	55	1	56	1	57	1	58	1	59	174
11 48	1	52	1	53	1	54	1	55	1	56	1	57	1	58	1	59	2	0	2	1	177
12 0	1	54	1	55	1	56	1	57	1	58	1	59	2	0	2	1	2	2	2	3	180
	3'	48"	3'	50"	3'	52"	3'	54"	3'	56"	3'	58"	4'	0"	4'	2"	4'	4"	4'	6"	

TABLE XXIX. For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other Time under any other Meridian.

Time from Noon.	Daily Variation of the Sun's Right Ascension in Time. 4' 8"	4' 10"	4' 12"	4' 14"	4' 16"	4' 18"	4' 20"	4' 22"	4' 24"	4' 26"	4' 28"	Ship's Long.
0h 0'	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0' 0"	0°
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	3
0 24	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	6
0 36	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 7	0 7	0 7	0 7	9
0 48	0 8	0 8	0 8	0 8	0 9	0 9	0 9	0 9	0 9	0 9	0 9	12
1 0	0 10	0 10	0 10	0 11	0 11	0 11	0 11	0 11	0 11	0 11	0 11	15
1 12	0 12	0 12	0 13	0 13	0 13	0 13	0 13	0 13	0 13	0 13	0 13	18
1 24	0 14	0 15	0 15	0 15	0 15	0 15	0 15	0 15	0 15	0 16	0 16	21
1 36	0 17	0 17	0 17	0 17	0 17	0 17	0 17	0 17	0 18	0 18	0 18	24
1 48	0 19	0 19	0 19	0 19	0 19	0 19	0 19	0 20	0 20	0 20	0 20	27
2 0	0 21	0 21	0 21	0 21	0 21	0 21	0 22	0 22	0 22	0 22	0 22	30
2 12	0 23	0 23	0 23	0 23	0 23	0 24	0 24	0 24	0 24	0 24	0 25	33
2 24	0 25	0 25	0 25	0 25	0 26	0 26	0 26	0 26	0 26	0 27	0 27	36
2 36	0 27	0 27	0 27	0 28	0 28	0 28	0 28	0 28	0 29	0 29	0 29	39
2 48	0 29	0 29	0 29	0 30	0 30	0 30	0 30	0 31	0 31	0 31	0 31	42
3 0	0 31	0 31	0 31	0 32	0 32	0 32	0 32	0 33	0 33	0 33	0 33	45
3 12	0 33	0 33	0 34	0 34	0 34	0 34	0 35	0 35	0 35	0 35	0 36	48
3 24	0 35	0 35	0 36	0 36	0 36	0 37	0 37	0 37	0 37	0 38	0 38	51
3 36	0 37	0 37	0 38	0 38	0 38	0 39	0 39	0 39	0 40	0 40	0 40	54
3 48	0 39	0 40	0 40	0 40	0 41	0 41	0 41	0 41	0 42	0 42	0 42	57
4 0	0 41	0 42	0 42	0 42	0 43	0 43	0 43	0 44	0 44	0 44	0 45	60
4 12	0 43	0 44	0 44	0 44	0 45	0 45	0 45	0 46	0 46	0 47	0 47	63
4 24	0 45	0 46	0 46	0 47	0 47	0 47	0 48	0 48	0 48	0 49	0 49	66
4 36	0 48	0 48	0 48	0 49	0 49	0 49	0 50	0 50	0 51	0 51	0 51	69
4 48	0 50	0 50	0 50	0 51	0 51	0 52	0 52	0 52	0 53	0 53	0 54	72
5 0	0 52	0 52	0 52	0 53	0 53	0 54	0 54	0 55	0 55	0 55	0 56	75
5 12	0 54	0 54	0 55	0 55	0 55	0 56	0 56	0 57	0 57	0 58	0 58	78
5 24	0 56	0 56	0 57	0 57	0 58	0 58	0 58	0 59	0 59	1 0	1 0	81
5 36	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 1	1 2	1 2	1 3	84
5 48	1 0	1 0	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 4	1 5	87
6 0	1 2	1 2	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 6	1 7	90
6 12	1 4	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 8	1 9	1 9	93
6 24	1 6	1 7	1 7	1 8	1 8	1 9	1 9	1 10	1 10	1 11	1 11	96
6 36	1 8	1 9	1 9	1 10	1 10	1 11	1 11	1 12	1 13	1 13	1 14	99
6 48	1 10	1 11	1 11	1 12	1 13	1 13	1 14	1 14	1 15	1 15	1 16	102
7 0	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 16	1 17	1 18	1 18	105
7 12	1 14	1 15	1 16	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 20	108
7 24	1 16	1 17	1 18	1 18	1 19	1 20	1 20	1 21	1 21	1 22	1 23	111
7 36	1 19	1 19	1 20	1 20	1 21	1 22	1 22	1 23	1 24	1 24	1 25	114
7 48	1 21	1 21	1 22	1 23	1 23	1 24	1 24	1 25	1 26	1 26	1 27	117
8 0	1 23	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	1 29	1 29	120
8 12	1 25	1 25	1 26	1 27	1 27	1 28	1 29	1 30	1 30	1 31	1 32	123
8 24	1 27	1 27	1 28	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	126
8 36	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	1 35	1 35	1 36	129
8 48	1 31	1 32	1 32	1 33	1 34	1 35	1 35	1 36	1 37	1 38	1 38	132
9 0	1 33	1 34	1 34	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 40	135
9 12	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 40	1 41	1 42	1 43	138
9 24	1 37	1 38	1 39	1 39	1 40	1 41	1 42	1 43	1 43	1 44	1 45	141
9 36	1 39	1 40	1 41	1 42	1 42	1 43	1 44	1 45	1 46	1 46	1 47	144
9 48	1 41	1 42	1 43	1 44	1 45	1 45	1 46	1 47	1 48	1 49	1 49	147
10 0	1 43	1 44	1 45	1 46	1 47	1 47	1 48	1 49	1 50	1 51	1 52	150
10 12	1 45	1 46	1 47	1 48	1 49	1 50	1 50	1 51	1 52	1 53	1 54	153
10 24	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 54	1 55	1 56	156
10 36	1 50	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 57	1 58	159
10 48	1 52	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	162
11 0	1 54	1 55	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	165
11 12	1 56	1 57	1 58	1 59	1 59	2 0	2 1	2 2	2 3	2 4	2 5	168
11 24	1 58	1 59	2 0	2 1	2 2	2 3	2 3	2 4	2 5	2 6	2 7	171
11 36	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	174
11 48	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	177
12 0	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 13	2 14	180
	4' 8"	4' 10"	4' 12"	4' 14"	4' 16"	4' 18"	4' 20"	4' 22"	4' 24"	4' 26"	4' 28"	

EXPLANATION AND USE OF TABLE XXIX.

THIS table is uſeful in finding the ſun's right aſcenſion at any time, by means of the right aſcenſion given in the ſecond page of the Nautical Almanac for noon at Greenwich. This table muſt be entered at the top with the daily variation of the ſun's right aſcenſion; and in the left hand column with the given time from noon; or in the right hand column with the longitude of the place; directly under the former and oppoſite to the latter, ſtands a correction in minutes and ſeconds, to be applied to the ſun's right aſcenſion at noon at Greenwich. The correction taken out with the time from noon, is to be added in the afternoon, but ſubtracted in the forenoon; and the correction taken out with the longitude of the place, is to be added in weſt, but ſubtracted in eaſt longitude.

Inſtead of finding the correction ſeparately for the longitude of the place and the time from noon, you may find it at one entry, in the following manner. Turn the ſhip's longitude into time (by TAB. XX.) and add it to the given time when in weſt longitude, but ſubtract it when in eaſt; the ſum or difference will be the time at Greenwich: find this time in the ſide column,* and the daily variation at the top, correſponding to which is the ſought correction; which is to be added to the ſun's right aſcenſion for the preceding noon at Greenwich.

EXAMPLE I.

Required the ſun's right aſcenſion at noon, May 24, 1804, ſea account, in the longitude of 45° W. of Greenwich.

May 24, ſea account is May 23 by N. A. The ſun's right aſcenſion by N. A. at Greenwich	3h.	59m.	55ſ.
Corr. Tab. XXIX. for 45° long. and daily var. 4m. 1ſec. add			30
Right Aſcen. required	4	0	25

EXAMPLE II.

Required the ſun's right aſcenſion at noon, June 24, 1804, ſea account, in the longitude of 120° E. of Greenwich.

June 24, ſea account is June 23, by N. A. on which day at noon the ſun's R. A. is	6h.	7m.	29ſ.
Corr. Tab. XXIX. for 120° long. and daily var. 4m. 9ſec. ſub.		1	23
Right Aſcen. required	6	6	6

EXAMPLE III.

Required the ſun's right aſcenſion, May 24, 1804, at 4h. P. M. ſea account, in the longitude of 45° W.

R. A. at noon in long. 45° W. by Ex. 1.	4h.	0m.	25ſec.
Corr. in Tab. XXIX. for 4h. P. M. add			40
R. A. May 24, 1804, at 4h. P.M.	4	1	5

EXAMPLE IV.

Required the ſun's right aſcenſion, June 24, 1804, at 9h. A. M. ſea account, in the longitude of 120° E.

R. A. at noon in longitude 120° E. by Ex. 2.	6h.	6m.	6ſ.
Corr. in Tab. XXIX. for 12 hours		2	5
for 9 hours		1	34
R. A. June 24, 1804, at 9h. A.M.	6	9	45

* If the time at Greenwich be more than 12h. you muſt firſt take out the correction for 12h. and then for the reſt of the time; the ſum of theſe two will be the correction.

The third and fourth examples may be worked by a ſingle entry of Table XXIX. as follows,

EXAMPLE III.

	d.	h.	m.
Given time by N.A. May	23	4	0
Long. 45° in time add		3	0
Time at Greenwich	23	7	0
	h.	m.	ſ.
Sun's R. A. May 23, at noon	3	59	55
Corr. Tab. XXIX. for 7h.		1	10
Sun's R.A. May 23, 1804, at 4h. P.M.	4	1	5

EXAMPLE IV.

	d.	h.	m.
Given time by N.A. June	23	21	0
Long. 120° in time		8	0
Time at Greenwich	23	13	0
	h.	m.	ſ.
Sun's R. A. June 23, at noon	6	7	29
Corr. Tab. XXIX. for 12h.		2	5
for 1h.			10
Sun's R. A. June 23, 21h. 0m.	6	9	44

If you wiſh to find accurately the time that any ſtar comes to the meridian, or the time of its riſing or ſetting, you muſt firſt take the ſun's right aſcenſion for noon at Greenwich, from the Nautical Almanac; then the ſtar's right aſcenſion from Table IX. and with theſe, find the approximate time of riſing, ſetting, or coming to the meridian, by the method already given in the precepts for uſing Tables IX. and X. Then calculate the ſun's right aſcenſion for this approximate time, and repeat the operation till the aſſumed and calculated times agree, and you will have the true time required.

For to explain this method, I ſhall uſe the examples already given, in explaining the manner of calculating by Tables IX. and X.

To find the Time when a Star comes to the Meridian.

EXAMPLE I.

At what time will Aldebaran be on the meridian of Salem, Jan. 2, 1804, ſea account?

	h.	m.	ſ.
Jan. 2, ſea acc. is Jan. 1, N.A. on which day the ſun's R. A. at noon at Greenwich is	18	43	20
Aldebaran's R.A. 4h. 24m. 41ſ. Add 24	28	24	41
Difference is the approximate time	9	41	21
Now calculating the ſun's R. A. for this time in the long. of Salem, 70° 50' W. of London, I find it to be	18	45	59
Aldebaran's R. A. + 24h.	28	24	41
True time of coming to the merid.	9	38	42

EXAMPLE II.

At what time will Pollux be on the meridian of Newburyport, March 31, 1804, ſea account?

	h.	m.	ſ.
March 31, ſea acc. is Mar. 30, N.A. on which day, at noon, the ſun's right aſcenſion is	0	35	15
This, ſubtracted from R.A. of Pollux	7	33	18
Approximate time of ſouthing	6	58	3
Correction of the ſun's R.A. from Tab. XXIX. for this time is		1	4
And for the long. 70° 46' W. of Lond.			43
The ſum of theſe two corrections is		1	47

which ſubtracted from the approximate time of ſouthing 6h. 58m. 3ſec. leaves the true time 6h. 56m. 16ſec.

The method uſed in the laſt example, of applying the corrections to the approximate time, inſtead of applying them to the right aſcenſion of the ſun, will be found more expeditious than the other method, made uſe of in ſolving Example I. But it muſt be noted, that the corrections applied to the approximate time have a contrary ſign to what they would have when applied to the right aſcenſion.

To find the Time of riſing or ſetting of a Star.

RULE. Enter Table X. with the declination of the ſtar at the top, and the latitude of the place at the ſide; the correſponding number will be the time of the ſtar's continuance above the horizon, when the latitude and declination are of the ſame name; but if they are of different names, the tabular number ſubtracted from 12h. will be the time of continuance above the horizon. Add this time to the ſtar's right aſcenſion, when you want to find the time of ſetting; but ſubtract it,* if you want the time of riſing. From this ſum or difference ſubtract the ſun's right aſcenſion* corrected for the longitude of the place; the remainder will be the approximate time ſought.† Enter Table XXIX. with the diſtance of this approximate time from noon, and the daily variation of the ſun's right aſcenſion; the correction correſponding is to be added to the approximate time in the forenoon, but ſubtracted in the afternoon, and you will have the corrected time of riſing or ſetting.

EXAMPLE I.

At what time will the ſtar Aldebaran ſet, May 24, 1804, ſea account, at Waſhington city?

The ſtar's declination is 16° 6½′ or 16° 7′N. and the latitude 38° 53′ N. correſponding to which in Table X. is	6h.	54m.
Star's right aſcenſion	4	25
Sum	11	19
May 24, ſea acc. or May 23 by N.A. at noon ſun's R. A. 4h. 0m.		
Corr. for long. 77° W. 1		
Sum ſubtract	4	1
Remains approximate time of ſetting	7	18
Corr. in Tab. XXIX. for 7h. 18m. ſub.		1
Corrected time of ſetting, P. M.	7	17

EXAMPLE II.

At what time will the Dog-Star Sirius riſe at Baltimore, Jan. 2, 1804, ſea account?

The ſtar's declination is 16° 27′ S. and the latitude of Baltimore is 39°20′ N. correſponding to which in Tab. X. is	6h.	56m.
Which ſubtracted from	12	0
Leaves the time of the ſtar's being above the horizon	5	4
Subtract from ſtar's R. A.	6	37
Remainder	1	33
Add	24	
Sum	25	33
Jan. 2, ſea acc. or Jan. 1, by N.A. at noon ſun's R. A. 18h. 43m.		
Corr. for long. 76° 50′ W. 0 1		
Subtract the ſum	18	44
Remains approximate time of riſing	6	49
Corr. in Tab. XXIX. for 6h. 49m. ſub.		1
Correct time of riſing in the afternoon	6	48

* Increaſing the number from which the ſubtraction is to be made, by 24 hours, when neceſſary.

† Rejecting 24 hours when it exceeds 24 hours. If the time of riſing or ſetting be more than 12h. it will be after midnight; but if leſs than 12h. it will be before midnight.

Explanation of Sea Terms.

ABACK. The ſituation of the ſails, when their ſurfaces are preſſed aft againſt the maſt by the force of the wind.

ABAFT or AFT. The ſternmoſt part of the ſhip: Carry aft any thing; that is, carry towards the ſtern. The maſt rakes aft, that is, hangs towards the ſtern. How cheer ye fore and aft? that is, How fares all the ſhip's company?

ABAFT THE BEAM denotes the relative ſituation of any object with the ſhip, when the object is placed in any part of that arch of the horizon, which is contained between a line at right angles with the keel and that point of the compaſs which is directly oppoſite to the ſhip's courſe. See Bearing.

ABOARD. The inſide of a ſhip. Aboard Main Tack! The order to draw the lower corner of the mainſail down to the cheſtree.

ABOUT. The ſituation of a ſhip as ſoon as ſhe has tacked or changed her courſe. About Ship; the order to the ſhip's crew to prepare for tacking.

ABREAST. The ſituation of two or more ſhips lying with their ſides parallel, and their heads equally advanced; in which caſe, they are abreaſt of each other.

ADRIFT. The ſtate of a ſhip broken from her moorings, and driving about without control.

AFLOAT. Buoyed up by the water from the ground.

AFORE. All that part of a ſhip which lies forward, or near the ſtem. It alſo ſignifies farther forward; as, the manger ſtands afore the fore-maſt; that is nearer to the ſtem.

AFTER. A phraſe applied to any object in the hinder part of the ſhip, as the after-hatchway, the after-ſails, &c.

AGROUND. The ſituation of a ſhip when her bottom or any part of it reſts on the ground.

AHEAD. Any thing which is ſituated on that point of the compaſs to which a ſhip's ſtem is directed, is ſaid to be ahead of her. See Bearing.

AHULL. The ſituation of a ſhip, when all her ſails are furled and her helm is laſhed to the lee ſide; by which ſhe lies nearly with her ſide to the wind and ſea, her head being ſomewhat inclined to the direction of the wind.

A-LEE. The poſition of the helm when it is puſhed down to the lee ſide.

ALL IN THE WIND. The ſtate of a ſhip's ſails, when they are parallel to the direction of the wind, ſo as to ſhake or ſhiver.

ALL HANDS HOAY! The call by which all the ſhip's company are ſummoned upon deck.

ALOFT. Up in the tops, at the maſt-heads, or any where about the higher rigging.

ALONG-SIDE. Side-by-ſide, or joined to a ſhip, wharf, &c.

ALONG-SHORE. Along the coaſt; a courſe which is in ſight of the ſhore, and nearly parallel to it.

ALOOF, is diſtance. Keep aloof, that is, keep at a diſtance.

AMAIN. The old term for yield, uſed by a man of war to an enemy; but it now ſignifies any thing done ſuddenly, or at once, by a number of men.

AMIDSHIPS. The middle of a ſhip, either with regard to her length or breadth.

ANCHOR. The inſtrument by which a ſhip is held. The anchor is foul; that is, the cable has got about the fluke of the anchor. The anchor is a-peek; that is, directly under the hawſe-hole of the ſhip. The anchor is a cock-bill; that is, hangs up and down the ſhip's ſide.

AN-END. The poſition of any maſt, &c. when erected perpendicularly on the deck. The top-maſts are ſaid to be an-end, when they are hoiſted up to their uſual ſtations.

APEEK. Perpendicular to the anchor; the cable having been drawn ſo tight as to bring the ſhip directly over it. The anchor is then ſaid to be apeek.

ASHORE. On the ſhore, as oppoſed to aboard. It alſo means aground.

ASTERN. Any diſtance behind a ſhip, as oppoſed to Ahead. See Bearing.

AT ANCHOR. The ſituation of a ſhip riding by her anchor.

ATHWART. Acroſs the line of a ſhip's courſe. Athwart-Hawſe; the ſituation of a ſhip when driven by accident acroſs the fore-part of another, whether they touch or are at a ſmall diſtance from each other, the tranſverſe poſition of the former being principally underſtood. Athwart the Fore-Foot; when any object croſſes the line of a ſhip's courſe, but ahead of her, it is ſaid to be athwart her fore-foot. Athwart-Ships; reaching, or in a direction, acroſs the ſhip from one ſide to the other.

ATRIP. When applied to the anchor, it means that the anchor is drawn out of the ground, and hangs, in a perpendicular direction, by the cable or buoy-rope. The topſails are ſaid to be atrip, when they are hoiſted up to the maſt-head, or to their utmoſt extent.

AVAST. A term used for stop, or stay; as, avast heaving, don't heave any more.

AWEIGH. The same as atrip, when applied to the anchor.

AWNING. A shelter or screen of canvas spread over the decks of a ship to keep off the heat of the sun. Spread the awning, extend it so as to cover the deck. Furl the awning; that is roll it up.

To BACK THE ANCHOR. To carry out a small anchor ahead of the large one, in order to support it in bad ground, and to prevent it from loosening or coming home.

To BACK ASTERN, in rowing, is to impel the boat with her stern foremost, by means of the oars.

To BACK THE SAILS. To arrange them in a situation that will occasion the ship to move astern.

To BAGPIPE THE MIZEN. To lay it aback, by bringing the sheet to the mizen shrouds.

To BALANCE. To contract a sail into a narrower compass, by folding up a part of it at one corner. Balancing is peculiar only to the mizen of a ship, and the mainsail of those vessels wherein it is extended by a boom.

BALE. Bale the boat; that is, to lade or throw the water out of her.

BALLAST, is either pigs of iron, stones, or gravel, which last is called shingle ballast; and its use is to bring the ship down to her bearings in the water, which her provisions and stores will not do. Trim the ballast; that is, spread it about and lay it even. The ballast shoots; that is, it shifts, or runs over from one side of the hold to the other.

BARE POLES. When a ship has no sail set, she is under bare poles.

BARGE. A carvel-built boat, that rows with ten or twelve oars.

BATTEN. A thin piece of wood. Batten down the hatches, is to lay battens upon the tarpaulins, which are over the hatches in bad weather, and nail them down that they may not be washed off.

BEAR A-HAND. Make haste, dispatch.

BEARING signifies the point of the compass which any two or more places bear from each other, or how any place bears from the ship by the compass; or it may be said to bear on the beam, abaft the beam, on the bow, the head or stern, &c.

BEARINGS of a Ship, is that line which is formed by the water upon her sides when she is at anchor, with her proportion of ballast, and stores on board. To bear to, is to sail into an harbour, &c. Bear round up; that is, put her right before the wind. Bring your guns to bear, is to point them to the object.

To BEAR IN with the Land, is when a ship sails towards the shore.

To BEAR OFF. To thrust or keep off from the ship's side, &c. any weight, when hoisting.

BEARING-UP, or BEARING-AWAY. The act of changing the course of a ship, in order to make her run before the wind, after she had sailed some time with a side wind, or close hauled; it is generally performed to arrive at some port under the lee, or to avoid some imminent danger occasioned by a violent storm, leak, or enemy in sight.

BEATING TO WINDWARD. The making a progress against the direction of the wind, by steering alternately close-hauled on the starboard and larboard tacks.

To BECALM. To intercept the current of the wind, in its passage to a ship, by any contiguous object, as a shore above her sails, a high sea behind, &c. and thus one sail is said to becalm another.

BEFORE THE BEAM, denotes an arch of the horizon comprehended between the line of the beam, and that point of the compass on which the ship stems. See Bearing.

BELAY. To make fast any running rope; as, Belay the main brace, or make it fast.

BEND. To apply to, and fasten; as, bend the sails, apply them to the yards and fasten them; unbend the sails, that is, cast them off and take them from the yards; her sails are unbent, she has none fixed; bend the cable, make it fast to the anchor.

BENEAPED. See Neaped.

BETWEEN-DECKS. The space contained between any two decks of a ship.

BIGHT of a Rope. Any part between the two ends. Bight, a narrow inlet of the sea.

BILGE. To break. The ship is bilged; that is, her planks are broken in by violence.

BILGE-WATER, is that which, by reason of the flatness of a ship's bottom, lies on her floor, and cannot go to the well of the pump.

BIRTH. A place; as, the ship's birth, the place where she is moored; an officer's birth, his place in the ship to eat or sleep in; birth the ship's company, that is, allot them their places to mess in; birth the hammocks, point out where each man's hammock is to hang.

BINNACLE. A kind of box to contain the compasses in upon deck.

BITTS. Very large pieces of timber in the fore part of a ship, round which the cables are fastened when the ship is at anchor. After-Bitts, a smaller kind of bitts upon the quarter-deck, for belaying the running rigging to.

To BITT the Cable, is to confine the cable to the bitts, by one turn under the cross-piece, and another turn round the bitt-head. In this position it may be either kept fixed, or it may be veered away.

BITTER. The turn of the cable round the bitts. Bitter-End; that part of the cable which stays within board, round about the bitts, when the ship is at anchor.

BLOCK. A piece of wood with running sheaves or wheels in it, through which the running rigging is passed to add to the purchase.

BOARD. To board a ship is to enter it in a hostile manner.

BOARD and BOARD, is when two ships touch each other. To make a board, is making a stretch upon any tack when a ship is working upon a wind. To board it up, that is to turn to windward. The ship has made a stern-board, that is when she loses ground in working upon a wind.

BOLD SHORE. A steep coast, permitting the close approach of shipping.

BONNET of a sail. Is an additional piece of canvas put to the sail in moderate weather to hold more wind. Lace on the bonnet, that is, fasten it to the sail. Shake off the bonnet, take it off.

BOOT-TOPPING. Cleaning the upper part of a ship's bottom, or that part which lies immediately under the surface of the water; and daubing it over with tallow, or with a mixture of tallow, sulphur, rosin, &c.

BOLT-ROPE. The rope which goes round a sail, and to which the canvas is sewed.

BOTH SHEETS AFT. The situation of a ship sailing right before the wind.

BOW-GRACE. A frame of old rope or junk, laid out at the bows, stems, and sides, of ships, to prevent them from being injured by flakes of ice.

BOW-LINES. Lines made fast to the sides of the sails to haul them forward when upon a wind, which being hauled taut, enables the ship to come nearer to the wind.

To BOWSE. To pull upon any body with a tackle, in order to remove it.

BOWSPRIT. A large mast or piece of timber which stands out from the bows of a ship.

BOXHAULING. A particular method of veering a ship, when the swell of the sea renders tacking impracticable.

BOXING. An operation somewhat similar to BOXHAULING. It is performed by laying the head-sails aback, to receive the greatest force of the wind in a line perpendicular to their surfaces, in order to return the ship's head into the line of her course, after she had inclined to windward of it.

BRACES. The ropes by which the yards are turned about to form the sails to the wind.

TO BRACE THE YARDS. To move the yards, by means of the braces, to any direction required. To brace about—To brace the yards round for the contrary tack. To brace sharp—To brace the yards to a position, in which they will make the smallest possible angle with the keel, for the ship to have head-way. To brace-to—To ease off the lee-braces, and round in the weather-braces, to assist the motion of the ship's head in tacking.

BRAILS. A name peculiar only to certain ropes belonging to the mizen, used to truss it up to the mast. But it is likewise applied to all the ropes which are employed in hauling up the bottoms, lower corners and skirts of the other great sails. To brail up—To haul up a sail by means of the brails, for the more readily furling it when necessary.

TO BREAK BULK. The act of beginning to unload a ship.

TO BREAK SHEER. When a ship at anchor is forced, by the wind or current, from that position in which she keeps her anchor most free of herself and most firm in the ground, so as to endanger the tripping of her anchor, she is said to break her sheer.

BREAMING. Burning off the filth from a ship's bottom.

BREAST-FAST. A rope employed to confine a ship side ways to a wharf or to some other ship.

TO BRING BY THE LEE. See TO BROACH TO.

TO BRING TO. To check the course of a ship when she is advancing, by arranging the sails in such a manner as that they shall counteract each other, and prevent her from either retreating or advancing. See TO LIE TO.

TO BROACH TO. To incline suddenly to windward of the ship's course, so as to present her side to the wind, and endanger her oversetting. The difference between BROACHING TO and BRINGING BY THE LEE may be thus defined: Suppose a ship under great sail is steering south, having the wind at N. N. W. then west is the weather-side, and east the lee-side. If, by any accident, her head turns round to the westward, so as that her sails are all taken a-back on the weather side, she is said to BROACH TO. If, on the contrary, her head declines so far eastward as to lay her sails aback on that side which was the lee-side, it is called BRINGING BY THE LEE.

BROADSIDE. A discharge of all the guns on one side of a ship both above and below.

BROKEN BACKED. The state of a ship which is so loosened in her frame as to drop at each end.

BY THE BOARD. Over the ship's side.

BY THE HEAD. The state of a ship when she is so unequally loaded as to draw more water forward than aft.

BY THE WIND. The course of a ship as near as possible to the direction of the wind, which is generally within six points of it.

BUNT-LINES. Lines that come down from the top of the maſt to the beam of the outſide of the ſail, and by which the bunt or belly of the ſail is hauled up outwards.

BUOY. A floating conical caſk, moored upon ſhoals to ſhow where the danger is; alſo uſed to anchors to ſhew where they lie, in caſe of the cable breaking.

CAP-SISE. Overturn. The boat capſiſed, that is, overſet. Capſiſe the quoil of rope, that is, turn it over.

CAPSTAN. An inſtrument by which the anchor is weighed out of the ground, it being a great mechanical power, and is uſed for ſetting up the ſhrouds, and other work where great purchaſes are required.

TO CAREEN. To incline a ſhip on one ſide ſo low down, by the application of a ſtrong purchaſe to her maſts, as that her bottom on the other ſide may be cleanſed by breaming.

CASTING. The motion of falling off, ſo as to bring the direction of the wind on either ſide of the ſhip after it had blown ſome time right a-head. It is particularly applied to a ſhip about to weigh anchor.

CAT-HEADS. The timbers on ſhip's bows with ſheaves in them, by which the anchor is purchaſed from the hauſe, and to which it is ſecured to the ſhip's ſide.

TO CAT THE ANCHOR is to hook the cat-block to the ring of the anchor and haul it up cloſe to the cat-head.

CAT'S PAW. A light air of wind perceived at a diſtance in a calm, ſweeping the ſurface of the ſea very lightly, and dying away before it reaches the ſhip.

CAULKING. Filling the ſeams of a ſhip with oakum.

CENTRE. This word is applied to that ſquadron of a fleet, in a line of battle, which occupies the middle of the line; and to that column (in the order of ſailing) which is between the weather and lee columns.

CHAINS. A place built on the ſides of the ſhip projecting out, and at which the ſhrouds are faſtened, for the purpoſe of giving them a greater angle than they could have if faſtened to the ſhip's ſide, and of courſe giving them greater power to ſecure the maſt.

CHAIN-PLATES, are plates of iron faſtened to the ſhip's ſides under the chains, and to theſe plates the dead eyes are faſtened by other plates.

CHAPELLING. The act of turning a ſhip round in a light breeze of wind when ſhe is cloſe-hauled, ſo that ſhe will lie the ſame way ſhe did before. This is uſually occaſioned by negligence in ſteering or by a ſudden change of wind.

CHASE. A veſſel purſued by ſome other. Chaſer—The veſſel purſuing.

CHEERLY. A phraſe implying heartily, quickly, cheerfully.

TO CLAW OFF. The act of turning to windward from a lee-ſhore to eſcape ſhipwreck, &c.

CLEAR is variouſly applied. The weather is ſaid to be clear, when it is fair and open; the ſea-coaſt is clear, when the navigation is not interrupted by rocks, &c. It is applied to cordage, cables, &c. when they are diſentangled, ſo as to be ready for immediate ſervice. In all theſe ſenſes it is oppoſed to FOUL. To clear the anchor is to get the cable off the flukes, and to diſencumber it of ropes ready for dropping. Clear hawſe—When the cables are directed to their anchors without lying athwart the ſtem. To clear the hawſe is to untwiſt the cables when they are entangled by having either a croſs, an elbow, or a round turn.

CLENCHED. Made faſt, as the cable is to the ring of the anchor.

CLEW. To haul up the ſails by the clew lines.

CLEW-LINES, are ropes which come down from the maſt to the lower corners of the ſails, and by which the corners or clews of the ſails are hauled up.

CLOSE-HAULED. That trim of the ſhip's ſails, when ſhe endeavours to make a progreſs in the neareſt direction poſſible towards that point of the compaſs from which the wind blows.

TO CLUB-HAUL. A method of tacking a ſhip when it is expected ſhe will miſs ſtays on a lee-ſhore.

TO CLUE UP. To haul up the clues of a ſail to its yard by means of the clue-lines.

COASTING. The act of making a progreſs along the ſea-coaſt of any country.

TO COIL THE CABLE. To lay it round in a ring, one turn over another.

TO COME HOME. The anchor is ſaid to come home when it looſens from the ground by the effort of the cable, and approaches the place where the ſhip floated, at the length of her moorings.

COMING TO denotes the approach of a ſhip's head to the direction of the wind.

COURSE. The point of the compaſs upon which the ſhip ſails. Courſes, a ſhip's lower ſails; as the fore-ſail is the fore courſe, the main-ſail, the main-courſe, &c. The ſhip is under her courſes, that is, has no ſail ſet but the main-ſail, fore-ſail and mizen.

COXSWAIN. The perſon who ſteers the boat.

CRANK. The ſhip is crank, that is ſhe has not a ſufficient cargo or ballaſt to render her capable of bearing ſail, without being expoſed to the danger of overſetting.

CROW-FOOT, is a number of ſmall lines ſpread from the fore parts of the tops, by means of the piece of wood through which they paſs, and being hauled taut upon the ſtays, they prevent the foot of the topſails catching under the top rim; they are alſo uſed to ſuſpend the awnings.

CUN. To direct. To cun a ſhip, is to direct the man at helm how to ſteer.

TO CUT AND RUN. To cut the cable and make ſail inſtantly, without waiting to weigh anchor.

TO DEADEN A SHIP'S WAY. To impede her progreſs through the water.

DEAD EYES. Blocks of wood through which the lanyards of the ſhrouds are reeved.

DEAD LIGHTS. A kind of window ſhutter for the windows in the ſtern of a ſhip, uſed in very bad weather only.

DEAD WATER. The eddy of water, which appears like whirl-pools, cloſing in with the ſhip's ſtern as ſhe ſails on.

DEAD-WIND. The wind right againſt the ſhip, or blowing from the very point to which ſhe wants to go.

DISMASTED. The ſtate of a ſhip that has loſt her maſts.

DOG-VANE. A ſmall vane with feathers and cork, and placed on the ſhip's quarter for the men at cun and helm, to ſee the courſe of the wind by.

DOG-WATCH. The watches from four to ſix, and from ſix to eight in the evening.

DOUBLING. The act of ſailing round or paſſing beyond a cape or point of land. Doubling upon—The act of incloſing any part of a hoſtile fleet between two fires, or of cannonading it on both ſides.

DOUCE. To ſtrike or haul down; as, douce the top-gallant ſails, that is, lower them.

DOWN-HAUL. The rope by which any ſail is hauled down; as the Jibb down-haul.

TO DOWSE. To lower ſuddenly, or ſlacken.

TO DRAG THE ANCHOR. To trail it along the bottom, after it is looſened from the ground.

TO DRAW. When a ſail is inflated by the wind, ſo as to advance the veſſel in her courſe, the ſail is ſaid to *draw*; and ſo *to keep all drawing* is to inflate all the ſails.

DRIFT. The angle which the line of a ſhip's motion makes with the neareſt meridian, when ſhe drives with her ſide to the wind and waves, and not governed by the power of the helm. It alſo implies the diſtance which the ſhip drives on that line.

DRIVER. A large ſail ſet upon the mizen yards in light winds. Drive.—The ſhip drives, that is, her anchor comes through the ground.

DROP. Uſed ſometimes to denote the depth of a ſail; as the fore-top-ſail *drops* twelve yards.

TO DROP ANCHOR. Uſed ſynonymouſly with *to anchor*. To drop a-ſtern.—The retrograde motion of a ſhip.

DUNNAGE. A quantity of looſe wood, &c. laid at the bottom of a ſhip to keep the goods from being damaged.

TO EASE, TO EASE AWAY, or to EASE OFF. To ſlacken gradually; thus they ſay, *eaſe* the bowline, *eaſe* the ſheet.

EASE THE SHIP. The command given by the pilot, to the ſteerſman, to put the helm hard a-lee, when the ſhip is expected to plunge her fore part deep in the water when cloſe hauled.

TO EDGE AWAY. To decline gradually from the ſhore or from the line of the courſe which the ſhip formerly held, in order to go more large.

TO EDGE IN WITH. To advance gradually towards the ſhore or any other object.

ELBOW, IN THE HAWSE. Is when a ſhip being moored, has gone round upon the ſhifting of the tides, twice the wrong way, ſo as to lay the cables one over the other: having gone once wrong, ſhe makes a croſs in the hawſe, and going three times wrong ſhe makes a round turn.

END FOR END. A term uſed when a rope runs all out of a block, and is unreeved; or in coming to an anchor, if the ſtoppers are not well put on, and the cable runs all out, it is ſaid to have gone out end for end.

END ON. When a ſhip advances to a ſhore, rock, &c. without an apparent poſſibility of preventing her, ſhe is ſaid to go *end on* for the ſhore, &c.

ENGAGEMENT. Action or fight.

ENSIGN. The flag worn at the ſtern of a ſhip.

ENTERING-PORT. A large port in the ſide of three deckers leading into the middle deck, to ſave the trouble of going up the ſhip's ſide to get on board.

EVEN KEEL. When the keel is parallel with the horizon, a ſhip is ſaid to be upon an *even keel*.

FAIR. A general term for the diſpoſition of the wind when favorable to a ſhip's courſe.

FAIR-WAY. The channel of a narrow bay, river, or haven, in which ſhips uſually advance in their paſſage up and down.

FACK, *or* FAKE. One circle of any rope or cable quoiled.

TO FALL A-BOARD OF. To ſtrike or encounter another ſhip when one or both are in motion. To fall a-ſtern.—The motion of a ſhip with her ſtern foremoſt. To fall calm.—To become in a ſtate of reſt by a total ceſſation of the wind. To fall down.—To ſail or be towed down a river nearer towards its mouth.

FALLING OFF denotes the motion of the ſhip's head from the direction of the wind. It is uſed in oppoſition to *coming to*.

FALL NOT OFF, *or* NOTHING OFF. The command of the steersman to keep the ship near the wind.

FATHOM. A measure of six feet.

TO FETCH AWAY. To be shaken or agitated from one side to another so as to loosen any thing which before was fixed.

FID. A square bar of wood or iron, with shoulders at one end; it is used to support the weight of the top-mast, when erected at the head of a lower-mast.

FID *for* SPLICING. A large piece of wood of a conical figure, used to extend the strands and layers of cables in splicing.

TO FILL. To brace the sails so as to receive the wind in them, and advance the ship in her course, after they had been either shivering or braced a-back.

FISH. A large piece of wood. Fish the mast, apply a large piece of wood to it to strengthen it.

FISH-HOOK. A large hook by which the anchor is received from under the hawser, and brought to the cat-head; and the tackle which is used for this purpose is called the fish-tackle.

TO FISH THE ANCHOR: To draw up the flukes of the anchor towards the top of the bow, in order to stow it, after having been catted.

FLAG. A general name for colors worn and used by ships of war.

FLAT-AFT. The situation of the sails when their surfaces are pressed aft against the mast by the force of the wind.

TO FLAT IN. To draw in the aftermost lower corner or clue of a sail towards the middle of the ship, to give the sail a greater power to turn the vessel. To flat in forward.—To draw in the fore-sheet, jib-sheet, and fore-staysail-sheet, towards the middle of the ship.

FLAW. A sudden breeze or gust of wind.

FLOATING. The state of being buoyed up by the water from the ground.

FLOOD-TIDE. The state of a tide when it flows or rises.

FLOWING SHEETS. The position of the sheets of the principal sails when they are loosened to the wind, so as to receive it into their cavities more nearly perpendicular than when close-hauled, but more obliquely than when the ship sails before the wind. A ship going two or three points large has *flowing sheets*.

FORE. That part of a ship's frame and machinery that lies near the stem. Fore and Aft. Throughout the whole ship's length. Lengthways of the ship.

FORE-REACH. To shoot a-head, or go past another vessel.

TO FORGE OVER. To force a ship violently over a shoal by a great quantity of sail.

FORWARD. Towards the fore part of a ship.

FOUL. Is used in opposition both to clear and fair. As opposed to clear, we say foul weather, foul bottom, foul ground, foul anchor, foul hawse. As opposed to fair, we say foul wind.

TO FOUNDER. To sink at sea by filling with water.

TO FREE. Pumping is said to free the ship when it discharges more water than leaks into her.

TO FRESHEN. When a gale increases it is said to freshen. To Freshen the Hawse.—Veering out or heaving in a little cable to let another part of it endure the stress of the hawse-holes. It is also applied to the act of renewing the service round the cable at the hawse-holes.

FRESHEN THE BALLAST. Divide or separate it.

FRESH WAY. When a ship increases her velocity she is said to get fresh way.

FULL. The situation of the sails, when they are kept distended by the wind.

FULL-AND-BY. The situation of a ship, with regard to the wind, when close-hawled; and sailing, so as to steer neither too nigh the direction nor to deviate to leeward.

TO FURL. To wrap or roll a sail close up to the yard or stay to which it belongs, and winding a cord round it, to keep it fast.

GAGE OF THE SHIP. Her depth of water, or what water she draws.

TO GAIN THE WIND. To arrive on the weather-side, or to windward of, some ship or fleet in sight, when both are sailing as near the wind as possible.

GAMMON THE BOWSPRIT. Secure it by turns of a strong rope passed round it, and into the cut-water, to prevent it from having too much motion.

GASKET. The rope which is passed round the sail to bind it to the yard when it is furled.

TO GATHER. A ship is said to gather on another as she comes nearer to her.

GIMBLETING. The action of turning the anchor round by the stock, so that the motion of the stock appears similar to that of the handle of a gimblet, when employed to turn the wire.

GIRT. The ship is girt with her cables when she is too tight moored.

TO GIVE CHASE TO. To pursue a ship or fleet.

GOOSE-WINGS OF A SAIL. The clues or lower corners of a ship's mainsail or foresail, when the middle part is furled or tied up to the yard.

Grappling-iron. A thing in the nature of an anchor, with four or ſix flukes to it.
Greave. To burn off the filth from her bottom.
Gripe of a ſhip. That thin part of her which is under the counter; and to which the ſtern-poſt joins. The ſhip gripes, that is, turns her head too much to the wind.
Grounding. The laying a ſhip a-ſhore, in order to repair her. It is alſo applied to running a-ground accidentally.
Ground-tackle. Every thing belonging to a ſhip's anchors, and which are neceſſary for anchoring or mooring; ſuch as cables, hawſers, tow-lines, warps, buoy-ropes, &c.
Ground-tier. That is, the tier of water-caſks which is loweſt in the hold, and is among the ſhingle ballaſt.
Growing. Stretching out; applied to the direction of the cable from the ſhip towards the anchors: as, the cable Grows on the ſtarboard bow.
Grummet. A piece of rope laid into a circular form, and uſed for large boat's oars inſtead of rowlocks, and alſo for many other purpoſes.
Gunnel. The large timber that runs along upon the upper part of a ſhip's ſide.
Gun-room. A diviſion of the lower deck abaft, incloſed with net-work, for the uſe of the gunner and junior-lieutenant, and in which their cabbins ſtand.
Gybing. The act of ſhifting any boom-ſail from one ſide of the maſt to the other.
Hail. To call to another ſhip.
Halyards. The ropes by which the ſails are hoiſted, as the top-ſail halyards, the jibb halyards, &c.
Hard-a-weather. Put the tiller quite up to windward.
Haul. Pull.
To *Haul the wind.* To direct the ſhip's courſe nearer to the point from which the wind blows.
Hawſe-holes. The holes in the bows of the ſhip through which the cables paſs. Freſhen hawſe, veer out more cable. Clap a ſervice in the hawſe, put ſomewhat round the cable at the hawſe-hole to prevent its chafing. To clear hawſe, is to untwiſt the cables where a ſhip is moored, and has got a foul hawſe. Athwart hawſe is to be acroſs or before another ſhip's head.
Hawſer. A ſmall kind of cable.
Head-faſt. A rope employed to confine the head of a ſhip to a wharf or to ſome other ſhip. Headmoſt. The ſituation of any ſhip or ſhips which are the moſt advanced in a fleet. Head-ſails. All the ſails which belong to the fore-maſt and bowſprit.
Head-ſea. When the waves meet the head of a ſhip in her courſe, they are called a head-ſea. It is likewiſe applied to a ſingle wave coming in that direction.
Head-to-wind. The ſituation of a ſhip when her head is turned to the point from which the wind blows, as it muſt when tacking.
Head-way. The motion of advancing, uſed in oppoſition to ſtern-way.
To *Heave.* To turn about a capſtan, or other machine of the like kind, by means of bars, handſpecs, &c. To Heave a-head. To advance the ſhip by heaving-in the cable or other rope faſtened to an anchor at ſome diſtance before her. To Heave a-peek. To heave-in the cable, till the anchor is a-peek. To Heave a-ſtern. To move a ſhip backwards by an operation ſimilar to that of heaving a-head. To Heave down. To careen. To Heave in the cable. To draw the cable into the ſhip, by turning the capſtan. To Heave in ſtays. To bring a ſhip's head to the wind, by a management of the ſails and rudder, in order to get on the other tack. To Heave out. To unfurl or looſe a ſail; more particularly applied to the ſtayſails: thus we ſay, looſe the topſails and heave out the ſtayſails. To Heave ſhort. To draw ſo much of the cable into the ſhip, as that ſhe will be almoſt perpendicularly over her anchor. To Heave tight or taut. To turn the capſtan round, till the rope or cable becomes ſtraightened. To Heave the capſtan. To turn it round. To Heave the lead. To throw the lead overboard, in order to find the depth of water. To Heave the log. To throw the log overboard, in order to calculate the velocity of the ſhip's way. Heave the capſtan. That is, turn it round with the bars. Heave handſomely. Heave gently or leiſurely. Heave hearty. Heave ſtrong and quick.
Head of the ſea, is the power that the ſwell of the ſea has upon a ſhip in driving her out, or faſter on, in her courſe, and for which allowance is made in the day's work.
Heel, or incline. She heels to port, that is, inclines or lays down upon her larboard or left ſide.
Helm. The inſtrument by which the ſhip is ſteered, and includes both the wheel and the tiller, as one general term. Helm's-a-lee. That is, the tiller is quite down to leeward.
High and dry. The ſituation of a ſhip when ſo far run a-ground as to be ſeen dry upon the ſtrand.
Hitch. To make faſt.
Hoiſt. To hawl, ſway, or lift up.
Hold, is the ſpace between the lower deck and the bottom of a ſhip, and where her ſtores, &c. lie. To ſtow the hold, is to place the things in it.

To *hold its own*, is applied to the relative situation of two ships when neither advances upon the other; each is then said to hold its own. It is likewise said of a ship which, by means of contrary winds, cannot make a progress towards her destined port, but which however keeps nearly the distance she had already run.

Home, implies the proper situation of any object; as, to haul home the topsail sheets is to extend the bottom of the topsail to the lower yard, by means of the sheets. In stowing a hold, a cask, &c. is said to be home, when it lies close to some other object.

Hulk. A ship without masts or rigging; also a vessel to remove masts into or out of ships by means of sheers, from whence they are called sheer hulks.

Hull of the ship. The body of it. To lay a hull, is to lay to, with only a small sail in a gale of wind. To hull a vessel, is to fire a shot into any part of her hull. *Hull-down*, is when a ship is so far off, that you can only see her masts. To *hull* a ship—to fire cannon-balls into her hull within the point-blank range. *Hull-to*—the situation of a ship when she lies with all her sails furled; as in *trying*.

In Stays. See to *heave* in stays.

Jeer-blocks. The blocks through which jeers are reeved.

Jeers. The ropes by which the lower yards are suspended.

Jibb. The foremast sail of a ship, set upon a boom which runs out from the bowsprit. *Jibb-boom*. A spar that runs out upon the bowsprit.

Jolly-boat. A small boat.

Junk. Old cable, or old rope.

Keel-haul. To drag a person backwards and forwards under a ship's keel for certain offences.

Keckled. Any part of a cable, covered over with old ropes, to prevent its surface from rubbing against the ship's bow or fore foot.

To Keep Away. To alter the ship's course to one rather more large, for a little time, to avoid some ship, danger, &c. *Keep away* is likewise said to the steersman, who is apt to go to windward of the ship's course. *To Keep Full*—to keep the sails distended by the wind. *To Keep Hold of the land*—to steer near to or in sight of the land. *To Keep Off*—to sail off or keep at a distance from the shore. *To Keep the land aboard*—the same as *to keep hold of the land*. *To keep the luff*—to continue close to the wind. *To keep the wind*—the same as *to keep the luff*.

Knippers. A large kind of plated rope, which being twisted round the messenger and cable in weighing, bind them together.

Knot. A division of the log-line, answering, in the calculation of the ship's velocity, to one mile.

To Labour. To roll or pitch heavily in a turbulent sea.

Laden in Bulk. Freighted with a cargo not packed, but lying loose, as corn, salt, &c.

Laid-Up. The situation of a ship when moored in a harbour, for want of employ.

Land-Fall. The first land discovered after a sea-voyage. Thus a *good land fall* implies the land expected or desired; a *bad land-fall* the reverse.

Land-Locked. The situation of a ship surrounded with land, so as to exclude the prospect of the sea, unless over some intervening land.

Lanyards of the shrouds, are the small ropes at the ends of them, by which they are hove taut, or tight.

Larboard. The left side of a ship, looking towards the head. *Larboard-Tack*—the situation of a ship when sailing with the wind blowing upon her larboard side.

Lash. To bind.

Lanch-ho, signifies high enough, or lower.

Laying the Land. A ship which increases her distance from the coast, so as to make it appear lower and smaller, is said to *lay the land*.

Leading-Wind. A fair wind for a ship's course.

Leak. A chink or breach in the sides or bottom of a ship, through which the water enters into the hull.

Lee. That part of the hemisphere to which the wind is directed, to distinguish it from the other part which is called to windward. *Lee-Gage*—a ship or fleet to leeward of another is said to have the lee-gage. *Lee-Lurches*—the sudden and violent rolls which a ship often takes to leeward, in a high sea; particularly when a large wave strikes her on the weather side. *Lee-Quarter*—that quarter of a ship which is on the lee-side. *Lee-Shore*—that shore upon which the wind blows. *Lee-side*—that half of a ship lengthwise, which lies between a line drawn through the middle of her length and the side which is farthest from the point of wind. *To Leeward*—towards that part of the horizon to which the wind blows. *Leeward Ship*—a ship that falls much to leeward of her course, when sailing close-hauled. *Leeward Tide*—a tide that sets to leeward. *Lee-way*—the lateral movement of a ship to leeward of her course; or the angle which the line of her way makes with a line in the direction of her keel. *To lie along*—to be pressed down sideways by a weight of sail in a fresh wind.

To Lie-to. To retard a ship in her course, by arranging the sails in such a manner as to counteract each other with nearly an equal effort, and render the ship almost immovable, with respect to her progressive motion or headway.

Lifts. The ropes which come to the ends of the yards from the mast-heads, and by which the yards are tossed up and down.

List. Incline. The ship has a list to port, that is, she heels to the larboard.

Log, and *Log-line*, by which the ship's path is measured, and her rate of going ascertained. *Log board*, on which is marked the transactions of the ship, and from thence it is copied into the log-book every twenty-four hours.

A Long Sea. An uniform motion of long waves.

Look-Out. A watchful attention to some important object or event that is expected to arise. Thus persons on-board of a ship are occasionally stationed to *look out* for signals, other ships, for land, &c.

To Loose. To unfurl or cast loose any sail.

To Lower. To ease down gradually.

Luff! The order to the steersman to put the helm towards the lee-side of the ship, in order to sail nearer to the wind.

To make a board. To run a certain distance upon one tack, in beating to windward. *To make foul water*—to muddy the water, by running in shallow places, so that the ship's keel disturbs the mud at bottom. *To make sail*—to increase the quantity of sail already set, either by unreefing or by setting others. *To make sternway*—to retreat or move with the stern foremost. *To make the land*—to discover it from afar. *To make water*—to leak.

To *man the yard*, &c. To place men on the yard, in the tops, down the ladder, &c. to execute any necessary duties.

Mast. The upright timber or trees on which the yards and sails are set.

Masted. Having all her masts complete.

Mend the service. Put on more service.

Messenger. A small kind of cable, which being brought to the capstan, and the cable by which the ship rides made fast to it, it purchases the anchor.

To *middle a rope.* To double it into two equal parts.

Midships. See *Amidships.*

To *miss stays.* A ship is said to *miss stays*, when her head will not fly up into the direction of the wind, in order to get her on the other tack.

Mizen-Mast. The mast which stands abaft, and from which its rigging and sails are named; as of the sails, mizen, mizen-top-sail, &c. and so also are the other sails, &c. named from the other masts.

Moor, is to secure a ship with two anchors. *Mooring*—securing a ship in a particular station by chains or cables, which are either fastened to an adjacent shore or to anchors at the bottom. *Mooring service*—when a ship is moored, and rides at one cable's length, the mooring service is that which is at the first splice.

Mouse. A kind of ball or knob, wrought upon the collar of the stays.

Muster. To assemble.

Narrows. A small passage between two lands.

Neap-tides. The tides in the first and last quarter of the moon, and are not either so high, so low, or so rapid as spring tides. A ship is said to be beneaped, when she has not water enough to take her off the ground, or over the bar, &c.

Near or no near. An order to the steersman not to keep the ship so close to the wind.

Nothing-off. A term used by the man at the cun to the steersman, directing him not to go from the wind.

Nun-buoy. The kind of buoys used by ships of war.

Oakum. Old rope untwisted and pulled open.

Off-and-on. When a ship is beating to windward, so that by one board she approaches towards the shore, and by the other stands out to sea, she is said to stand *off-and-on* shore.

Offing. To seaward from the land. A ship is in the offing, that is, she is to seaward, at a distance from the land. She stands for the offing, that is, towards the sea.

Offward. From the shore; as when a ship lies aground and leans towards the sea, she is said to heel *offward.*

On board. Within the ship; as, he is come on board.

On the beam. Any distance from the ship on a line with the beams, or at right angles with the keel. See *bearing.*

On the bow. An arch of the horizon, comprehending about four points of the compass on each side of that point to which the ship's head is directed. Thus, they say, the ship in sight bears three points on the starboard bow; that is three points, towards the right-hand, from that part of the horizon which is right a-head. See *Bearing.*

On the quarter. An arch of the horizon, comprehending about four points of the compass on each side of that point to which the ship's stern is directed. See *on the bow.*

Open. The situation of a place exposed to the wind and sea. It is also expressed of any distant object to which the sight or passage is not intercepted.

Open Hawse. When the cables of a ship at her moorings lead straight to their respective anchors, without crossing, she is said to ride with an *open hawse*.
Orlop. The deck on which the cables are stowed.
Over-board. Out of the ship; as, he fell over-board, meaning, he fell out of, or from the ship.
Over-grown Sea is expressed of the ocean when the surges and billows rise extremely high.
Over-haul. To clear away and disentangle any rope; also to come up with the chase; as, we over-haul her, that is, we gain ground of her.
Over-Rake. When a ship at anchor is exposed to a head-sea, the waves of which break in upon her, the waves are said to *over-rake* her.
Over-set. A ship is *over-set*, when her keel turns upwards.
Out-of-trim. The state of a ship, when she is not properly balanced for the purposes of navigation.
Parcel a rope. Is to put a quantity of old canvass round it before the service is put on. *Parcel a seam.* Is to lay a narrow piece of canvass over it after it is caulked, before it is payed.
Parliament-heel. The situation of a ship when she is made to stoop a little to one side, so as to clean the upper part of her bottom on the other side. See *Boot-topping.*
Parting. Being driven from the anchors, by the breaking of the cable.
To Pawl the capstan. To fix the pawls, so as to prevent the capstern from recoiling, during any pause of heaving.
To pay. To daub or cover the surface of any body, with pitch, tar, &c. in order to prevent it from the injuries of the weather.
To pay away or pay out. To slacken a cable or other rope, so as to let it run out for some particular purpose.
To Pay off. To move a ship's head to leeward.
To *peek the Mizen.* To put up the mizen yard perpendicular by the mast.
Peek. To ride a stay-peck, is when the cable and the fore-stay form a line. To ride a short peck, is when the cable is so much in as to destroy the line formed by the stay-peck. To ride with the yards a peck, is to have them topped up by contrary lifts, so as to represent St. Andrew's cross.
Pendant. The long narrow flag worn at the mast head by all ships of the navy. Brace pendants are those ropes which secure the brace-blocks to the yard arms, and are always double, in case of one being shot away, the other may secure the yards in its proper position.
Pitching. The movement of a ship, by which she plunges her head and after-part alternately into the hollow of the sea.
Point-Blank. The direction of a gun when levelled horizontally.
Points. A number of plated ropes made fast to the sails for the purpose of reefing.
Pooping. The shock of a high and heavy sea upon the stern or quarter of a ship, when she scuds before the wind in a tempest.
Port. A name given on some occasions to the larboard side of the ship; as, the ship heels to port, top the yards to port, &c. Also a harbour or haven.
Ports. The holes in the ship's sides from which the guns are fired.
Port the helm! The order to put the helm over to the larboard side.
Port-last. The gunnel.
Press of Sail. All the sail a ship can set or carry.
Pudding and dolphin. A large and lesser pad made of ropes, and put round the masts under the lower yards.
Purchase. Any sort of mechanical power employed in raising or removing heavy bodies.
Quarters. The respective stations of the officers and people in time of action. Quartering, distributing the men into different places. Quarter-bill, the list of the ship's company, with their stations for action noticed.
Quarter-wind, is when the wind blows in abaft the main shrouds.
Quoil, is a rope or cable laid up round, one fake over another.
To Raise. To elevate any distant object at sea by approaching it; thus, *to raise the land* is used in opposition to *lay the land.*
To *Rake.* To cannonade a ship at the stern or head, so that the balls scour the whole length of the decks.
Range of Cable. A sufficient length of cable drawn upon deck before the anchor is cast loose, to admit of its sinking to the bottom without any check.
Ratlines. The small ropes fastened to the shrouds, by which the men go aloft.
Reach. The distance between any two points on the banks of a river, wherein the current flows in an uninterrupted course.
Ready about! A command of the boatswain to the crew, and implies that all the hands are to be attentive and at their stations for tacking.
Rear. The last division of a squadron, or the last squadron of a fleet. It is applied likewise to the last ship of a line, squadron, or division.

Reef. Part of a fail from one row of eyelet-holes to another. It is applied likewife to a chain of rocks lying near the furface of the water.
Reefing. The operation of reducing a fail by taking in one or more of the reefs.
To *Reeve.* To pafs the end of a rope through any hole, as the channel of a block, the cavity of a thimble, &c.
Rendering. The giving way or yielding to the efforts of fome mechanical power. It is ufed in oppofition to jambing or fticking.
Ride at anchor, is when a fhip is held by her anchors, and is not driven by wind or tide. To *ride athwart,* is to ride with the fhip's fide to the tide. To *ride hawfe fallen,* is when the water breaks into the hawfe in a rough fea.
Righting. Reftoring a fhip to an upright pofition, either after fhe has been laid on a careen, or after fhe has been preffed down on her fide by the wind.
To *Right the helm,* is to bring it into midfhips, after it has been pufhed either to ftarboard or larboard.
Rigging out a boom. The running out a pole at the end of a yard to extend the foot of a fail.
To *Rig the capftern.* To fix the bars in their refpective holes.
Road. A place near the land where fhips may anchor, but which is not fheltered.
Rolling. The motion by which a fhip rocks from fide to fide like a cradle.
Rough-Tree. A name applied to any maft, yard, or boom, placed in merchant's fhips, as a rail or fence above the veffel's fide, from the quarter-deck to the fore-caftle.
Rounding-in. The pulling upon any rope which paffes through one or more blocks in a direction nearly horizontal; as, *round-in* the weather-braces.
Rounding. Old ropes faftened on the cable near the anchor to keep it from chafing.
Round-turn. The fituation of the two cables of a fhip when moored, after they have been feveral times croffed by the fwinging of the fhip.
Rounding-up. Similar to *rounding-in,* except that it is applied to ropes and blocks which act in a perpendicular direction.
To *Row.* To move a boat with oars.
Rowfing. Pulling up a cable or rope without the affiftance of tackles.
Rudder. The machine by which the fhip is fteered.
Rullock. The nitch in a boat's fide, in which the oars are ufed.
To *Run out a warp.* To carry the end of a rope out from a fhip in a boat, and faftening it to fome diftant object, fo that by it the fhip may be removed by pulling on it.
To *Sag to leeward.* To make confiderable lee-way.
Sailing-trim is expreffed of a fhip when in the beft ftate for failing.
She fands, or *fends.* When the fhip's head or ftern falls deep in the trough of the fea.
Scanting. The variation of the wind, by which it becomes unfavourable to a fhip's making great progrefs, as it deviates from being large, and obliges the veffel to fteer clofe-hauled or nearly fo.
Scudd. To go right before the wind; and going in this direction without any fail fet is called *fpooning.*
Scuttling. Cutting large holes through the bottom or fides of a fhip, either to fink her or to unlade her expeditioufly when ftranded.
Sea. A large wave is fo called. Thus, they fay a *heavy fea.* It implies likewife the agitation of the ocean, as, a *great fea.* It expreffes the direction of the waves, as, a *head fea.* A *long fea* means a uniform and fteady motion of long and extenfive waves; a *fhort fea,* on the contrary, is when they run irregularly, broken, and interrupted.
Sea-boat. A veffel that bears the fea firmly, without ftraining her mafts, &c.
Sea-clothes. Jackets, trowfers, &c.
Sea-mark. A point or object on fhore confpicuoufly feen at fea.
Sea-room. A fufficient diftance from the coaft or any dangerous rocks, &c. fo that a fhip may perform all nautical operations without danger of fhipwreck.
Seaze. To bind or make faft.
Serve. To wind fomething about a rope to prevent it from chafing or fretting. The fervice is the thing fo wound about the rope.
Setting. The act of obferving the fituation of any diftant object by the compafs.
To *Set fail.* To unfurl and expand the fails to the wind, in order to give motion to the fhip.
To *Set up.* To increafe the tenfion of the fhrouds, back-ftays, &c. by tackles, lanyards, &c.
Settle. To lower; as, *fettle the top-fail halyards,* lower them.
To *Settle the land.* To lower in appearance. It is fynonymous with *to lay the land.*
Shank-painter. The rope by which the fhank of the anchor is held up to the fhip's fide; is alfo made faft to a piece of iron chain, in which the fhank of the anchor lodges.
To *Shape a courfe.* To direct or appoint the track of a fhip in order to profecute a voyage.
Sheer. The fheer of the fhip is the curve that is between the head and the ftern, upon her fide. *The fhip fheers about,* that is, fhe goes in and out.
To *Sheer off.* To remove to a greater diftance.

Sheers, are spars lashed together and raised up for the purpose of getting out or in a mast.

To *Sheet-home*. To haul the sheets of a sail home to the block on the yard-arm.

To *Shift the helm*. To alter its position from right to left, or from left to right.

To *Ship*. To take any person, goods, or thing, on board. It also implies to fix any thing in its proper place, as, to *ship the oars*, to fix them in their rullocks.

Shivering. The state of a sail when fluttering in the wind.

Shoal. Shallow.

To *Shoe the anchor*. To cover the flukes with a piece of plank to give it firmer hold in soft ground.

To *Shoot a-head*. To advance forward.

Shore. A general name for the sea-coast of any country.

To *Shorten sail*. Used in opposition to *make sail*.

Sinnett. A small plated rope, made from rope yarns.

Slack-water. The interval between the flux and reflux of the tide, when no motion is perceptible in the water.

Slatch, is applied to the period of a transitory breeze.

To slip the cable. To let it run quite out when there is not time to weigh the anchor.

To slue. To turn any cylindrical piece of timber about its axis without removing it. Thus, to *slue a mast*, or *boom*, is to turn it in its cap or boom-iron.

Sound. To try the depth of water.

Sounding-line. A line to sound with, which is marked in the following manner: Black leather, at 2 and 3 fathoms, white at 5, red at 7, black at 10, white at 13, (some seamen use black at 10 and 13) white at 15 as at 5, red at 17 as at 7, two knots at 10 fathoms, and an additional knot at ever 10 fathoms, with a single knot midway between each 10 fathoms to mark the line at every 5 fathoms.

To *Spell the mizen*. To let go the sheet and peek it up.

To spill. To discharge the wind out of the cavity or belly of a sail, when it is drawn up in the brails, in order to furl or reef it.

Spilling-lines, are ropes contrived to keep the sails from being blown away when they are clewed up in blowing weather.

Splice. To make two ends of ropes fast together by untwisting them, and then putting the strands of one piece with the strands of the other.

Split. The state of a sail rent by the violence of the wind.

Spoon-drift. A sort of showery sprinkling of the sea-water, swept from the surface of the waves in a tempest, and flying like a vapour before the wind.

Spray. The sprinkling of a sea, driven occasionally from the top of a wave, and not continual as a *spoon-drift*.

To *Spring a mast, yard*, &c. To crack a mast, yard, &c. by means of straining in blowing weather, so that it is rendered unsafe for use. *To spring a leak*. When a leak first commences, a ship is said to *spring a leak*. To *spring the luff*. A ship is said to *spring her luff* when she yields to the effort of the helm, by sailing nearer to the wind than before.

Spring stays, are rather smaller than the stays, and placed above them, and intended to answer the purpose of the stay if it should be shot away, &c.

Spring-tides, are the tides at new and full moon, which flow highest and ebb lowest.

Spurling-Line, is a line that goes round a small barrel, abaft the barrel of the wheel, and coming to the front beam of the poop deck, moves the tell-tale with the turning of the wheel, and keeps it always in such position, as to shew the position of the tiller.

Spur-shoes, are large pieces of timber which come abaft the pump well.

Squall. A sudden violent blast of wind.

Square: This term is applied to yards that are very long, as *taunt* is to high masts.

To *square the yards*. To brace the yards so as to hang at right angles with the keel.

To stand on. To continue advancing. *To stand in*. To advance towards the shore. *To stand off*. To recede from the shore.

Starboard. The right-hand side of the ship, when looking forward. *Starboard-tack*. A ship is said to be on the *starboard-tack* when sailing with the wind blowing upon her starboard-side. *Starboard the helm!* An order to push the helm to the starboard-side.

To stay a ship. To arrange the sails and move the rudder so as to bring the ship's head to the direction of the wind, in order to get her on the other tack.

Stays. Large ropes coming from the mast heads down before the masts, to prevent them from springing when the ship is sending deep.

Steady! The order to the helmsman to keep the ship in the direction she is going at that instant.

Steering. The act of directing the ship's way by the movement of the helm.

Steerage-way. Such degree of progressive motion of a ship as will give effect to the motion of the helm.

To stem the tide. When a ship is sailing against the tide at such a rate as enables her to overcome its power, she is said to *stem the tide*.

STEEVE. Turning up. The bowsprit steeves too much, that is, it is too upright.
STERNFAST. A rope confining a ship by her stern to any other ship or wharf.
STERNMOST. The farthest a-stern, opposed to HEADMOST.
STERNWAY. The motion by which a ship falls back with her stern foremost.
STIFF. The condition of a ship when she will carry a great quantity of sail without hazard of overſetting. It is used in opposition to CRANK.
STOPPERS. Large kind of ropes, which being fastened to the cable in different places abaft the bitts, are an additional security to the ship at anchor.
TO STOW. To arrange and dispose a ship's cargo.
TO STREAM THE BUOY. To let it fall from the ship's side into the water, previously to casting anchor.
STRETCH OUT. A term used to men in a boat when they should pull strong.
TO STRIKE. To lower or let down any thing. Used emphatically to denote the lowering of colours in token of surrender to a victorious enemy.
TO STRIKE SOUNDING. To touch ground when endeavouring to find the depth of water.
SUED or SEWED. When a ship is on shore and the water leaves her, she is said to be sued: if the water leaves her two feet, she sues, or is sued two feet.
SURF. The swell of the sea that breaks upon shore or on any rock.
TO SURGE THE CAPSTERN. To slacken the rope heaved round upon it.
SWAY-AWAY. Hoist.
SWELL. The fluctuating motion of the sea either during or after a storm.
SWEEPING. The act of dragging the bight or loose part of a rope along the surface of the ground, in a harbour or road, in order to drag up something lost.
SWINGING. The act of a ship's turning round her anchor at the change of wind or tide.
TO TACK. To turn a ship about from one tack to another, by bringing her head to the wind.
TAKING-IN. The act of furling the sails. Used in opposition to SETTING.
TAKING A-BACK. See A-BACK.
TAMPINS, or TOMKINS. The bung, or piece of wood, by which the mouth of the cannon is filled to keep out wet.
TARPAULIN. A cloth of canvas covered with tar and saw-dust, or some other composition, so as to make it water proof.
TAUGHT. Improperly though very generally used for TIGHT.
TAUNT. High or tall. Particularly applied to masts of extraordinary length.
TELL-TALE. An instrument which traverses upon an index in the front of the poop deck, to shew the position of the tiller.
TENDING. The turning or swinging of a ship round her anchor in a tide-way at the beginning of ebb and flood.
THWART. See A-THWART. THWART SHIPS. See A-THWART SHIPS.
THUS! An order to the helmsman to keep the ship in her present situation, when sailing with a scant wind.
TIDE-WAY. That part of the river in which the tide ebbs and flows strongly.
TIDE IT UP. To go with the tide against the wind.
TILLER. A large piece of wood, or beam, put into the head of the rudder, and by means of which the rudder is moved.
TIER. A row; as a tier of guns, a tier of casks, a tier of ships, &c.
TOPPING. Pulling one of the ends of a yard higher than the other.
TORT, or TAUT, signifies tight.
TO TOW. To draw a ship in the water by a rope fixed to a boat or other ship which is rowing or sailing on.
TRAVERSE. To go backwards and forwards.
TREY-SAIL. A small sail used by cutters and brigs in blowing weather.
TRICE, TRICE UP. To haul up and fasten.
TRIM. The state or disposition by which a ship is best calculated for the purposes of navigation. TO TRIM THE HOLD. To arrange the cargo regularly. TO TRIM THE SAILS. To dispose the sails in the best arrangement for the course which a ship is steering.
TO TRIP THE ANCHOR. To loosen the anchor from the ground, either by design or accident.
TROUGH OF THE SEA. The hollow between two waves.
TRUCK. A round piece of wood put upon the top of flag-staves, with sheaves on each side for the halyards of the flags to reeve in.
TRYING. The situation in which a ship, in a tempest, lies-to in the trough or hollow of the sea, particularly when the wind blows contrary to her course.
TURNING TO WINDWARD. That operation in sailing, whereby a ship endeavours to advance against the wind.
TO UNBALLAST. To discharge the ballast out of a ship.
TO UNBEND. To take the sails off from their yards and stays. To cast loose the anchor from the cable. To untie two ropes.

To UNBIT. To remove the turns of a cable from off the bits.

UNDER FOOT is expressed of an anchor that is directly under the ship.

UNDER SAIL, or UNDER WAY. When a ship is sailing she is said to be UNDER WAY.

UNDER THE LEE OF THE SHORE, is to be close under the shore which lies to windward of the ship.

UNFURL. Cast loose the gasket of the sail.

To UNMOOR. To reduce a ship to the state of riding at single anchor, after she has been moored.

To UNREEVE. To draw a rope from out of a block, thimble, &c.

To UNRIG. To deprive the ship of her rigging.

UVROU. The piece of wood by which the legs of the crow-foot are extended.

VAN. The foremost division of a fleet in one line. It is likewise applied to the foremost ship of a division.

VANE. A small kind of a flag worn at each mast-head.

To VEER, or WEAR THE SHIP. To change a ship's course from one tack to the other, by turning her stern to windward.

VEER. Let out, as veer away the cable.

VEER. Shift. The wind veers, that is, it shifts, changes.

To VEER AND HAUL. To pull a rope tight, by alternately drawing it in and slackening it.

VIOL, or VOYAL. A block through which the messenger passes in weighing the anchor. A large messenger is called a VIOL.

WAKE. The path or track impressed on the water by the ship's passing through it, leaving a smoothness in the sea behind it. A ship is said to come into the wake of another when she follows her in the same track, and is chiefly done in bringing ships to, or in forming the line of battle.

WALES, are strong timbers that go round a ship a little above her water-line.

WARP. A small rope employed occasionally to remove a ship from one place to another.

To WARP. To remove a ship by means of a warp.

WATERLINE. The line made by the water's edge when a ship has her full proportion of stores, &c. on board.

WATER-BORNE. The state of a ship, when there is barely a sufficient depth of water to float her off from the ground.

WATER-LOGGED. The state of a ship, become heavy and inactive on the sea, from the great quantity of water leaked into her.

WATER-TIGHT. The state of a ship when not leaky.

WEATHER. To weather any thing is to get to windward of it. Synonymous with windward.

WEATHER-BEATEN. Shattered by a storm. WEATHER-BIT. A turn of the cable about the end of the windlass. WEATHER-GAGE. When a ship or fleet is to windward of another she is said to have the WEATHER-GAGE of her. WEATHER-QUARTER. That quarter of the ship which is on the windward side. WEATHER-SIDE. The side upon which the wind blows.

To WEIGH ANCHOR. To heave up an anchor from the bottom.

To WIND A SHIP. To change her position, bringing her head where her stern was.

WIND-ROAD. When a ship is at anchor, and the wind being against the tide, is so strong as to overcome its power and keep the ship to leeward of her anchor, she is said to be WIND-ROAD.

WIND'S-EYE. The point from which the wind blows.

To WINDWARD. Towards that part of the horizon from which the wind blows.

WINDWARD TIDE. A tide that sets to windward.

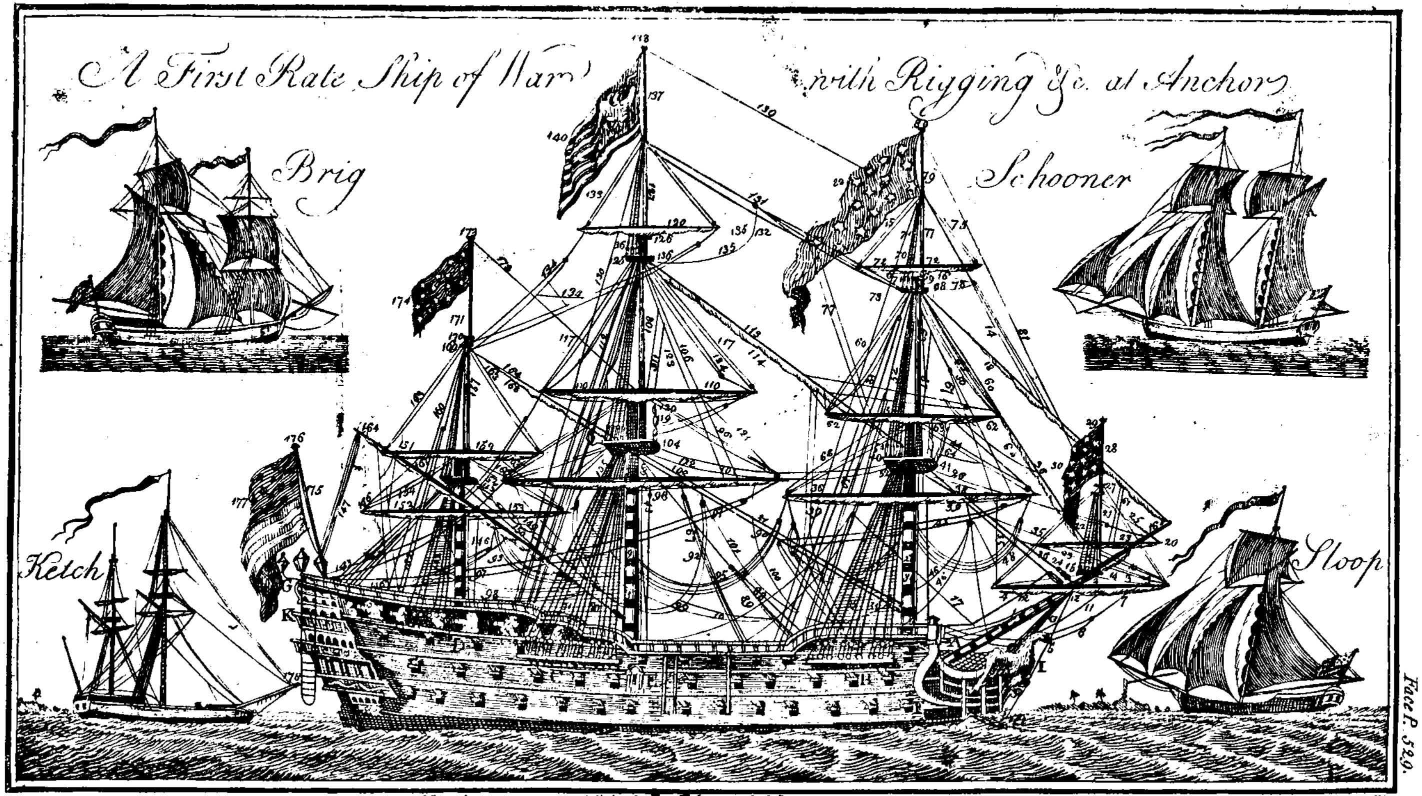
To WORK A SHIP. To direct the movements of a ship, by adapting the sails and managing the rudder according to the course the ship has to make.

To WORK TO WINDWARD. To make a progress against the direction of the wind.

WOOLD. To WOOLD is to bind round with ropes, as the mast is woolded.

YARDS. The spars upon which the sails are spread.

YAWING. The motion of a ship, when she deviates from her course to the right or left.



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Face P. 529.

EXPLANATION of the PLATE deſcribing the RIGGING, &c. of a FIRST-RATE SHIP OF WAR.

1 BOWSPRIT
2 Yard and ſail
3 Gammoning
4 Horſe
5 Bobſtay
6 Spritſail ſheets
7 Pendants
8 Braces and pendants
9 Halyards
10 Liffts
11 Clewlines
12 Spritſail horſes
13 Buntlines
14 Standing liffts
15 Spritſail tops
16 Flying jibboom
17 Flying jib, ſtay, and ſails
18 Halyards
19 Sheets
20 Horſes
21 SPRITSAIL TOP MAST
22 Shrouds
23 Yard and ſail
24 Sheets
25 Liffts
26 Braces and Pendants
27 Cap
28 Jack-ſtaff
29 Truck
30 Union jack
31 FORE-MAST
32 Runner and tackle
33 Shrouds
34 Lanyards
35 Stay and lanyards
36 Preventer ſtay and lanyard
37 Woolding the maſt
38 Yard and ſail
39 Horſes
40 Top
41 Crowfoot
42 Jeers
43 Yard-tackles
44 Liffts
45 Braces and pendants
46 Sheets
47 Fore tacks
48 Bowlines and bridles
49 Fore buntlines
50 Fore leechlines
51 Fore top-rope
52 Puttock ſhrouds
53 FORE TOP-MAST
54 Shrouds and halyards
55 Yard and ſail
56 Stay and ſail
57 Runner
58 Backſtays
59 Halyards
60 Liffts
61 Braces and pendants
62 Horſes
63 Clewlines
64 Bowlines and bridles
65 Reef tackles
66 Sheets
67 Buntlines
68 Croſstrees
69 Cap
70 FORETOP GAL. MAST
71 Shrouds and lanyards
72 Yards and ſails
73 Backſtays
74 Stay
75 Liffts
76 Clewlines
77 Braces and pendants
78 Bowlines and bridles
79 Flag-ſtaff
80 Truck
81 Flag-ſtaff ſtay
82 Burgee
83 MAIN-MAST
84 Shrouds
85 Lanyards
86 Runner and tackles
87 Pendant of the gornet
88 Guy of ditto
89 Fall of ditto
90 Stay
91 Preventer ſtay
92 Stay-tackle
93 Woolding the maſt
94 Jeers
95 Yard tackles
96 Liffts
97 Braces and pendants
98 Horſes
99 Sheets
100 Tacks
101 Bowlines and bridles
102 Crowfoot
103 Top-rope
104 Top
105 Buntlines
106 Leechlines
107 Yard and ſail
108 MAIN TOP-MAST
109 Shrouds and lanyards
110 Yard and ſail
111 Puttock ſhrouds
112 Backſtays
113 Stay
114 Stayſail & ſtay & halyards
115 Runners
116 Halyards
117 Liffts
118 Clewlines
119 Braces and pendants
120 Horſes
121 Sheets
122 Bowlines and bridles
123 Buntlines
124 Reef-tackles
125 Croſstrees
126 Caps
127 MAINTOP GAL. MAST
128 Shrouds and halyards
129 Yard and ſail
130 Backſtays
131 Stay
132 Stayſail and halyards
133 Liffts
134 Braces and pendants
135 Bowlines and bridles
136 Clewlines
137 Flag-ſtaff
138 Truck
139 Flag-ſtaff ſtay
140 American ſtandard
141 MIZEN MAST
142 Shrouds and lanyards
143 Pendants and buttons
144 Yard and ſail
145 Crowfoot
146 Sheet
147 Pendant lines
148 Peckbrails
149 Stayſail
150 Stay
151 Derrick and ſpan
152 Top
153 Croſs-jack yard
154 Croſs-jack liffts
155 Croſs-jack braces
156 Croſs-jack ſlings
157 MIZEN TOP-MAST
158 Shrouds and lanyards
159 Yard and ſail
160 Backſtays
161 Stay
162 Halyards
163 Liffts
164 Braces and pendant
165 Bowlines and bridles
166 Stays
167 Clewlines
168 Stayſail
169 Croſstrees
170 Cap
171 Flag-ſtaff
172 Flag-ſtaff ſtay
173 Truck
174 Union-jack
175 Enſign ſtaff
176 Truck
177 Enſign
178 Poop-ladder
179 Bower cable

HULL.

A Cat-head
B Fore channels
C Main channels
D Mizen channels
E Entering port
F Hauſe-holes
G Poop lanthorns
H Cheſstrees
I Head
K Stern

Evolutions at Sea.

Of the Ballast and Lading.

WHEN a ship is loading, it should be considered, that her tendency to pitch or roll depends not alone on her form, but even more upon the more or less advantageous distribution of the heaviest parts of her cargo.

Particular attention is to be paid to moderate her pitching, as that is what most fatigues a ship and her masts; and it is mostly in one of these motions that masts are seen to break, particularly when the head rises after having pitched. Although the rolling be proportionably a more considerable movement than pitching, it is seldom any accident is seen to arise from it, as it is always a slow one. It is however not less proper to prevent it as much as possible. This will in general be easily obtained, without being any way detrimental to the ship's stiff carrying of sail, if, when the ballast is iron, you stow it up to the floor heads; because it will recall the ship with less violence after her having inclined, and it will act on a point but little distant from the centre of gravity.

In the merchant-service the stowage consists, besides the ballast, of casks, cases, bales, boxes, &c. which are all carefully wedged off from the bottom, sides, pump-well, &c. and great attention paid that the most weighty materials are stowed nearest to the centre of gravity, or bearing of the ship; and higher or lower in the hold agreeably to the form of the vessel. A full low-built vessel requires them to be stowed high up, that the centre of gravity may be raised, to keep her from rolling away her mast, and from being too stiff and laboursome; as, on the contrary, a narrow high-built vessel requires the most weighty meterials to be stowed low down, nearest the kelson, that the centre of gravity may be kept low, to enable her to carry sail, and to prevent her oversetting.

To anchor in fine weather in a place where you will ride head to wind, being close-hauled.

Being under the three topsails, fore-topmast stay-sail, and mizen, stand on until you are within about two ships' lengths of the place where you mean to drop your anchor; then put the helm a-lee, and haul down the fore-topmast stay-sail. As soon as the topsails shiver clue them up briskly, before you lower; except the mizen topsail, which is to be laid to the mast, and the mizen sheet hauled flat aft, the instant the ship begins to have stern-way, by reason of the wind being a-head. Then shift the helm to windward, and let go the anchor, veering away the cable, to give it time to settle in the ground, until the vessel falls off, when she is to be checked, to bring her head to the wind. When that is done, right the helm, and haul up the mizen.

To anchor in fine weather in a place where you will ride head to wind, the wind being large.

If you have the wind large, whether on the beam or more aft, the operation is still the same, only hauling up a little sooner to keep to windward, because it is in your power to drift as much as you think requisite, and because the ship will be entirely stopped as soon as all her sails begin to catch a-back, and you will have done cluing them up when they begin to shake. The mizen top-sail is next to be heaved to the mast, the helm put a-weather, and the anchor let go, as soon as the head-way ceases: then after giving her a sufficiency of cable, bring the ship up. If she has been going large she will not range precisely head to wind, since her headway ceases as soon as the sails are taken a-back, and the effort of the wind acts on all the rigging of the ship to impel her both a-stern and to leeward, which is indeed augmenting the effect of the rudder, as the helm is a-weather to bring the vessel to the wind: but as the power of the wind is very great to pay the ship's head off, it balances, wholly or partly, (according as the ship goes a-stern with more or less velocity) the effort of the rudder and that of the mizen: thus she drifts, and remains as it were lying-to with all her sails a-back. This is the reason why we keep a little to windward, and let go the anchor, to bring the ship head to wind at the proper time; which she will do the more readily as she is withheld forward only by the cable, while the wind on her side forces her to leeward.

To anchor in fine weather in a place where you are to ride head to the stream and wind, the wind being large.

If you are obliged to ride with the head to the stream, you must, when it comes from to windward, put the helm a-lee in setting the mizen, then clue up the sails; and when the ship's head is right in the direction of the stream, let go the anchor, provided she has quite lost her head way; for, else, you would get foul of the anchor stock by running over it. This must never be neglected, unless you find yourself under the necessity to bring up in any situation in which you may happen to be, which is almost always the case when you are taken too short to have time to stop the vessel: a reason why there is often a necessity of casting a second anchor, which generally catches the ground by assistance of the first, which has begun to diminish the velocity of the ship; and as many of the sails are to be hauled down as you can, and as quick as possible.

To anchor in fine weather in a place where you will ride head to the stream, which comes from leeward, the wind being large.

When the current comes from to leeward, you must keep the ship away till her head comes to the set of the stream, and take in all the sails, to diminish as speedily as possible her head way, which always continues of itself long enough when the wind is aft or very large; and when the ship is stopped by the effort of the water, let go the anchor, without waiting for the vessel gathering stern-way, if the current is rapid; and, in this case, as well as all those wherein there is a sea, or blowing fresh, the ship requires a great length of cable.

To come to an anchor with the wind aft.

First, hand the main topsail, and then lower the fore topsail down on the cap; and when you are within a reasonable distance of the place where you mean to drop anchor, (which distance is to be judged of from the readiness of the ship to obey the helm, and from her velocity) the tiller may be put either one way or the other, the fore topsail and fore topmast-staysail clued up and taken in, the mizen-topsail braced sharp up, and the mizen-sheet hauled flat aft. When the ship ranges close to the wind, she is, as it were, lying-to under the mizen and mizen-topsails, with the last mentioned sail full or a-back, according as you may have occasion to shoot a-head or drop a-stern; so that, if you are too much to windward of the spot where you mean to bring to, you drift till you arrive at it: if you are precisely in the proper birth, you let go the anchor in lowering down the mizen-topsail, which is to be furled as soon as the vessel is brought up; then the ship will come head to wind by the power of the mizen, which must be brailed up as soon as it shakes.

Scudding under a foresail, to come to an anchor.

The foresail must be clued up when at some distance from your birth; and, some part of the way, run under bare poles. When near enough to sheer to the wind, you execute it by putting the helm hard a-lee; and, as soon as the ship is come-to, let go the anchor, giving her a large scope of cable, and observing to check her handsomely, in order to make her ride head to wind: as stopping her at first too short might endanger her cable or anchor. Should the first not bring her up, a second may be let go.

To anchor with a spring, in order to present the vessel's side to a place or ship you wish to cannonade.

This is executed when you know that the wind or current will bring your head, when at anchor, towards the object you mean to attack: for, should the wind or tide bring your broadside to bear on the object you mean to cannonade, the spring would only be a precaution to get under way more quickly in case you were obliged to retreat, or in case the wind or tide should shift.

Get a large snatch-block in the aftermost port, on the same side you wish to present to the wind or current, and on the same side with the anchor and cable with which you mean to bring up; then, through the block, reeve a hawser, the end of which is to be clinched to the ring of the anchor you mean to let go; the other part is brought to the capstern, with necessary ranges of the cable and hawser on deck. That done, and the ship being arrived at the birth, you are to deaden her way according to circumstances: you let go the anchor, and veer away enough cable and hawser, now a little more of the one, and then a little more of the other, according as you wish to present more head or stern; which you can do by heaving on the spring, or, what is the same, veering away more cable. Should you find it requisite to shift your position, you have only to veer out more of the hawser.

To come to an anchor in roads that are often crowded with ships, and to leave clear births for others.

The best anchoring births in these places are mostly known by marks, and of course are occupied by the first ships.

In a tide or trade-wind road-stead, the next ship that comes should not anchor right a-head or a-stern of the first ship and so as to lie in the other's hawse, but should come-to on the bow and quarter at a sufficient distance to prevent other ships from coming between, and in a slanting direction from the tide or wind. This might contribute to the safety of ships when it blows strong upon a lee-tide or in strong sea-breezes, as each single ship may then veer away what cable necessary, and keep clear of the other ship's hawse a-stern; or, in case of driving or casting, they have a better chance of keeping clear of each other.

To get up an anchor, in ships which have a main and jeer capstern.

In large ships which have a main and jeer capstern, and the strain is thought too great for the messenger alone, the viol is used thus: Three or four turns are taken round the jeer-capstern with one end, so as to leave that side clear on which the cable is coming in; and pass the other end through the viol block, which is lashed round the main-mast on the lower deck. It is then carried forward, and passed round the rollers in the manger near the hawse-holes; then brought aft, and spliced to the other end with a short splice, and the ends marled down tight. That side of the viol on which the cable is coming in is fastened to the cable by nippers; and thus the continued efforts of the capstern are conveyed to the cable, until it is hove in. The nippers are clapt on in the manger, from one to two fathoms asunder; and the viol is applied to the midships, or inside of the cable. Nippers are clapt on by taking three or four turns round the viol, four turns round the cable and viol, and then three or four turns round the cable. This method is an exceeding good one, and very suitable to quick heaving; but, when the strain is great, and the cable muddy, the nippers clapt on after this method will not nip sufficiently; and sometimes recourse is had to the following method: Throw sand or ashes upon the cable, and take a long dry nipper; which middle, and pass one-half aft, racking it in and out round the cable and viol; then worm its end round the viol only. After this, pass the other half in the same manner forward, but worm its end round the cable only, and let each end of the nipper be held on. The advantages of this method are, that, as the strain of the cable lies forward and that of the viol aft, the nipper will be drawn so tight as effectually to hold the cable till something gives way: also they can never jamb, for both ends are clear for taking off. Another method, when the strain is great, is, to have nippers with an overhand-knot made at one end; and with that end a round turn taken round the cable and viol, leaving three or four feet of the end; then, with the other end, take three or four racking turns, and expend nearly the remainder with turns round the cable and viol, laying the knotted end under and over each of the last turns: the end is then held fast. The men who clap on the nippers are attended by boys, who hold the ends of them, and follow the progression of the cable as it is hove in: and, as the nippers arrive near the main-hatchway, they are taken off and carried forward, where they are again clapt on: and so in succession, until the cable is hove in sufficiently to raise the anchor above the water. It is then stoppered round all before the bits: that is, round the cable and viol. The anchor is then catted, and afterwards fished. To shift the viol for heaving in a second anchor, it must be unspliced, and the turns round the capstern reversed. When the strain is so great as to require other purchases, the top tackles may be used thus: The double block is lashed to the main-mast or topsail-sheet bits, the treble block is lashed on the cable, and the fall brought to the capstern. If the top tackle falls are thought insufficient, any hawser may be used that will reeve through the blocks.

To get up an anchor in ships which have not a jeer-capstern.

Ships without a jeer-capstern have no viol, but heave in their cables by the messenger, which has an eye spliced in each end; one of which ends is passed with three or four turns round the capstern on the upper deck, and the other end passed forwards round the rollers, at the fore-part of the manger; then brought aft to the other end, and lashed thus: Several turns are passed through the eyes crossing each other in the middle, then a half-hitch is taken round the parts, and the end stopped with spunyarn. The remainder of the operation is performed as by the viol, with this exception; the messenger is applied to the outside of the cable; and, when the nippers are insufficient, the messenger may be hitched thus: The bight of the messenger is fastened round the cable at the manger with a rolling hitch, and the bight seized round the cable before the hitch. This practice is by no means so good as the others.

When getting under way in a sea-gale, the viol is better than a messenger, as the sending of the ship carries all the strain to the main-capstern, and endangers the men at the bars; whereas, with a viol, the strain is taken to the viol-block, and the men at the forejeer capstern heave in security.

To get up a second anchor.

Suppose, by the former methods, that the starboard anchor is gotten up, and that the cable of the second anchor enters the larboard hawse-hole, the operation of getting up the second anchor is the same, observing only that the messenger must be shifted, and the turns on the capstern reversed, to change the disposition and side: and the men, who before held on the larboard side in the first operation, will hold on the starboard side now. The motion of the capstern is performed the contrary way, and the cable on the larboard side is fixed and hove in.

To get up an anchor in merchant ships.

Most merchant ships and small vessels heave up their anchors by a windlass; round which are taken three turns of the cable, and held on by hand, or by a jigger: thus—the end of the rope which has the sheave is passed round the cable, with a round turn, close to the windlass, the leading part of the rope coming over the sheave, and stretched aft, by means of the fall passing through the jigger-block; the standing part of the fall is made fast round a stantion, at the fore part of the quarter-deck, and the leading part is bowsed upon, which jambs the turns taken round the cable, and, when the jigger arrives abreast of the hatchway, it is removed forward, and the cable is jambed by a handspeck at the windlass, until the jigger is refixed.

To weigh an anchor with the long-boat.

This is done by taking the long-boat to the buoy of the anchor, and putting the buoy-rope over the davit of the long-boat, and a tackle on the buoy-rope; by which, with the assistance of men on the fall, the anchor is weighed out of the ground. This being accomplished, the cable is hove in on board; the buoy rope and tackle being secured in the boat, they approach the ship as the cable is hove in, and the anchor catted and stowed. Small anchors and grapnels are got up by the davit, hauling upon the cable or grapnel-rope by hand.

To weigh an anchor by under-running.

This is by placing the cable over the davit-head, and under-running it, till it is nearly a-peek, when it is tripped by means of tackles as before by the buoy-rope. This method is troublesome, and is only adopted when the buoy is gone, and a ship cannot get near her anchor for want of water.

To get under sail when the ship is swinging head to wind, and you want to cast either to starboard or larboard, in a place where there is no current.

To cast to starboard.

Heave short on your anchor till it is a-peek; then haul in quite home the larboard braces, forward and starboard braces abaft; loosen, sheet home, and hoist the topsails; put the helm a-starboard, and heave till the anchor is a-weigh. The moment the anchor quits the ground, the ship will begin to fall off to starboard. As soon as this movement is perceived, hoist the jib and fore-topmast-staysail, if necessary, to help her; and when she has sufficiently fallen off, her sails abaft (which are trimmed sharp for the larboard-tack) will fill. But, unless for very superior reasons, you had better continue lying-to till the anchor is catted, taking care to haul the mizen-sheets close aft, if the ship be inclined to fall off too much.

To cast to larboard.

Haul in the starboard-braces forward and the larboard aft, and put the helm a-port. The rest of the operation is the same as the preceding, only changing starboard for port.

To get under sail, when the ship is riding head to wind and tide.

If a ship, riding head to wind and tide, wanted to get under sail, after having decided on which side it is best to have her cast, it must be performed according to one of the foregoing methods, except with regard to the helm, which must be put to starboard, either before the anchor loosens, or while it does, if you wish to cast to port; because the water coming from forward, acts with the same force on the rudder as if the ship went with the current, impelling the rudder to starboard and head to port. Therefore, it is evident in this case, the helm ought to be put to starboard; which, on the contrary, would be put to larboard, was the ship to be cast to port.

If the ship, after the anchor is out of the ground, goes a-stern faster than the current runs, the helm must then be used as if there was no current, because the excess of velocity, whereby the ship exceeds that of the water, acts upon the rudder.

If it blows fresh, so that you cannot set your topsails without reefing them, let that be done before they are sheeted home; and if it blow so hard as to be obliged to go only under a fore-sail, it would be then sufficient to loosen the fore-topsail, without sheeting it home, after having braced it quite close on the side opposite to that you want the ship to cast, not forgetting however to put the helm the same way as you cast, as soon as you perceive the ship going a-stern: and when the ship has fallen off sufficiently, then is the time to fill and trim the fore-

To get under sail when the ship is swinging with her head to the current, and with the wind a point abaft the beam.

Heave short on your anchor till it is a-peek; next to this, loosen, sheet home, and hoist the foresail and mizen-topsail, keeping the wind in, and heave vigorously at the capstern till the anchor is a-weigh. At the same time hoist the jib and fore-topmast stay-sail, or haul out the mizen, according as circumstances may require. Whether you wish to come to windward, or fall off more quickly, you must still continue to heave round the capstern briskly to get the anchor up, till you find yourself sufficiently offward to bring to, in order to stow it with ease, or to stand on under an easy sail with the anchor hanging out to windward, if the situation of things will admit of it. You may sometimes also hoist up both the main and fore topsails, as soon as you get ready; but in certain cases, as when obliged to make the best of your way from an enemy, every sail possible must be set at once which the weather will admit of; especially when obliged to haul by the wind; in which case, the anchor must be got up and catted as well as it can: there are cases even when, without loosing your time in weighing it, you crowd as many sails as you possibly can, and depart in cutting or slipping the cable.

To get under sail with a spring.

If a ship be in a place too confined to cast under her sails only, or being obliged to put to sea in a gale of wind, without hoisting the anchors, you must, for greater safety, in casting the right way, get a spring out, to be clapped on the cable by which the ship swings, by passing a hawser or a stream cable through the aftermost port, on the opposite side to that you mean to cast; and after that spring is well hove tight at the capstern, hoist the jib and fore topmast stay-sails, loose and sheet home the fore topsail; when that is done, and if the weather permits, brace quite close the head-sails on the same side with the spring. When this is executed, slip or cut the cable, heaving briskly at the same time on the spring, till the ship has paid off sufficiently. Then fill the sails, by setting the mizen-topsail and every other sail you mean to employ, and slip or cut the spring, as circumstances may require. Care must be taken, not to let the ship fall off too much before the spring is cut; because, having no way through the water, she will not come to the wind so soon as might be wished; and for the same reason the spring must not be cut, till she has fallen off as much as is necessary; because, although she has no other motion but that of falling off, the vessel might perhaps not wear enough to answer the purpose.

To get under sail with a leading wind, in a tide way.

If the ship to be got under sail has a leading wind, and is in the midst of vessels, or in a narrow channel, where it would be difficult to cast her upon the lee-tide, she should be got under sail before the weather-tide is done. Thus the casting of the ship would be avoided, and she may be steered through the fleet or channel with safety.

Should it however, blow so fresh upon the windward-tide, as to force the ship end-on with her cable, it will be impossible to heave it in, without sheering the ship over from side to side, and heaving in briskly as the ship slacks the cable; but as this is attended with much danger, by the ship suddenly bringing up upon each sheer, it will be best to heave a-peek upon the first setting of the windward-tide, before the ship swings to bring the wind abaft.

To cast a ship upon the larboard tack, and back her a-stern of danger.

We suppose the ship to lie at single anchor, with the wind and tide the same way, and ships or shoals right a-stern, in the intended course, and that to clear them, you must cast upon the larboard-tack, and make a stern-board.

Make every thing as ready as possible before weighing: let the three topsails be hoisted, the yards braced up sharp with the larboard braces, and the mizen hauled out. Thus situated, when the anchor weighs, put the helm a-port. The tide, running aft, acts upon the starboard side of the rudder; and in that direction it will cast the ship the right way, and bring the wind upon the larboard-bow. The wind being on the larboard-bow and the topsails a-back, will soon give the ship sternway through the water; then the water will act against the larboard side of the rudder, and powerfully prevent the ship falling too fast off from the wind. Thus she will drive till the anchor is got quite up, and may be so continued till she has past the shoals and has room to veer, and get upon her proper course.

It is advantageous to make a stern-board in getting under way from a single anchor in the above situation. The anchor heaves up more easily when the ship goes a-stern; and while heaving up, it serves to keep the ship's head to the wind. A ship, however, cannot long be steered stern foremost when under sail, so as to keep the wind before the beam; but she will in a little time drive broadside through the water, till she gets headway, and then it is proper to veer, provided the anchor be quite up.

To cast a ship on the larboard tack, in a tide-way, with the wind two points on the starboard-bow.

A ship riding in a tide-way, with the wind two points on the starboard-bow, and so near the shore, on the larboard-side, that she must be cast upon the larboard-tack to clear the shore, the three topsails must be hoisted, and the yards sharp braced up, with the larboard braces forward, and the starboard braces aft, with the starboard fore-top bowline well hauled, putting the helm hard to port at the anchor's weighing: the tide acting upon the rudder, and the wind upon the sails braced in that direction, brings the ship about, with the wind on the larboard bow, before she gets sternway, which should be always strictly noticed; for, in all proceedings of this kind, if a ship gets sternway before she brings the wind right a-head, she will not come about the right way. In that case, it is best to veer away the cable directly, and bring the ship up again: and carry out a kedge or small anchor on the larboard-bow, hauling its cable or hawser in tight on the larboard quarter, when the bower anchor is a-peek. If this fail, the ship must lie till the windward tide makes, to bring the wind on the larboard-bow, when the ship may be got under-way, and clear the shore.

To cast a ship upon the larboard tack in a lee-tide, and shoot her by the wind a-head of danger.

If there be just room enough to close by the wind to clear a danger lying to leeward, much depends on heaving up briskly the anchor after it is out of the ground, and having proper sails ready to set to the best advantage. The three topsails must be hoisted, and the yard sharp braced up, with the larboard braces forward, and the starboard braces aft, when the anchor is at a long peek. At weighing the anchor, put the helm hard to port, then the action of the tide upon the rudder and the wind on the fore topsail, will cast the ship off the right way, so as to fill the after-sails, when the fore topsail may be soon braced about and filled before she gets sternway. The helm will keep the ship under command sufficiently to steer her by the wind a-head clear of danger: but if the ship gets sternway in casting, the helm should be kept hard a-weather, to prevent her falling off too much from the wind; and when she gets headway again, be cautious how the weather-helm is eased with the anchor much below the bows, by which the resistance forward is increased, and the ship may be brought up in the wind, so as to prevent her shooting clear of the danger. This must be guarded against by the weather-helm and head-sails, as jib, fore-topmast, staysail, &c. As soon as the ship has shot far enough a-head to clear the danger to leeward, and there being but little room a-head, it is best to bring the ship to and drive with the helm a-lee, with the main and mizen topsail a-back, and the fore topsail shivering till the anchor is up; then take proper time to veer.

To cast on the larboard tack, when riding with the wind right a-head, and to veer her short round before the wind in little room.

The head-sails should only be loose, viz. the fore-topsail hoisted and the fore-sail loose: brace sharp up with the larboard-braces, the jib and fore-topmast staysail set, with the larboard-sheets flat aft. When the anchor is a-peek, and a lee-tide running, at weighing the anchor, the helm should be put to port so far as to bring the wind two points on the larboard-bow, which should be kept so by steering the ship till the tide ceases to run aft. Then put the helm hard to starboard, or a-lee; and, when the ship gets sternway, the water will act powerfully on the starboard, or lee, side of the rudder, turning the ship's stern to windward, whilst the wind, acting at the same time upon the head-sails a-back, will box her round off upon her heel, so as to bring the wind nearly aft by the time she loses her sternway. Then the ship will cease falling off and soon get head-way, which should be attended to, and the head-sails braced about flat with the starboard-braces, and the helm shifted hard to port at the same time.

When there is no tide, but still water, at weighing the anchor, the helm must be hard to starboard: and, as the ship gets sternway, the water meets with so much resistance against the starboard-side of the rudder in that direction, that the rudder acts with great power to turn the ship's stern round to port, and the head-sails being set and trimmed as before-mentioned, and the foresail let fall with the starboard-bowline hauled close forward, will assist to cast the ship so far round the right way, by the same time she loses her sternway, as then to permit your proceeding as before directed. To ensure success, heave the anchor up briskly. The same methods are adopted in casting the ship on the starboard-tack, only the helm and sails are managed the contrary way.

To tack a ship in getting to windward as much as possible.

To execute this with propriety, care must be taken that the ship does not yaw, that she is not too near or too far from the wind; because both situations are equally prejudicial.

When this medium is obtained, haul the mizen out, while you put at the same time the helm a-lee, brace the sail to windward, in order that it may be as much as possible exposed to the wind. When the ship is come to the wind, so as to cause the square-sails to shiver, let go the jib and all the staysail-sheets before the main-mast: at the moment when all the sails catch a-back, and particularly the mizen topsail, let it be braced sharp about the other way: hauling up at the same time the weather-clue of the main-sail; and, when the wind is right a-head, or even a little before, haul the main-sail, and trim sharp for the other tack as fast as possible. The jib and staysail sheets are also to be shifted over at the same time, in righting the helm, whether the ship has lost her way, or even still advances a-head. Then, as soon as she has passed the direction of the wind about 45°, in continuing her evolution, shift the foremast's sails, which are to be trimmed with the same celerity as in putting the helm a-lee, if you fear the ship (which must still go a-stern if the operation be slowly executed) will not fall off sufficiently: for, if the sails are braced about briskly, she will never have sternway; on the contrary, she will get a great deal to windward.

To tack a ship, without endeavouring to get to windward.

There are circumstances sometimes when it is found necessary to tack, without caring much whether the ship loses to windward. For example: When a ship is found suddenly to be close to the land, in the night, or in foggy weather, near a danger, or some vessel, which must instantly be avoided by staying the ship, because you find yourself to windward, and too near the object from which you wish to recede; in this case, when it is necessary to deaden the ship's way, and tack at the same time, you must suddenly put the helm hard a-lee; and, in the same instant, let go the jib, fore, and stay-sail sheets, without touching the bowlines; and great care must be taken that the effect of the mizen is preserved as much as possible. When the sails begin to shiver, the mizen is to be hauled quite to windward; then, if the ship takes well the wind a-head, the remainder of the operation must be executed as directed in the preceding case; but, if you should miss stays, you must proceed according to the second method of veering, called boxhauling.

To tack a ship in a dangerous rough sea, when her staying is doubtful.

Let every thing be got clear and ready; the hands at their proper stations, the sails trimmed fair, and the ship steered just full, and close by the wind. Take the advantage of the smoothest time when the ship has the most head-way. The other necessary precautions are, to haul down the jib, if set, and not to put the helm a-lee all at once, but to luff the ship up by degrees, to shake the sails. When they shake, give these orders:—The helm hard a-lee; let go the lee-sheets forward, but not the lee-braces and fore-top bowline, as that usual practice backs the head-sails too soon, and stops the ship's headway, which ought to continue to give power to the helm till the wind is brought a-head, or the ship will not stay. Raise tacks and sheets and main-sail haul, when the wind is a-point on the weather-bow; this swings the yards round sharp, that the main tack may be got close down, whilst the head sails becalm the fore-leech of the main and main-top sails; while the wind, blowing aslant on the after-leech of these sails, acts jointly with the rudder to turn the ship's stern, so as to bring her about the right way.—When she has fallen off five or six points, let go and haul.

When a ship comes about, she is sure to have sternway by the time the head-sails are hauled; therefore, the helm should not then be shifted a-lee, but should be kept hard a-weather, till her stern-way ceases. The water, acting upon the weather-side of the rudder prevents the ship falling round off from the wind, which the helm, when hard a-lee, occasions, while the sternway continues. Notice should be made by the compass, that the ship continues coming about till the wind is on the other bow; for, if she stops with the wind a-head, and her headway is perceived to be done, the helm should be directly shifted to the other side; so that, by the sternway, the water may act upon the rudder and bring her about, and then the helm should not be kept a-lee, but directly shifted and kept hard a-weather till her sternway ceases. For the reason just given, the head-sails may be hauled as soon as possible; for, the ship will be sure to fall off the faster and farther in proportion to her sternway; so that the weather braces should be tended, to prevent the head-yards flying fore and aft, as they will do when it blows fresh; and to keep the head-sails shivering, that the fore-tack may be got close down easily, and the ship stopt the sooner from falling off. Shift the helm a-lee when the sternway ceases, and the head-sails may be trimmed sharp as the ship is perceived to come-to.

On turning to windward in very narrow channels.

At weighing, if the wind is partly across the tide, it will cast the ship with her head towards the weather-shore, which she may be kept clear of, by driving with the sails a-back till the anchor is up and stowed; and, as the tack towards the weather-shore is the shortest, it is prudent to back as near the lee-side as possible, in order to make the first board the longer; to get the three top-sails, jib, stay-sail, and mizen, properly set; and to get all ready in time for tacking. Make as bold as possible with the weather-shore, because on that side a ship is always surest in coming about; and, in case of missing stays, a ship may be backed off from the weather-shore, till she has room to fill and set the sails, and get sufficient headway to try her in stays again without danger. But, when the ship is got about, and standing towards the lee-shore, it may be necessary to put her in stays in good time; because she does not so certainly stay when going flanting with the tide as when going across it.

By staying her thus in good time, if she even miss stays, there may be room enough to fill and try her the second time, or to use such means as may prevent her going on shore.

But, when the wind is right against the tide, which begins to make to windward, be cautious not to weigh the anchor till the ship swings end-on to the tide, and brings the wind so far aft, that she may be steered right against the tide till the anchor is up and stowed, and the sails, with which the ship is to work, are all ready.

Haul the wind and get ready for tacking, when you are close over to one side, to gain the whole breadth of the channel for getting underway. For this purpose, let the first trip be made as short as possible, till it is found how the ship works upon both tacks; and then make longer or shorter boards accordingly, but take care not to stand into an eddy tide on either side, which has often occasioned ships to miss stays and go on shore. If a ship will not stay, she must be veered, box-hauled, or club-hauled.

To veer a ship without losing the wind out of her sails.

To execute this evolution both the main-sail and mizen must be hauled up, the helm put a-weather, and the mizen top-sail a shivering, which will be kept so till the wind be right aft, suppressing for that purpose the effect of all the staysails abaft the centre of gravity. As the ship falls off, (which she will do very rapidly) round-in the weather-braces of the sails on the fore and main mast, keeping them exactly trimmed to the direction of the wind, and remembering also that the bowlines are not to be started till the ship begins to veer. As she falls off, ease away the fore-sheet, raise the fore-tack, and get aft the weather-sheet, as the lee one is eased off; so that, when the ship is right before the wind, the yards will be exactly square. Then shift over the jib and staysail sheets; and, the ship continuing her evolution, haul on board the fore and main tacks, and trim all sharp fore and aft, remembering to haul aft the mizen and mizen-staysail sheets as soon as they will take the right way, or when the ship's stern has a little passed the direction of the wind. When the wind is on the beam, right the helm to moderate the great velocity with which the ship comes-to; the sails being trimmed, stand on by the wind.

To veer a ship that has lost her fore-mast.

Run out the end of a cable or hawser over the lee-quarter, and buoy it up from the ground with empty casks, &c. in case of coming into shoal-water with little wind. This will assist the helm with such power as to make the ship veer and steer at pleasure.

A spare yard or boom, rigged out abaft the mizen-shrouds, may guy the end of the cable or hawser more or less on either quarter, according as the ship may have occasion to sail. It may be easily shifted from side to side, and guyed out to leeward in proportion to the ship's griping, to answer sailing upon both tacks; and, when sailing before the wind, it may be secured over the middle of the stern, which will prevent the ship's broaching-to against the helm either way.

This would likewise much assist deep-laded bad-steering ships, and prevent their broaching-to, to which they are liable in spite of the best helmsmen, often occasioning them to lie-to, even with a fair wind. With a little contrivance by blocks lashed to the rails on the quarters, to lead the guys fair to the steering wheel-barrel, it may be made to steer a ship that has lost her rudder.

To veer when lying-to under a main-sail.

Advantage must be taken of the ship's falling off to put the helm a-weather, and ease away the main-sheet roundly; and, when the ship has fallen off about 30°, let go the main bowline, and round in the weather-brace, taking care to keep the sail full. When the ship is before the wind, get on board the main tack, and right the helm, to moderate her coming-to.

If, in the beginning, the ship is found difficult to veer, the fore staysail may be hoisted, and the sheets hauled well aft: but it is to be hauled down as soon as the ship is before the wind.

A second method.

Make fast a four-inch rope to the slings of the main-yard; and, when the ship comes-to, so as to shiver the main-sail, bring it down before the sail to the topsail-sheet bitts, and let it be hauled tight and belayed. Then, as soon as she falls off, put the helm a-weather, and let go the main sheet. By these means, the lee-part of the sail no longer has any power to keep the ship to the wind, and the weather-part acting before the centre of gravity will cause her to veer faster than by the first method; though, in general, the first method will answer the purpose.

To veer under bare poles.

The fore-staysail must, if circumstances will allow it, be hoisted. But, if that cannot be done, the head-yards are to be braced up as sharp as possible, and those abaft pointed to the wind. Then, if the ship veers, she will steer under the masts and ropes only. A number of seamen, sent up and placed close to each other in the weather fore-shrouds, will be found also of very great service.

To boxhaul a ship, or the second method of veering.

In this evolution, the most rapid execution is necessary. Briskly, and at the same instant, haul up both the mainsail and the mizen; shiver the main and mizen topsails; put the helm hard a-lee; raise the fore-tack; let go the head bowlines, and brace about the head-yards sharp the other way; and let the jib and staysail sheets go in the same instant. When the ship has fallen off 90°, brace the after-yards square, in order to give the ship a little way, and to help her (with the rudder, the situation of which must be changed) to double the point where all the sails shiver; and when the wind is aft, you will proceed as in the method of "veering without losing the wind out of the sails."

If the circular motion of the ship, after she has fallen off 90°, continues pretty rapid, the filling of the after-sails, to give the ship headway, may be dispensed with; because she continues to turn by the effect of her helm, which must not be shifted, since the vessel still continues her sternway. Therefore after having veered a few degrees more, the wind will fill all her sails and the ship consequently will have headway. Then change the situation of the rudder to bring her before the wind.

In a case of absolute danger, when it might be necessary to go a-stern and fall off more rapidly, put the helm a-lee, brace all the sails a-back, observing not to brace the after-sails more than square, that they may not counteract the head-sails, which are braced sharp a-back to pay the ship's head off; because the effect of the after-sails, in this situation, is to impel the ship abaft in the direction of her keel; which, with those forward, contribute to give her fresh sternway, in order to cause the ship to veer with greater celerity. The jib and fore topmast staysail sheets being hauled over to windward, will assist the ship in falling off and going a-stern.

When a ship is taken a-back by bad steerage or a shift of wind, she may sometimes be brought on the same tack again by instantly bracing sharp round the head-sails, and keeping fast the jib and staysail sheets. One must recollect, also, the after-sails are not to be touched till the ship has sufficiently fallen off; and when that shall be the case, trim the sails and stand on as before. The rudder is to be used as occasion may require, according as the ship has head or stern way.

Boxhauling is deemed the surest and readiest way to get a ship under command of the helm and sails, with the least loss of ground to leeward, when a ship refuses stays. The masters of sloop-rigged vessels, turning to windward in narrow channels, when they want but little to weather a certain point, run up in the wind till the headway ceases, then they fill again upon the same tack: this they call making a *half-board*. Thus a ship, in boxhauling, may be said to make two half-boards, first running with her head, then with her stern, up in the wind; by which two motions a ship rather gains to windward.

To clubhaul a ship.

Clubhauling is practised when it is expected that a ship will refuse stays upon a lee-shore.—Place the hands to their stations for putting the ship about, and some by the lee anchor; then put the helm down, and if the ship make a stand before she brings the wind a-head, let go the anchor and haul the main-sail When the wind is a-head, cut the cable, and the ship will cast the way required. The after-sails being full, let go and haul.

Another method.

Bend a hawser to the kedge-anchor on the lee-bow, and bring the end into one of the after-ports, or over the taffarel. Let go the anchor, brace up all sharp the contrary way, put the helm a-lee, and haul in briskly on the hawser. As soon as she gets head-way, cut or slip the hawser, and carry a press of sail.

To lie-to to windward of a ship, so as not to drift near her.

The main-topsail must be braced sharp a-back, keeping the fore and mizen topsails full; because the wind acts with a very small sine of incidence on a sail when full, in comparison to what it does when braced sharp a-back: so that the fore-topsail, being full, draws the ship a-head, and the effect of falling off is opposed by the main and mizen topsails. She will of course not fall off much; nor will her lee-way be very considerable; for the ship is well kept to the wind, by the disposition given to her sails.

To lie-to under the lee of another ship.

The fore-topsail ought to be braced sharp a-back, the main and mizen topsails kept full, because these two last-mentioned sails tend to give the ship headway, and keep her to the wind: they may be assisted by the mizen, which will oppose the falling off occasioned by the fore-topsail. Thus, should the ship to windward fall off violently, or drift too much, you are more ready to veer short round, and avoid being boarded; because the fore-topsail being braced sharp a-back, the impulse of the wind on it is much greater than if it were full; and it is well disposed to veer suddenly, as soon as the power of the other sails is suppressed.

To bring-to with the fore or main topsails a-back to the mast or filled.

Either the fore or main topsail must be braced sharp a-back, and the lee-bowline hauled up a little: the other two topsails trimmed sharp; with the mizen hauled out, and the helm a-lee.

If you bring-to with the fore-topsail to the mast, the head-yards may be only laid square. Then the wind will act obliquely on the sail, and the ship will fall off but little, because its effect is in the direction of the keel from forward aft, and the sails abaft keep the ship to. The main-topsail may be worked in the same manner, if you wish not to expose yourself much to the wind.

To bring-to with the three topsails a-back.

The jib and staysails being hauled down, brace sharp round at once all the sails you wish to lie a-back in hauling up the lee-bowlines, the better to expose the sails to the action of the wind: haul out the mizen, and put the helm hard a-weather.

To fill, when lying-to with the fore topsail to the mast.

Brail up the mizen, hoist the jib and fore-topmast staysail, shiver the main and mizen topsails, and, when the ship has fallen off 20° or 30°, fill the fore-topsail, which was a-back before, and stand on.

To fill when lying-to with the main topsail to the mast.

Brace sharp and briskly the fore topsail a-back; shiver the main and mizen topsails; hoist the jib and fore topmast staysails, and brail up the mizen, all at the same time; and when the ship has fallen off 20° or 30°, fill the fore topsail and stand on.

If you are obliged to keep the wind on the same tack as that on which you are lying-to, you have only to right the helm, fill the topsail which is a-back, and trim it sharp, to continue your course.

A second method.

Trim the topsail which was to the mast, in order to give the ship way through the water, and be able to tack or run large, according as may be found necessary. But this method is very tedious, unless you mean to heave in stays; in which case it will be most expeditious.

A third method.

Shiver the main and mizen topsails, keeping the fore topsail full, righting the helm, and running up the jib and fore topmast-staysail at the same time. As soon as the ship has fallen off enough to get headway, fill the after-sails, and keep the ship in the direction you mean to follow. It is easily seen that this method, though the most common, is not the most expeditious, when you have to veer considerably.

To fill when lying-to with all the sails to the mast.

Brail up the mizen, lay the after-yards square, and shift the helm a-lee. When the ship has fallen off sufficiently to fill the after-sails, those forward are then to be braced about and trimmed full also, in order to stand on.

Of lying-to in a gale of wind.

To lie-to when it blows hard, keep as close to the wind as possible under some one sail well trimmed, with the helm lashed a-lee as much as may be requisite for the ship; and as ships commonly bring-to from the stress of contrary winds, care should be taken to heave-to under such sail as will least strain the ship; because there are some ships which lie-to better under the foresail than mainsail, others are more easy under the mainsail, some under a mizen, and many vessels lie-to best under a main staysail.

Lying-to under a foresail.

This is advantageous for veering when you are well to windward; but it augments the lee-way and is more subject to break the sea on board, on account of the ship's continual falling off: because in that movement she gathers way by yielding to the impulse of the gale, and is afterwards recalled to the wind by the helm; so that in springing the luff she meets the wave which comes from to windward.

Lying-to under the mainsail.

The ship does not in this situation fall off so easily as in the last mentioned mode, because its effect passes abaft the centre of gravity of the ship; but it keeps the ship more to the wind and consequently occasions less lee-way.

Lying-to under the mizen.

Under the mizen ships keep better to the wind than under any other sail, because it is farther abaft the centre of gravity than any of the rest, consequently ought to keep the vessel from drifting more than any of the others; but it is inconvenient should you have occasion to veer suddenly.

Lying-to under the main staysail.

Under the main staysail a ship will not make so much lee-way as under a foresail, because its efforts passes very near the centre of gravity; but it will however cause her to drift more than the mainsail; so that this mode of lying-to is a mean between the two others, and is preferable whan it blows strong enough for that sail to support the rolling of the ship. It ought likewise to be preferred, because the ship will veer under that sail, the action of which passes at a small distance from the centre of gravity, and the power of which overcomes the resistance which all ships meet from the fluid under their lee; a resistance which always gives them a great inclination to fly up in the wind when it blows hard, or when under a heavy press of sail.

Lying-to under the fore, main, and mizen staysails.

All the preceding modes of lying-to have their peculiar faults; but the preferable way is under the fore staysail, the main staysail, and mizen staysail; because under these sails the ship will steer and is in a better situation for veering than under any other sail; for, only haul down the mizen staysail and put the helm a-weather, when the two other sails, being before the centre of gravity, will cause her to fall off; she will then soon gather way and steer easily.

Should the gale continue very hard, and one of these staysails be blown away, the loss is not of much consequence, as the courses, in case of an emergency, are ready to set; whereas the courses are not so readily replaced when lost. This mode, therefore, appears preferable in every respect,* whether you wish to veer or keep your wind: because, if the ship does not sufficiently keep the wind, you may haul out the balanced mizen, or take in the fore-staysail, or even the main-staysail. One of these staysails, before the centre of gravity of the ship, is sufficient to make her veer as soon as the after-ones are suppressed. There are, besides, these following considerations for so doing: The ship will carry sail better; because, as the centre of effort of these on her is very low, she drifts less, holds a better wind, and goes faster through the water; and these three or four sails are so situated as to give the whole body of the ship play, which will strain her less than when under one single sail, which cannot by itself work it from aft forward.

Of sounding in fair weather, whether close-hauled or going large.

Close-hauled.

If close-hauled, brail up the mizen and mizen-staysail, let go the main-sheet that the sail may shiver, put the helm a-lee, and back the mizen-topsail by bracing it square. The head-sails, as well as the jib and stay-sails, are to be kept in their first situation; recollecting to haul tight and belay the lee-braces. When the ship has nearly lost her headway, though continuing still to come to the wind, yet catch that moment to heave the lead, and it is to be hauled in again with all possible dispatch. To fill again, haul aft the main-sheet, trim the mizen-topsail, and right the helm.

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* *Should the sea run too high for the lower staysails to keep the ship steady, a close-reefed main-topsail will be found to answer the purpose admirably.*

Going large.

In going large, you have only to put the helm a-lee, to brail up the mizen, and to belay the lee braces quite tight, to prevent the yards having too much play when the sails are shivering. It is impossible to tack in this situation, as the jib and head sails are always in action; and the square sails soon coming to shake, on account of their sheets not being tacked, they lose all their power, and the ship is soon at a stand.

Another method preferable to the former.

Going large.

Brace the head sails square, haul down the jib and staysails, without stirring the after-sails, and put the helm a-lee. While the ship has still a little headway, heave the lead from the place where you haul it in; that lead will go first a little a-stern, but the ship, being head to wind, will soon herself go a-stern right upon the line; and as the helm is a-lee, the ship easily veers. But, if you wish to keep her to longer, right the helm and haul the mizen out, to prevent the ship's falling off.

If you have studding sails set, they must be hauled down, particularly the lower ones; because, should the wind take them a-back their power on the boom might bring the ship round entirely, for they act on a lever without the ship, the fulcrum of which is on the outside of the vessel before the centre of gravity. If, however, the helm is continued a-lee till the ship falls off she will not come about, because then the vessel goes a-stern with great velocity, and the rudder acts powerfully to make her veer; but the fact is, that the ship will go a great deal a-stern, and will continue to do so much longer.

Close-hauled.

If close-hauled, or a very little from the wind, the helm is to be put a-lee, and the instant the sails are taken a-back the head sails are to be filled by briskly bracing them square, without waiting for the wind being right a-head; then, a little before the ship has lost her way, heave the lead from the place where you haul it in, and then proceed as before.

On ships driving.

When it happens that there is not sufficient room to work in a tide's way, through a crowd of ships, or in a narrow channel, but that a ship must drive by the help of the tide, it may be done provided the tide be strong enough in proportion to the wind. This art consists in keeping the ship in a fair way, by a management of the rudder and the sails.

To drive to windward, when the wind is against the tide.

If the channel is sufficiently broad, the ship should be drifted broad-side to the wind, as the tide will then have the greatest power on her; and could the ship be backed a-stern or shot a-head at pleasure, she might be kept drifting upon the same tack with safety; but ships in a tide's way can never be backed so far a-stern as they will shoot a-head. At the first of a stern-board a ship will go briskly a-stern, but will soon fall off, and drift with the wind abaft the beam, forging a-head; for this reason she must be drifted with the helm a-lee. It follows, as a ship will shoot more a-head than she can be backed a-stern, that she will at length arrive at the opposite shore, when she must be stayed or veered, and drifted upon the other tack. If she is to be stayed, (which is preferable, because less drift will be lost by it) let the sails be filled in time to give the ship sufficient headway to bring her about, then put the hem a-lee. Should she come about, the sails and helm having now a proper position for a stern-board upon the other tack, need not be touched till her sternway ceases, when the helm must be shifted a-lee; but should the ship refuse stays, then brace sharp round the head-yards, and boxhaul her, by which method she will lose much less drift than by veering.

If the ship, now drifting broadside, is approaching a narrow channel, where drifting in this position, she must be veered and dropped stemming the tide stern foremost. In this case, that the drift may be as much as possible, it will be necessary to take in sail, and reduce the ship's headway till she has only steerage-way left; thus a vessel may be dropped through a fleet of ships at anchor without danger.

To drive, when the wind is across the tide.

Should the wind be a little across the tide, a ship may be easily drifted in the fair way, with her head towards the weather-shore; for thus it will be found that she can be backed and filled at pleasure, and generally be drifted with the sails shivering, in which position they oppose least power to prevent the drift.

It frequently happens in serpentine rivers that the tide sets across; in this case the ship must be drifted with her head to the side from which the tide sets. These sets are best discovered by observing the opening or shutting of two objects in the direction of the channel.

To bend a course in fair weather.

Stretch the sail a-thwart the deck, the starboard-side of the sail to the starboard-side, the larboard to the larboard-side; then bend yard-ropes to the ear-ring cringles, and make fast the head ear-rings a few feet up upon the yard-ropes. The bunt-lines, leech-lines, clue-garnets, and all the geer bent, make fast a rope-band to each bunt-line and leech-line leg, that the men may be enabled to catch the head of the sail from the yard. Now man well the yard-ropes, bunt-lines, leech-lines, and clue-garnets, and run the sail up to the yard. The sail aloft, send the hands up to bring it to, and let them haul out the weather ear-ring first, then the lee; and, if it is a new sail, let them ride the head-rope to stretch it. The sail being hauled square out upon the yard, make fast the rope-bands, keeping the head of the sail well upon the yard.

To bend a topsail in fair weather.

Overhaul the leeches of the sail, put in the ear-rings, bend the bow-line legs, lay out the clues, and open them if necessary, and make the sail up snug again; then round down upon the lee top-sail-haliards till the weather fly-block is high enough to bring the sail up over the guard-iron: then rack the tie over to the weather-rigging. Now pile the sail upon slings, with the lee-side uppermost; hook on the topsail-haliards, and run the topsail up into the top; then stretch the sail round the fore-part of the top, bend the jeer, and make fast the head ear-rings a few feet up upon the reef-tackle pendants, with a rope-band or two to each bunt-line leg — The jeer being bent, man the reef-tackles, bunt-lines, and clue-lines, and haul out the sail.— Now let the hands lay out upon the yard, and haul out the weather ear-rings first; then haul out to leeward, and ease off to windward till the sail is square, when make fast the rope-bands, keeping the head of the sail well up upon the yard.

To set a mainsail, or foresail.

Before the sail is loosed, let the double block of a tackle be made fast to the weather-clue, and the single block be hooked low down upon the chess-tree, and the fall led aft. Then man well the tack and fall at the same time; and, when the sail is loosed, ease away the weather clue-garnet, let go the bunt-lines and leech-lines, bowse down upon the tackle, and take in the main-tack: the main-tack being down, haul aft the sheet, brace up the yard, and haul the main-bowline.

To set a topsail.

Let a tackle be in readiness to clap on either sheet, as may be required. First, man the lee-sheet; and, the sail being loosed, ease down the bunt-lines and lee clue-line, and haul home the lee-sheet; then haul home the weather-sheet, hoist the sail, and brace up as required.

Should the wind be quartering, the lower and topsail yards should be braced well into the wind, before the sail is sheeted home.

To take in a course.

Man well the weather clue-garnet, ease off the tack and bowline, and run it up; then man the lee clue-garnet, bunt-lines, leech-lines, and weather-brace; and, being all ready, ease away the sheet, haul up the clue-garnet, bunt-lines, and leech-lines, and round-in the weather-brace, till the yard is pointed to the wind. Then haul tight the trusses, braces, lifts, and rolling tackle, and let the hands furl the sail.

To take in the foresail in the time of veering.

When the ship begins to veer, the yard being kept braced sharp up, let go the tack and bowline, and haul up the weather clue-garnet. When the ship is nearly before the wind, the bunt and leech lines, and the other clue-garnet, may be hauled up; and, if the situation admits of it, and occasion requires, the ship may be steered with the wind on the quarter, till the sail is secured.

To take in a topsail.

There are many opinions upon the best mode of performing this. Some approve of cluing up to windward first, and others to leeward. If the weather-side is to be clued up first, the weather-brace must be rounded well in, and the yard got close down upon the lifts, otherwise the lee-rigging will be in danger of being carried away by the great pressure of the lee yard-arm. If the weather-brace can be rounded well in, and the yard be got close down, it will be best to clue up to windward first, for thus the sail may be taken in without a shake: but, if the weather-brace cannot be hauled in to ease the yard off the lee-rigging, recourse must be had to clueng up to leeward first. In this case, it will be best, if hands can be spared, to man both the clue-lines, bunt-lines, and weather-brace, at the same time; thus, when the lee-sheet is eased off, the weather-brace may be hauled in with ease, and the yard laid to the wind; and, when the lee clue-line is half up, ease off the weather-sheet, and run up the weather clue-line; then haul tight the lee-brace, bowse tight the rolling-tackle, and furl the sail.

To take in a jib.

Man well the down-haul, let go the haliards, ease off the sheet, and haul down briskly; and, when the sail is close down, ease away the out-haul, and haul the sail in to the bowsprit-cap; then let it be stowed away in the fore-staysail netting.

To haul in a lower studding-sail.

To haul in a lower studding-sail, blowing fresh, lead one of the sheets clear aft, and man it well; then lower away briskly the outer haliards, to spill the sail; ease off the tack, run in upon the sheet, and lower away the inner haliards as required.

To haul down a topmast studding-sail.

Man well the deck-sheet and down-haul, ease off the yard-sheet, and haul the yard close out to the tack-block; then ease away the tack; and haul down both upon the deck-sheet and down-haul.

To brail up and haul down a main-topmast staysail.

Man well the lee-brail and down-haul, having a few hands to gather in the slack of the weather-brail; then let go the haliards, ease off the sheet, and haul down and brail up as briskly as possible. When the sail is down, let go the tack, and stop the sail over to the lee fore-rigging.

To brail up a mizen.

Man well the lee-brails, ease off the mizen-sheet, and brail up briskly, taking in at the same time the slack of the weather-brails. After the sail is hauled up, stop its foot by passing the gasket round to leeward, which will spill it.

To take in a topgallant-sail.

The lee-sheet must be started first, and clued up, and then the weather-sheet.

To unbend a course.

First furl the sail, then cast off the rope-bands, and make them fast round the sail, clear of the gaskets. When the rope-bands are all off, ease off the lee ear-ring, and lower down the sail; and, when the people upon deck have got hold of the lee-part of the sail, ease away the weather ear-ring.

To unbend a topsail.

First cast off the points of the reefs, keeping fast the ear-rings; then furl the sail, and cast off the rope-bands, which make fast round the sail, clear of the gaskets. After this, cast off the lee ear-rings, aud haul the lee-side of the sail into the top; then haul in the weather-side. Now unbend the reef-tackle pendants, buntlines, and bowlines; bight the sail snugly up together; and send it down by the clew-lines to windward or leeward, as most convenient.

On scudding or bearing away in a storm.

When the waves run high, and sudden necessity requires to bear away, it should be considered that the lower sails forward, which the ship may be veered under when she comes before the wind, may be becalmed by the height of the waves breaking violently against the stern; and that therefore a close-reefed main-topsail should be set to catch the wind, because it is a loftier sail, and may always be kept drawing full above the waves. This increases the ship's headway so much that the waves will not strike her abaft with so great a velocity as when her headway is less.

Hence it follows, that, when going to scud before high waves, the close-reefed main-topsail should be the last square-sail taken-in in a laboursome ship.

Of a ship overset on her side.

A common but not always a certain method to recover ships from this dangerous situation, is to cut away the masts: however, as this expensive method may fail, stopwaters only, on the lee-quarter at sea, may cause the ship to veer; or, where there is ground, an anchor or anchors dropped from the lee-bow, may bring the wind a-head and take the sails a-back, so as to cast the ship on the other tack, and bring her upright.

To rig a main top-mast.

Tar the mast-head, get the cross-trees over, fix the bolsters and parcel them, put over button-pendants, then the shrouds, breast-back-stay, proper and spring-stay and cap, sway up the mast and fid it, seize in the dead eyes, stay the mast, set up the shrouds, rattle them down, lash the bullock-blocks to the mast-head.

To rig a top-gallant-mast.

Send down the top-rope, reeve it through the sheave-hole, and make it fast round the hounds of the mast and standing part of the rope, leaving enough end to make fast to the cap, which done, sway away, when the head is through the cap, make fast the spare end or standing part of the top-rope to the cap, cut the seizing, clap on the grommet, then the shrouds, back-stays and stay, sway up the mast, fid it, and set the rigging up.

To rig a bowsprit.

Lash the collar fore-stay for the bob-stays and bowsprit shrouds, then the collar for the spring-stays, then the block for the top-mast-stay, fix the man-rope, gammon the bowsprit, and set bob-stays and shrouds up.

To rig a jib-boom.

Put over the traveller, horses, guys, the top gallant stay-block, and lash on the blocks for the top gallant-bowline and jib-down-haul-block to the traveller.

To rig a lower yard.

Get it athwart the gunwale, lash the jeers, quarter clue-garnets, bunt-lines, leach-lines and slab-line blocks; then put over the yard-arms, the horses brace pendants, the yard-tackle pendants, then the top-sail sheet and lift-blocks, reeve the jeers, braces, lifts and yard-tackle falls, truss parcels, sway the yard up, and haul all taut.

To rig a fore top-sail yard.

Reeve a hawser for a top-rope through the bullock block and send it down, and having put over the horses, make the top-rope fast to the middle of the yard, stopping it to the yard-arm, sway it up above the top, put over the brace-pendants and lift-blocks, reeve the lifts and braces, cut the yard-arm-seizing and cross the yard, lash the tye, buntline and clue-line-blocks, reeve the tye and halyards, sway it up above the cap, and parcel it, reeve the clue-lines, bunt-lines and reef-tackles.

To rig a top-gallant-yard.

Seize the clue-line-blocks on, put the horses over the yard-arms, sway it upon the cap and rig the yard arms, by putting on the brace-pendants and lifts, then cross the yard and parcel it.

To steer the ship when her rudder is lost.

Take a large spar, or part of a top-mast, and cut it flat in the form of a stern-post, bore holes at proper distances in that part which is to be the fore part of the preventer or additional stern-post, then take the thickest plank on board, and make it as near as possible into the form of a rudder, bore holes at proper distances in the fore part of it, and in the after-part of the preventer stern-post to correspond with each other; and reeve rope grammots through those holes in the rudder and after-part of the stern-post for the rudder to play upon.

Through the preventer stern-post reeve guys, and at the fore part of them fix tackles, and then put the machine overboard; when it is in a proper position or in a line with the ship's stern-post, lash the upper part of the preventer-post to the upper part of the ship's stern-post, then hook tackles at or near the main chains and bowse taut on the guys to confine it to the lower part of the preventer stern-post;—having holes bored through the preventer and proper stern-post, run an iron bolt through both, taking care not to touch the rudder, which will prevent the false stern-post from rising up or falling down.

By the guys on the after-part of the rudder, and tackles fixed to them, the ship may be steered, taking care to bowse taut the tackles on the preventer stern-post to keep it close to the proper stern-post.

Marine Infurances.

INSURANCE is a contract by which the infurer undertakes, in confideration of a premium equivalent to the hazard run, to indemnify the perfon infured againft certain perils or loffes, or againft fome particular event. All infurances, whether againft fire or on lives, fall within this general defcription; but the fubject meant to be confidered here is that of MARINE INSURANCES. From this definition it appears to be a contract of indemnity againft thofe perils to which fhips and goods are expofed in the courfe of their voyage from one place to another.

A complete fyftem of this branch of law cannot be fuddenly erected; but it is the boaft of this age, that in it the great foundations of marine jurifprudence have been laid, by clearly developing the principles on which policies of infurance are founded, and by applying thofe principles to particular cafes. In the following treatife we fhall endeavour to render the law of it fo clear as to be a guide to the merchant, owner, freighter, and man of bufinefs. To effect this we have divided the fubject, and it will be difcuffed in the following order.

I. The Policy.	X. Fraud in Policies.
II. The Conftruction of the Policy.	XI. Sea-Worthinefs.
III. Perils of the Sea.	XII. Illegal Voyages.
IV. Capture and Detention of Princes.	XIII. Re-Affurance and Double Infurance.
V. Barratry of the Mafter or Mariners.	XIV. Changing the Ship.
VI. Partial Loffes and Adjuftment.	XV. Deviation.
VII. General Average.	XVI. Non-compliance with Warranties.
VIII. Salvage.	XVII. Return of Premium.
IX. Abandonment	XVIII. Bottomry and Refpondentia.

I. THE POLICY.

The Policy is the inftrument by which the contract of indemnity is effected between the infurer and infured; and it is figned only by the infurer who is called the underwriter. Of policies there are two kinds, *valued* and *open*; and the only difference between them is this, that in the former goods or property infured are valued at prime coft, at the time of effecting the policy; in the latter the value is not mentioned, but in cafe of lofs muft be proved.

Policies of affurance when once they are underwritten, can, generally fpeaking, never be altered by any authority whatever; becaufe it would be an opening to fraud, and would introduce uncertainty into a fpecies of contract of which certainty and precifion are the moft effential requifites. It muft be obferved, however, that cafes frequently exift in which a policy, upon proper evidence, may be altered: and after figning policies are frequently altered by confent of the parties.

An inftance of the former kind of the alteration of the policy occurred before Lord Hardwicke. The infurance on the fhip was five hundred pounds, and the policy ftated that the adventure was to commence immediately from the departure of the fhip from Fort St. George to London. The plaintiff fuggefted that the owner had employed a Mr. Halhead to infure the fhip with the defendants, to commence *from her arrival at Fort St. George*; that a label, agreeable to thofe inftructions, with all the particulars of the agreement, had been entered in a book and fubfcribed by Halhead and two of the directors of the company; that, by a *miftake*, the policy was made out different from the label; that the fhip being loft in the bay of Bengal, *after* her arrival at Fort St. George, but *before* her departure for England, the company refufe to pay; the plaintiff therefore prayed that the miftake might be rectified, and that the company might be ordered to pay five hundred pounds with intereft.

His lordfhip was of opinion that the label was a memorandum of the agreement, in which the material parts of the policy were inferted; that although the policy was ambiguous, the label made it clear; and as it was only *a miftake of the clerk* it ought to be rectified according to the label, Motteux *v.* the Governor and Company of the London Affurance, 1 Atkyns, 545.

A policy of infurance is the property of the infured; and if it be wrongfully withheld, either by his broker or any other perfon, he may recover it by an action of trover. Harding *v.* Carter and another: fitting at Guildhall, Eafter vacation, 1781.

Policies of infurance are generally printed leaving blanks for the infertion of names and all other requifites. It is therefore frequently neceffary to infert written claufes, and thefe written claufes and conditions thus inferted are to be confidered as part of the real contract; the court will look to them to find out the intention of the parties, and will confequently fuffer fuch conditions to control the printed words.

We will now proceed to confider, firft, what things may be infured; fecondly, what the requifites of a policy are.

1ft. *What Things may be infured.*

The moft frequent fubjects of marine infurance are fhips, goods, merchandizes, the freight or hire of fhips. But although infurances upon fuch property moft frequently occur, yet there are cafes which can hardly fall within any of thofe defcriptions.

Thus bottomry and *respondentia* are a particular species of property which may be the subject of insurance. But then it must be particularly expressed in the policy to be *respondentia* interest: for under a general insurance on goods, the party insured cannot recover money lent on *bottomry*. Such has been and is at this day the established usage of merchants.

This was decided in an action upon a policy of insurance, "upon *goods and merchandizes* loaden, or to be loaden, &c." The evidence appeared to be, that before the signing of the policy the plaintiff had lent Capt. Tryon *upon the goods* then loaden and to be loaden on board the said ship on account of the said Capt. Tryon, the sum of seven hundred and sixty-four pounds at *respondentia*, for which a bond was executed in the usual form: that the ship at the time of the loss had goods and merchandizes on board, the property of Capt. Tryon, of greater value than all the money he had borrowed: that the ship was afterwards burnt, and all the goods and merchandize were totally consumed and lost. Upon these facts, the question was, whether the plaintiff could recover. This case was twice argued at the bar, the court took time to consider it, and were unanimous in their determination.

Lord Mansfield, in delivering the judgment of the court, observed to this effect. I inclined to support this insurance, being convinced that it is fair, and that the doubt has arisen by a slip in omitting to specify (as it was intended to have been done) that this was a *respondentia* interest. The ground of supporting this insurance, if it could have been supported, was a clause of the 19 Geo. II. c. 37. § 5, which as to the purpose of insurance, considers the borrower as having a right to insure only for the surplus value, over and above the money he has borrowed at *respondentia*. Yet we are all satisfied that this act of parliament never meant, or intended to make any alteration in the manner of insurances; its view was to prevent gaming or wagering policies, where the insurer had no interest at all: and if the lender of money at *respondentia* were to be at liberty to insure for more than his whole interest, it would be a gaming policy; for it is obvious that if he could insure all the goods and insure his *respondentia* interest besides, this would amount to an insurance beyond his whole interest. In describing *respondentia* interest, the act gives the lender alone the right to make insurance on the money lent: so that the act left it on the practice. I have looked into the practice, and I find that bottomry and *respondentia* are a *particular species* of insurance in themselves, and have taken a particular denomination. I cannot find even a *dictum* in any writer, foreign or domestic, that the *respondentia* creditors may insure upon the *goods, as goods*. I find too by talking with intelligent persons very conversant in the knowledge and practice of insurances, that they always do mention *respondentia* interest, whenever they mean to insure it. It might be greatly inconvenient to introduce a practice *contrary to general usage*, and their may be some opening to fraud if it be not specified. The grounds of our resolution is, "that it is now established as the law and practice of merchants, that *respondentia* and bottomry must be specified and mentioned in the policy of insurance." Glover *v.* Black, 3 Burr. 1394.

But though this case is certainly good law, yet it has since been ruled, that money expended by the captain for the use of the ship, and for which *respondentia* interest was charged, may be recovered under an insurance on *goods, specie*, and *effects*, provided *the usage of the trade*, which in matters of insurance is always of great weight, sanctions it.

Thus, in an action upon a policy of insurance on *goods, specie*, and *effects*, of the plaintiff, who was also the captain on board the ship, the plaintiff claimed under that insurance, money expended by him in the course of the voyage for the use of the ship, and for which he charged "*respondentia* interest."

Lord Mansfield said, as to whether the words "*goods, specie*, and *effects*," extended to this interest, I should think not, if we were only to consider the words made use of. But here there is an *express usage* which must govern our decision. A great many captains in the East-India service swear that this kind of interest is always insured in this way, and here the person insured is the captain. Gregory *v.* Christie, K. B. Trinity Term, 24 Geo. III.

Insurances upon the wages of seamen are forbidden; a regulation founded upon wisdom and sound policy; for by this salutary law the sailors are interested in the return of the ship: and they will on that account be prevented from deserting it when abroad, from leaving it unmanned, and will be more anxious for its preservation. This regulation, however, does not mean to prevent mariners from insuring those wages which they are intitled to receive abroad, or goods which they have purchased with those wages in order to bring them home; but in such a case they are to be considered in the same light with other men.

It has long been a question how far insurances upon the ships or goods of enemies are politic; but whether such a contract be founded in principles of sound policy or not, it is certainly not contrary to the law of England, as it is established at this day.

2dly, *Of the Requisites of a Policy.*

The essentials in a policy of insurance are, first, the name of the person for whom the insurance is made; secondly, the name of the ship and master; thirdly, whether they are ships, goods, or merchandizes upon which the insurance is made; fourthly, the name of the place where the goods are laden, and whither they are bound; fifthly, the time when the risk begins and when it ends; sixthly, all the various perils and risks which the insurer takes upon him.

felf; feventhly, the confideration, or premium, paid for the rifk or hazard run; Eighthly, the month, day, and year on which the policy is executed; ninthly, the ftamps required by act of Congrefs.

First. Of the name of the perfon infured.

Every policy of affurance ought to contain the name or the ufed ftile and firm of dealing of one or more of the perfons interefted in fuch infurance; or inftead thereof the name or firm of the confignor or configuee of the goods and property to be infured, or the name or firm of the perfons who order or effect fuch policy.

Secondly. Of the names of the fhip and mafter.

It feems to be neceffary, by the law and ufage of merchants to infert the names of the fhip and mafter, in order to afcertain the bottom upon which the adventure is to be made, and the captain by whofe direction the fhip is to be navigated. Sometimes, however, there are infurances generally, "upon any fhip or fhips," expected from a particular place; and although it is more accurate to infert the name of the captain, it is not certain that the infurance would be void if a different captain from that mentioned in the policy came into the fhip; efpecially as the policy always contains the words "or whofoever elfe fhall go for mafter in faid fhip."

Thirdly. Whether they are Ships, Goods, or Merchandizes, upon which the Infurance is made.

It is abfolutely neceffary that there fhould be a fpecification upon which of thefe the underwriter infures. But it is another queftion, whether, in policies upon goods, it be neceffary to declare the particulars. The practice is very unfettled; in the opinion, however, of very refpectable merchants, the particulars of goods fhould be fpecified, if poffible, by their marks, numbers and packages, and not under the general denomination of merchandize. When goods are coming from abroad, it is better to infure under general expreffions, on account of the various cafualties which may happen to obftruct the purchafe of the commodities intended to be fent.

There are certain kinds of merchandize, which are of a perifhable nature, on account of which, there is inferted a memorandum at the foot of the policy, by which it is declared, that, in infurances upon corn, fifh, falt, fruit, flour and feed, the underwriters will not be anfwerable for any partial lofs, but only for general average, except the fhip be ftranded. That in infurances on fugar, tobacco, hemp, flax, hides and fkins, they confider themfelves free from partial loffes, not amounting to *five per cent.* and that on all other goods, as well as on the fhip and freight, if the partial lofs be under *three dollars per cent.* unlefs it arife from a general average, or the ftranding of the fhip, the underwriter confiders himfelf difcharged.

There are fome kinds of property, which do not fall under the general denomination of *goods* in a policy; and for the lofs of which the underwriters are not anfwerable, unlefs they are fpecifically named; fuch as *goods lafhed on deck, the captain's clothes, and the fhip's provifions.* A policy on *goods* means only fuch goods as are merchantable, and a part of the cargo; and, therefore, when goods like the prefent are meant to be infured, they are always infured by name; and the premium is greater. Rofs *v.* Thwaite, Sitt. after Hilary, 16 Geo. III.

Fourthly. The Name of the Place at which the Goods are laden, and to which they are bound.

This has been always held to be neceffary in policies, and muft be fo, on account of the evident uncertainty which would follow from a contrary practice, as the infurer would never know what the rifk was which he had undertaken to infure; and, therefore, if a fhip be infured from London to , a blank being left by the lader of the goods to prevent a furprize by an enemy, and if in her voyage fhe happen to be caft away, though there be private inftructions for her port, yet the infured muft fit down with his lofs, by reafon of the uncertainty. Molloy, b. 2, c. 7. f. 14.

It is alfo cuftomary to ftate in the policy at what port or place the fhip may touch and ftay during the voyage, fo that it fhall not be confidered as a *deviation* to go to any of thofe places.

Fifthly. The time when the Rifk commences, and when it ends.

The Englifh policies expreffly declare, that "the adventure fhall begin upon the faid goods and merchandize, *from the loading thereof on board the faid fhip*, and fo fhall continue until the faid fhip, goods and merchandizes, fhall be arrived at L. and upon the faid fhip until fhe hath moored at anchor 24 hours in good fafety; and *upon the goods till the fame be there fafely difcharged and landed.*" From thefe words, it is obvious, that the infurers are not anfwerable for any accident which may happen to the goods in lighters or boats going a-board, *previous* to the voyage; yet as the policy fays, the rifk fhall continue *till the goods are fafely landed*, it feems the infurer continues refponfible for the rifk to be run in carrying the goods in boats to the fhore. If there be a lofs, however, in thefe cafes, the accident muft have happened, while the goods were in the boats or lighters belonging to the fhip; but in a cafe where the owner of the goods brings down his own lighter, receives the goods out of the fhip, and before they reach land, an accident happens, whereby the goods are damaged, the infurer is difcharged, although the infurance be upon goods to London, and *till the fame be fafely landed there.* Sparrow *v.* Carrothers, 2 Stra. 1236.

In the unloading of goods there should be no unreasonable delay, but this must always depend upon circumstances.

The risk on the body of a ship is generally to commence, "from *her beginning to load at* and so shall continue and endure *until the said ship shall arrive at* and hath there been moored at anchor 24 hours in good safety." This mode of stating the commencement of the risk must commonly be applied to insurances on ships outward bound; for, when insurance is made on the homeward risk, the beginning of the adventure is sometimes stated to be "immediately from and after her arrival at the port abroad;" at other times, "from the departure;" and, in short, it is very variable, depending upon the inclination of the insured.

Sixthly. Of the various Perils and Risk against which the Underwriter insures.

The words now used expressive of the insurer's risks are very extensive, including "all perils of the sea, men of war, fire, enemies, pirates, rovers, thieves, jettisons, letters of mart and counter-mart, surprisals, takings at sea, arrests, restraints and detainments, of all kings, princes and people, of what nation, condition, or quality soever; barratry of the master or mariners, and all other perils, losses and misfortunes, that have or shall come to the hurt, detriment or damage of the said goods and merchandizes, and ship, or any part thereof." In addition to these, however, it is frequently the practice to insure her *lost or not lost*, in which, if the ship should be lost, at the time of the insurance, still the underwriter, provided there be no fraud, is liable. This practice is peculiar to American and English policies, not being adopted by other nations.

Seventhly. The Consideration or Premium for the Risk or Hazard run.

This is always expressed to have been received at the time of underwriting; "we the assurers confessing ourselves paid the consideration due unto us for this assurance by the assured." This being subscribed by the underwriter, it is proper to enquire whether, if the premium were not actually paid at the time, he could afterwards maintain an action for it against the *assured*, who might then produce his subscription in evidence against himself. Questions, upon policies of assurance, stand most broadly upon the usage of the place where the policy is effected, and this question would, no doubt, be determined by usage. By the custom of London, the underwriter credits the broker, and not the assured, for the premium; and therefore the underwriter cannot demand it of the assured; but the broker as certainly could.

Eightbly. The Day, Month and Year, on which the Policy is executed.

This insertion seems very necessary, because, by comparing the date of the policy with the date of facts which happened afterwards, or are material to be proved, it will frequently appear, whether there is any reason to suspect fraud or improper conduct on the part of the insured.

Ninthly. That it be duly stamped.

An Act of Congress passed July 6th. 1797, has imposed the following stamp-duties on policies of insurance. If the ship or vessel, &c. insured, is going from one district to another in the United States, 25 cents. If going from the United States to any foreign port or place, when the sum insured is 500 dollars, or under, 25 cents; exceeding 500 dollars, 1 dollar.

By an Act of Congress passed Feb. 28, 1799, any policy of insurance other than those above specified, must be stamped as follows, viz. when the sum insured is 500 dollars, or under, 25 cents; exceeding 500 dollars, 1 dollar.

II. THE CONSTRUCTION OF THE POLICY.

In the construction of policies two rules chiefly prevail, viz. to give effect to the intentions of the parties, and to the *usage of trade*, with respect to the particular voyages or risks to which the policy relates.

In a case so early as in the time of James the Second, a policy of insurance was construed to run until the ship had ended and was discharged of her voyage; for arrival at the port to which she was bound, was not a discharge *till she was unloaded.*

But although this construction is right, where the policy is general from A to B, yet if it contains the words usually inserted "*and till the ship shall have moored at anchor twenty-four hours in good safety,*" the underwriter is not liable to any loss arising from seizure after she has been twenty-four hours in port: even if such seizure was in consequence of an act of barratry of the master *during the voyage.* Lockyer and others *v.* Offley. 1 Term Rep. p. 252.

Upon an insurance from London to the East-Indies, warranted to depart with convoy, the facts were, that the ship went from London to the Downs, and from thence with convoy, and was lost. It was adjudged that the clause "warranted to depart with convoy," must be construed according to the usage among merchants, that is, from such place where convoys are to be had, *as the Downs.* Lethulier's case. 2 Salk. 443.

The ship Success was insured "*at and from Leghorn to the port of London, and till there moored twenty-four hours in good safety.*" She arrived the 8th of July at Fresh Wharf and moored, but was the same day served with an order to go back to the Hope to perform a fourteen days quarantine. The men upon this deserted her, and on the 12th of the month the captain applied to be excused going back, which petition was adjourned to the 28th, when the regency ordered her back; and on the 30th she went back, performed the quarantine, and then sent up for orders to air the goods; but before she returned the ship was burnt, on the 23d of August, and the question was, whether the insurer was liable.

Lord chief justice Lee ruled, that though the ship was so long at her moorings, yet she could not be said to be there in *good safety*, which must mean the *opportunity* of unloading and discharging—Waples *v.* Eames, 2 Stra. 1243.

In an insurance upon *freight*, if an accident happens to the ship before any goods are put on board, which prevents her from sailing, the insured upon the policy cannot recover the freight which he would have earned if she had sailed.—Tongue *v.* Watts, 2 Stra. 1251.

But if the policy be a valued policy, and part of the cargo be on board when such accident happens, the rest being ready to be shipped, the insured may recover to the whole amount.—Montgomery *v.* Egginton. 3 Term Rep. 362.

The words "at and from Bengal to England," mean the *first arrival* at Bengal; and when such words are used in policies, *first arrival* is always implied and understood.—1 Atk. 584.

When a ship is insured *at and from a place* and it arrives at that place, as long as the ship is preparing for the voyage upon which it is insured, the insurer is liable: but, if all thoughts of the voyage be laid aside, and the ship lie there five, six or seven years, with the *owner's* privity, the insurer is not liable—Chitty *v.* Selwin, 2 Atk. 359.

A ship was insured at and from Jamaica to London: she had also been insured from London to Jamaica generally, and was lost in coasting the island, after she had touched for some days at one port there, but before she had delivered all her outward-bound cargo at the other ports of the island. The question was, when the outward-bound risk commenced, and at what time the outward-bound risk determined. A special jury, after an examination of merchants as to the custom, decided, that the outward risk ended when the ship had moored in *any* port of the island, and did not *continue* till she came to the last port of delivery—Camden *v.* Cowley. 1 Blackst. 417.

And this has been since confirmed by Lord Mansfield, who laid down this doctrine, that the outward risk *upon the ship* ended twenty-four hours after its arrival in the first port of the island to which it was destined; but that the outward policy *upon goods* continued till they were landed—Barrass *v.* London Assurance. Sittings after Hilary, 1782.

An action was brought upon a policy of insurance "on goods, in a Dutch ship, from Malaga to Gibraltar, and at and from thence to England and Holland, both, or either; on goods, as hereunder agreed, beginning the adventure from the loading, and to continue till the ship and goods be arrived at England or Holland, and there safely landed. The agreement was, "that, upon the arrival of the ship at Gibraltar, the goods might be unloaded, and reshipped in one or more British ship or ships for England and Holland, and to return one *per cent.* if discharged in England." It appeared in evidence, that, when the ship came to Gibraltar, the goods were unloaded, and put into a *store ship*, (which it was proved was always considered as a ware house,) and that there was then no British ship there. Two days after the goods were put into the store-ship, they were lost in a storm.

Lee, chief justice.—Policies, are to be construed largely, for the benefit of trade, and for the insured. Now, it seems to be a strict construction, to confine this insurance only to the unloading and reshipping, and the accidents attending that act. The construction should be according to the course of trade in this place; and this appears to be the usual mode of unloading and reshipping in that place, viz. that, when there is no British ship there, then the goods are kept in store-ships. Where there is an insurance on goods on board such a ship, that insurance extends to the carrying the goods to shore in a boat. So, if an insurance be of goods to such a city, and the goods are brought in safety to such a port,, though distant from the city, that is a compliance with the policy, if that be the usual place to which the ships come. Therefore, as here is a liberty given of unloading and reshipping, it must be taken to be an insuring under such methods as are proper for unloading and reshipping. There is no neglect on the part of the insured, for the goods were brought into port the 19th, and were lost the 22d, of November. This manner of unloading and reshipping is to be considered as the necessary means of attaining that which was intended by the policy; and seems to be the same as if it had happened in the act of unshipping from one ship into another. And as this is the known course of the trade, it seems extraordinary, if it were not intended. This is not to be considered as a suspension of the policy; for, as the policy would extend to a loss happening in the unloading and reshipping from one ship to another, so any means to attain that end come within the meaning of the policy. The plaintiff had a verdict.—Tiernay *v.* Etherington. 1 Bur. 348.

The decisions on this subject, notwithstanding the vast variety of their circumstances, are uniform in principle; and the judges always make a constant reference to the usage of trade.

At the same time, though the general rule be to refer to the usage of the trade, yet the parties contracting may, by their own agreement, prevent such a latitude of construction. In order to do this, it is not necessary that express words of exclusion should be inserted in the policy; but if, from the terms used, the court can collect, that such was the intention of the parties, that construction, which is most agreeable to their intention, will prevail.—Lavabre *v.* Wilson, Doug. 27.

When an insurance is made on one species of property, the damage suffered by loss of property, different from that named in the policy, cannot be recovered. Thus a man, who has insured a cargo of *goods*, cannot recover the *freight* which he has paid for the carriage of that cargo; nor can an owner, who insures the *ship merely*, demand satisfaction for the loss of merchandize, laden thereon, or ask from the insurers *extraordinary wages paid to the seamen, or the value of provisions consumed*, by reason of the detention of the *ship* at any port longer than was expected.—Fletcher and others *v.* Poole. Sittings after Easter, 1796.—Baille *v.* Modigliani, Hilary Term, 25 Geo. III.

On a policy, on a *ship*, sailors wages or provisions are never allowed in settling the damages; for, if a ship is detained, in consequence of any injury received in a storm, though the underwriter must make good that damage, yet the insured cannot come upon him for the amount of wages or provisions during the time she was so repairing.—Robertson *v.* Ewer, 3 Term Rep. 127.

But, on a policy on a ship and *furniture*, where the *provisions for the crew* were burnt, it was determined, that *provisions for the crew* are comprehended under *furniture*, and that the underwriter was of course answerable for their loss.—Brough *v.* Whitmore, 4 Term. Rep. 206.

In order to entitle the insured to recover, the loss must be a direct and immediate consequence of the peril insured, and not a remote one.

In an action on a policy of insurance on the ship Mary, a letter of marque, the words of the policy were, "at and from Liverpool to Antigua, *with liberty to cruise six weeks*, and to return to Ireland, or Falmouth, or Milford, with any prize or prizes." The ship having been taken this action was brought, when a verdict was found for the plaintiffs.

The material parts of the evidence were, that the policy was made on the 9th of February, 1779, and there was no time fixed in it for the commencement or the duration of the voyage. The captain of the ship swore, that he sailed from Liverpool on the 28th of February; he was five days before he cleared the land; and he proceeded on his direct voyage till the 14th of March, chacing, however, at different times, from the 7th to the 14th, at which time he began his cruise, giving notice thereof to the crew, and ordering a minute of it to be entered into the log-book, which was done. From the 14th of March, he continued cruising about the same latitude till the 17th or 18th of April, when he discontinued the cruise, of which he also gave notice, intending to go to the Burlings, off Lisbon, in the course of his voyage. On the 23d he renewed the cruise, of which he gave notice, as before, and ordered a minute, to that purpose, to be entered in the log-book. From that time he continued cruising till the 28th of April, when he was taken by an American privateer. Many witnesses were examined, some of whom thought that the liberty of cruising, given by the policy, meant six successive weeks; others conceived, that, if the separate times of cruising, when added together, should not exceed the space of six weeks, the terms of the insurance would be complied with; but none of them could prove any usage, as none of the witnesses ever knew a case exactly circumstanced like the present.

A motion was made for a new trial; upon which Lord Mansfield said, Here, the subject-matter, in my opinion, is decisive to shew, that the six weeks meant one *continued* period of time. A cruise is a well known expression for a connected portion of time. There are frequently articles for a month's cruise, a six-week's cruise, &c. Such a liberty, as in this case, to a letter of marque, is an excuse for a deviation; for the true meaning is, "I will excuse a deviation for six weeks." If they had meant separate days, they would have said forty-two days—The court ordered a new trial.

Insurance on a ship and cargo, from Liverpool to Oporto. The ship sailed, but was driven back by contrary winds; and, before she could sail again, an embargo was laid. The insured applied to the underwriters for leave to put guns on board, and to take out a letter of marque. The underwriters consented to the guns, for her defence, but refused the letter of marque. Notwithstanding which, a general letter of marque was obtained, and put on board. The ship sailed and was taken on her voyage out. The jury thought that the letter of marque was not intended to be used but in the voyage home. The court however determined that this vacated the policy.—Denison *v.* Modigliani, 5 Term, Rep. K. B. 580, Easter-Term. 1794.

Thus it appears, that the material rules to be adhered to, in the construction of policies, are the intention of the parties entering into the contract, and the usage of trade.

III. PERILS OF THE SEA.

It may in general be said, that every thing which happens to a ship in the course of her voyage, by the immediate act of God, without the intervention of human agency, is a peril of the sea. Thus every accident happening by the violence of wind or waves, by thunder or lightning, by driving against rocks, by the stranding of the ship, or by any other violence which human prudence could not foresee, nor human strength resist, may be considered as a loss within the meaning of such a policy; and the insurer must answer for all damages sustained in consequence of such accident. 1 Magens, 52, 76.

If a ship has been missing, and no intelligence received of her within a reasonable time after she failed, it shall be presumed that she founded at sea. Newby *v.* Read, sittings after Michaelmas, 3 Geo. III.

And even in action on a policy, in which there was a warranty *against captures and seizures*, where it was insisted for the defendant, that as captures and seizures were excepted, it lay upon the plaintiff to prove that the loss happened in the particular manner stated. Lord Chief Justice Lee said it would be unreasonable to expect certain evidence of such a loss, where every body on board is presumed to be drowned; and all that can be required, is the best proof the nature of the case admits of, which the plaintiff has given. The jury found a verdict for the plaintiff. Green *v.* Brown, 2 Stra. 1190.

A practice prevails among insurers that a ship should be deemed lost if not heard of in twelve months after her departure, or after the time of the last intelligence from her. If, under this usage, the insurer should pay the money, supposing the ship lost, when it really is not, he may as we shall see hereafter, recover it back in an action.

IV. CAPTURE AND DETENTION OF PRINCES.

A ship is to be considered as lost by capture, though she be never condemned at all, nor carried into any port or fleet of the enemy, and the insurer must pay the value. If after a condemnation the owner recover or retake her, the insurer can be in no other condition than if she had been retaken or recovered before condemnation. The insurer runs the risk of the insured, and undertakes to indemnify; he must therefore bear the *loss actually* sustained. So that if after condemnation the owner recovers the ship in her complete condition, but has paid salvage or been at any expense in getting her back, the insurer must pay the loss so actually sustained. No capture by the enemy can be so total a loss as to leave no possibility of recovery.

Where a capture has been made, whether it be legal or not, the insurers are liable for the charges of a compromise made, *bona fide*, to prevent the ship from being condemned as prize, or to avoid a greater expense. Berens *v.* Rucker, 1 Blackst. 313.

In cases of capture, the underwriter is immediately responsible to the insured. But if the ship be recovered before a demand for indemnity, the insurer is only liable for the amount of the loss actually sustained at the time of the demand: or if the ship be restored at any time subsequent to the payment by the underwriter, he shall then stand in the place of the insured, and receive all the benefits and advantages resulting from such restitution. All these regulations have their foundation in this great principle, that a policy of insurance is nothing more than a contract of indemnity.

The underwriter is likewise answerable for all loss or damage arising to the insured, "*by the arrests, restraints, and detainments, of all kings, princes, and people, of what nation, condition, or quality whatsoever.*"

The only question then is, what shall be considered as such detention. Lord Mansfield has said, that the insured may abandon in case merely of an arrest or embargo by a prince, not an enemy; and consequently such an arrest is a loss within the meaning of the word *detention.* 2 Burr. 696.

An embargo is an *arrest* laid on ships or merchandize by public authority, or a prohibition of state commonly issued to prevent foreign ships from putting to sea in time of war, and sometimes also to exclude them from entering our ports. Ships are frequently detained to serve a a prince in an expedition, and for this end have their loading taken out, without any regard to the colours they bear or the princes to whose subjects they belong. And this is an arrest within the meaning of the policy.

In case of a detention by a foreign power, which in time of war may have seized a neutral vessel at sea, and carried it into port to be searched for enemy's property, all the charges consequent thereon must be borne by the underwriter; and whatever costs may arise from an improper detention must always fall upon them. Saloucci *v.* Johnson, Hil. 25 Geo. III.

But, though an underwriter is liable for all damage arising to the owner of the ship or goods from the restraint or detention of princes, yet that rule is not extended to cases where the insured navigates against the laws of those countries in the ports of which he may chance to be detained, or to cases where there shall be a seizure for non-payment of custom. 2 Vern. 176.

If indeed any of those acts were committed by the master of the ship, without the knowledge of the insured, the underwriter would be liable, not for losses by *detention*, but for a loss by the barratry of the master.

Since the case of Robertson *v.* Ewer, mentioned before, there seems to be very little doubt but that an underwriter is liable to pay damages arising by the detention or seizure of ships by the government of the country to which they belong; for an embargo had been laid by Lord Hood on all shipping at Barbadoes, and it was never doubted that the insurer was liable for any loss which might have been sustained by such detention, provided the loss had happened to any of the property specifically insured. If the ship be detained by the order of the sovereign before her departure for the voyage, but *after the risk commenced*, the insurer by our law is liable for the damage occasioned by such detention, as the words in the policy do in themselves import no restriction to the restraints and embargoes by foreign potentates only.

Although the words of this part of the policy are, "*arrests, restraints, and detainments, of all kings, princes, and people, of what nation, condition, or quality, whatsoever*;" yet the word *people* must be understood as applying to *those people who are the ruling power of the country*, and not to any assemblage of people who arrest the ship in a violent and riotous manner. Nesbitt *v.* Lushington, 4 Term Rep. 783.

Before the insured can recover against the underwriter in cases of detention, he must first *abandon* to the insurers his right, and whatever claims he may have to the goods insured. This point will be treated of under the head of abandonment.

V. BARRATRY OF THE MASTER OR MARINERS.

Barratry is committed when the master of the ship or the mariners, cheat the owners or insurers, whether it be by running away with the ship, sinking her, deserting her, embezzling the cargo, or by carrying a ship a course different from their orders. Postlethwaite's Dict. 1 vol. p. 136, 214. These definitions are so very comprehensive that they seem to take in every case of barratry known to the law of England. From a review of the decisions on this subject, it appears that any act of the master, or of the mariners, which is of a criminal nature, or which is grossly negligent, tending to their own benefit, to the prejudice of the owners of the ship, *without their consent or privity*, is barratry.

It is not necessary in order to intitle the insured to recover for barratry that the loss should happen *in the act of barratry*: that is, it is immaterial whether it take place *during* the *fraudulent* voyage, or *after* the ship has returned to the regular course; for the moment the ship is carried from its right track with an evil intent, barratry is committed. Cowp. Rep. 155.

But the loss in consequence of the act of barratry must happen *during the voyage insured*, and within the time limited by the policy; for if the captain be guilty of barratry by smuggling, and the ship afterwards arrive at the port of destination, and *be there moored at anchor twenty-four hours in good safety*, the underwriters are not liable if after this she should be seized for that act of smuggling. Lockyer *v.* Offley, 1 Term Rep. p. 252.

If the act of the captain be done with a view to the benefit of his owners, and not to advance his own private interest, no barratry is committed. To constitute barratry, it must be *without the knowledge or consent of the owners*.

On a case stated for the opinion of the court, Lord Mansfield observed, It is somewhat extraordinary that the word *barratry* should have crept into insurances, and still more that it should have continued in them so long; for the underwriter insures the conduct of the captain, whom he does not appoint and cannot dismiss, to the owner, who can do either. The point to be considered is whether barratry, in the sense in which it is used in our policies of insurance, can be committed against any but the owners of the ship. It is clear, beyond contradiction, that it cannot; for barratry is something contrary to the duty of *master and mariners*, the very terms of which imply that it must be in the relation in which they stand to the *owners of the ship*. The words used are the *master and mariners*, which are very particular. *An owner cannot commit barratry.* He may make himself liable by his *fraudulent conduct* to the owner of the goods, but not *as for barratry*. And besides barratry cannot be committed against the owner, *with his consent*: for though the owner may become liable for a civil loss by the misbehaviour of the captain, if he consents, yet that is not *barratry*. Barratry must partake of something criminal, and must be committed *against the owner* by the *master* or *mariners*. In the case of Vallejo and Wheeler, the court took it for granted, that barratry could only be committed against the owner of the ship.

If the owner be also master of the ship, any act, which in another master would be construed barratry, cannot be so in him.

If the parties insert in the policy the words *in any lawful trade*, if the captain commit barratry by smuggling, the underwriters are answerable. For otherwise the word *barratry* should be struck out of the policy; and most clearly the stipulation in the policy respecting the employment of the ship in a lawful trade, must mean, as was said by Lord Kenyon, in delivering the unanimous opinion of the court, *the trade* on which she is sent by the owners. Havelock *v.* Hancil, 3 Term Rep. 277.

A very accurate definition of one species of *barratry* has been laid down in the case of Ross *v.* Hunter.

This was an insurance on goods on board the Live Oak, at and from Jamaica to New-Orleans. She sailed on the voyage, insured in May, 1783, and arrived, in June following, at the mouth of the river Mississippi. When the captain had got thus far, he dropped anchor, and went in his boat up the river to New-Orleans; and, on his return, without carrying the ship to her port of destination, stood away for the Havannah; after his departure whence he was never afterwards heard of. A verdict was found for the plaintiff against the underwriter.

Mr. Justice Buller said, in one sense of the word, barratry is a *deviation* by the captain, *for fraudulent purposes of his own.* Then the question in this case is, whether the captain did deviate *with a fraudulent view.* The jury have thought that he had a fraudulent intention, and therefore the verdict is right. 4 Term Rep. 35.

VI. PARTIAL LOSSES, AND ADJUSTMENT.

A total loss does not always mean that the property insured is irrecoverably lost or gone; but that, by some of the perils mentioned in the policy, it is in such a condition as to be of little use or value to the insured, and so much injured as to justify him in abandoning to the insurer, and in calling upon him to pay the whole amount of his insurance, as if a total loss had actually happened. But a total loss is so intimately blended with the doctrine of abandonment, that we shall refer what may be said on this subject till we come to the head of abandonment. Here it will be sufficient to remark, that in case of a total loss, literally so called, the *prime cost* of the property insured, or the value mentioned in the policy, must be paid by the underwriter; at least as far as his proportion of the insurance extends. The insurer has nothing to do with the market; he has no concern in any profit or loss which may arise to the merchant from the sale of the goods. If they be totally lost, he must pay the value of the things he insured at the *outset*; he has no concern in any subsequent value. So, if part of the cargo, capable of a several and distinct valuation at the outset, be totally lost, as, if there be one hundred hogsheads of sugar, and ten happen to be lost, the insurer must pay the prime-cost of those ten hogsheads, without any regard to the price for which the other ninety may be sold.

The word average, in *policies*, has two significations; it means "*a contribution to a general loss*;" and it also is used to signify "*a particular partial loss.*" That which means "*a contribution to a general loss*" will be treated of in the next division.

Partial loss (the subject of our present enquiry) implies a damage, which the ship may have sustained, in the course of her voyage, from any of the perils mentioned in the policy; when applied to the cargo, it means the damage which goods may have received, without any fault of the master, by storm, capture, stranding, or shipwreck, although the whole, or the greater part thereof, may arrive in port. The partial losses fall upon the owners of the property so damaged, who must be indemnified by the underwriter.

The underwriters of London expressly declare, as appears from a memorandum at the foot of the policy, that they will not answer for partial losses, not amounting to 3 *per cent.* This clause was intended to prevent the underwriters from being continually harrassed by trifling demands. But, at the same time that they provide against trifling claims for partial losses, they undertake to indemnify against losses, however inconsiderable, that arise from a general average.

When we speak of the underwriters being liable to pay, whether for total or partial losses, it must always be understood, that they are liable only in proportion to the sums which they have underwritten. Thus, if a man underwrite 100*l.* upon property valued at 500*l.* and a total loss happened, he shall be answerable for 100*l.* and no more, that being the amount of his subscription; if only a partial loss, amounting to 60*l.* or 70*l. per cent.* upon the whole value, he shall pay 60*l.* or 70*l.* being his proportion of the loss.

As to the question of how the proportion of damage is to be ascertained, the grand and leading case is that of Lewis and another *v.* Rucker, 2 Bur. 1167, from which, as it was so ably treated by Lord Mansfield, we think it necessary to give copious extracts.

A rule having been obtained by the plaintiffs, who were the insured, for the defendant (the insurer) to shew cause, why a verdict, obtained by him, should not be set aside, and a new trial had:

The court after hearing the matter fully debated, took time to advise, and their unanimous opinion was delivered, to the following effect, by

Lord Mansfield.—This was an action brought upon a policy, by the plaintiffs, for Mr. James Bordieu, upon the goods on board a ship, called the Vrow Martha, at and from St. Thomas's Island to Hamburgh, from the loading at St. Thomas's Island till the ship should arrive and land the goods at Hamburgh. The goods, which consisted of sugars, coffee, and indigo, were valued; the clayed sugars at 30*l. per.* hogshead; the Muscovado sugars at 20*l. per* hogshead; and the coffee and indigo were likewise respectively valued. The sugars were warranted free from average, (that is partial loss) under 5*l. per cent.* and all other goods free from average under 3*l. per cent.* unless general or the ship be stranded.

In the course of the voyage the sea-water got in; and, when the ship arrived at Hamburgh, it appeared that every hogshead of sugar was damaged. The damage the sugars had sustained made it necessary to sell them immediately, and they were accordingly sold; but the difference between the price which they brought, on account of the damage, and that which they might then have been sold for at Hamburgh, if they had been sound, was as 20*l.* 0*s.* 8*d. per* hogshead is to 23*l.* 7*s.* 8*d. per* hogshead; (that is, if sound, they would have been worth 23*l.* 7*s.* 8*d. per* hogshead; as damaged, they were only worth 20*l.* 0*s.* 8*d. per* hogshead.)

The defendant paid money into court, by the following rule of estimating the damage: *he paid the like proportion of the sum, at which the sugars were valued in the policy, as the price of the damaged sugars bore to sound sugars at Hamburgh, the port of delivery.* And the only question was, by what measure or rule the damage, upon all the circumstances of the case, ought to be estimated.

The special jury (amongst whom there were many sensible merchants) found the defendant's rule of estimation to be right, and gave the verdict for him.

And it is now the duty of the court to say, whether the jury have estimated the damage by a proper measure. This is the rule by which it was estimated.

The defendant takes the proportion of the difference between sound and damaged at the port of delivery, and pays that proportion upon the value of the goods specified in the policy, and has no regard to the price in money, which either the sound or the damaged goods bore in the port of delivery. He says, the proportion of the difference is equally the rule, whether the goods come to a rising or a falling market. For instance, suppose the value in the policy to be 30*l.* the goods are damaged, but sell for 40*l.*—if they had been sound they would have sold for 50*l.* The difference then between the sound and damaged is a fifth, consequently the insurer must pay a fifth of the prime cost, or value in the policy, that is 6*l.* *e converso*, if they come to a losing market, and sell for 10*l.* being damaged, but would have sold for 20*l.* if sound, the difference is one-half; the insurer must pay half the prime cost, or of the value in the policy, that is 15*l.*

To this rule an objection has been made; that it is going by a different measure in the case of a partial, from that which governs in case of a total loss; for, upon a total loss, the prime cost, or value in the policy must be paid. The answer to which objection is, that the distinction is founded in the nature of the thing. Insurance is a contract of indemnity, against the perils of the voyage, to the amount of the value in the policy; and, therefore, if the thing be totally lost, the insurer must pay the whole value which he insured at the outset. But where a part of the commodity is spoiled, no measure can be taken from the prime cost to ascertain the quantity of the damage sustained. The only way is, to fix whether the thing be a third or fourth worse than the sound commodity; and then you pay a third or fourth of the prime cost, or value of the goods so damaged.

We are of opinion, that the rule by which the jury have gone is the right measure.

Wherever there is a specific description of casks, or goods, the rule of estimating the average is as above stated; but, in a subsequent case, the property, which consisted in various goods, taken from an enemy, was valued at the sum insured, and part was lost by perils of the sea; consequently the same rule could not be adopted, on account of the nature of the thing insured. The only mode was to go into an account of the whole value of the goods, and take a proportion of that sum as the amount of the goods lost. Le Cras *v.* Hughes, East. Term, 22 Geo. III.

Some goods are in their nature perishable; and therefore the underwriters have, by express words inserted in their policy, declared that they will not be answerable for any partial loss happening to *corn, fish, salt, fruit, flour* and *seed*, unless it arise by way of a general average, or in consequence of the ship being stranded. Upon this clause it is necessary to observe, that *corn* is a general term, and includes many particulars; peas and beans have been held to come within the meaning of the word. Mason *v.* Skurray, Sit. after Hilary, 1780.

But in a late trial at Guildhall, in the court of common-pleas, Mr. Justice Wilson was of opinion, that the term *salt* did not include *salt-petre.*—Journu *v.* Bourdieu, Sittings after East. Term, 27 Geo. III.

It has likewise been determined, that there cannot be a total loss of corn, fish, salt, fruit, flour or seed, but by the *absolute destruction* of the things insured; for, while it specifically remains, though wholly unfit for use, and though the loss of it exceeds the sum to be paid for the freight of it, that this is not such a loss as is to be borne by the underwriters. Wilson *v.* Smith, 3 Bur. 1550. Mason *v.* Skurray, Sittings after Hilary Term, 1780.

When the quantity of damage sustained in the course of the voyage is known, and the amount which each underwriter of the policy is liable to pay, is settled, it is usual for the underwriter to endorse on the policy "*adjusted this loss at so much per cent,*" or some words to the same effect. This is called an adjustment.

After an adjustment has been signed by the underwriter, if he refuse to pay, the owner has no occasion to go into a proof of his loss, or any of the circumstances respecting it; but, if any fraud were used in obtaining the adjustment, that would be a ground for setting it aside. Hog *v.* Gouldney, Sitt. after Trin. 1745. Beawes, Lex Merc. 310. Thellusson *v.* Fletcher, Dougl. 301.

If any insurer pay money for a total loss, and in fact it be so at the time of adjustment; if it afterwards turn out to be only a partial loss, he shall not recover back the money so paid to the insured: for substantial justice is done by putting him in place of the insured, and giving him all the advantages that may arise from the salvage. DaCosta *v.* Frith, 4 Burr. 1966.

VII. GENERAL AVERAGE.

Whatever the master of a ship in distress does for the preservation of the whole, in cutting away masts or cables, or in throwing goods overboard to lighten his vessel, which is what is meant by jettison or jetson, is permitted to be brought into a general average: in which all who are concerned in ship, freight, and cargo, are to bear an equal or proportionable part of the loss of what was so sacrificed for the common welfare; and it must be made good by the insurers in such proportion as they have underwritten. 1 Magens, 55.

In order to make the act throwing the goods overboard legal, the ship must be in distress and the sacrificing a part must be necessary to preserve the rest.

If the ship ride out the storm and arrive in safety at the port of destination, the captain must make regular protests, and must swear, in which some of the crew must join, that the goods were cast overboard for no other cause but for the safety of the ship and the rest of the cargo. Beawes, 148. Molly, l. 2. c. 6 s. 2.

There can be no contribution (which is another word used frequently for this species of *averages*) without the ejection of some goods, and the saving of others: but it is not always necessary for the purpose of contribution that the ship should arrive at the port of destination.

If the jettison does not save the ship, but she perish in the storm, there shall be no contribution of such goods as may happen to be saved; because the object for which the goods were thrown overboard was not attained. But if the ship be once preserved by such means and continuing her course, should afterwards be lost, the property saved from the second accident shall contribute to the loss sustained by those whose goods were cast out upon the former occasion. 2 Magens, 98.

It is hardly necessary to state with minuteness the various accidents and charges that will entitle the party suffering to call upon the rest for a contribution; because we may refer them all to this principle, that all losses sustained and expences incurred voluntarily and deliberately, with a view to prevent a *total loss* of the ship and cargo, ought to be equally borne by the ship and her remaining lading. Such, for instance, is the damage sustained in defending a ship against an enemy or pirate; such is the expence of curing and attendance upon the officers or mariners wounded in such defence: and such also is the sum which the master may have promised to pay for the ransom of his ship to any privateer or pirate, when taken. A master who has cut his mast, parted with his cable, or abandoned any other part of the ship and cargo, in a storm, in order to save the ship, is well entitled to this compensation: but if he should *lose* them by the storm, the loss falls only upon the ship and freight; because the tempest only was the occasion of this loss, without the deliberation of the master and crew; and was not done with a view to save the ship and lading. Upon the principle it is established, that when a ship arrives at the mouth of a harbour, and the master, finding that his ship is too heavy laden to sail up, is obliged to put part of the cargo into hoys and barges; the owners of the ship and of the goods that remained are obliged to contribute if the lighters perished. But if the ship should be lost, and the lighters saved, the owners of the goods so preserved were not to contribute to the proprietors of the ship and cargo lost. 2 Magens, 96. 183.

The difference is this, the lightening of the ship was an act of deliberation for the general benefit: whereas the circumstance of the lighters being saved, and the ship lost, was accidental, no way proceeding from a regard for the whole. 1 Magens, 56.

It is not only the value of the goods thrown overboard that must be considered in a general average, but also the value of such as receive any damage by wet, &c. from the jettison of the rest. Beawes, 148. Molloy, l. 2, c. 6. s. 8.

If a ship be taken by force, carried into some port, and the crew remain on board to take care of and reclaim her, not only the charges of reclaiming shall be brought into a general average, but the wages and expence of the ship's company during her arrest, from the time of her capture and being disturbed in her voyage. Beawes, 150.

But sailors wages and victuals, when they are under a necessity of performing quarantine, in which case the master would have been obliged to maintain and pay them, though his vessel had arrived only in ballast, do not come into general average, yet charges, occurring by an extraordinary quarantine, should be brought into a general average.

Whether the extraordinary wages and victuals expended during the detention by a foreign prince not at war, ought to be brought into a general average, so as to charge the underwriter, has never been expresly determined, although it seems to be the general opinion that they should.

So likewise where a ship is obliged to go into port for the benefit of the whole concern, the charges of loading and unloading the cargo, and taking care of it, and the wages and provisions of *the workman hired for the repairs*, become general average. Da Costa *v.* Newnham, 2 Term. Rep. 407.

By the antient laws of Rhodes, Oleron and Wisbuy, the ship and all the remaining goods shall contribute to the loss sustained. The most valuable goods, though their weight should have been incapable of putting the ship in the least hazard, as diamonds or precious stone, must be valued at their just price in this contribution, because they could not have been saved to the owners but by the ejection of the other goods.—Neither the persons of those in the ship, nor the ship-provisions, nor the respondentia-bonds, suffer any estimation; nor does wearing apparel in chests and boxes, nor do such jewels as belong to the person merely; but if the jewels are a part of the cargo, they must contribute.

Those who carry jewels by sea ought to communicate that circumstance to the master; because the care of them will be increased in proportion to their worth, to prevent their being thrown overboard promiscuously with other things; and hence their preservation will be a common benefit. 1 Magens, 63.

The wages of sailors are not to contribute to the general loss; a provision intended to make this description of men more easily consent to a jettison as they do not then risk their all, being still assured that their wages will be paid. 1 Magens, 71.

The way of fixing a right sum, by which the average ought to be computed, can only be by examining what the whole ship, freight and cargo, if no jettison had been made, would have produced nett, if they all had belonged to one person, and been sold for ready money. And this is the sum whereon the contribution should be made, all the particular goods bearing their nett proportion. 1 Magens, 69.

Gold, silver and jewels, contribute to a general average, according to their full value, and in the same manner as any other species of merchandize. 1 Magens, 62, and Peters *v.* Milligan, Sittings at Guildhall after Michaelmas, 1787.

The contribution is in general not made till the ship arrive at the place of delivery; but accidents may happen, which may cause a contribution before she reach her distined port. Thus, when a vessel has been obliged to make a jettison, or, by the damages suffered, soon after sailing, is obliged to return to her port of discharge; the necessary charges of her repairs, and the replacing the goods thrown overboard, may then be settled by a general average. 1 Magens, 60.

The following examples of adjusted Averages are here subjoined, having received the approbation of some experienced Merchants.

The Sea Horse, capt. Dix, laden with hemp, flax, and iron, bound from Riga to Boston, ran on shore coming through the Grounds at Elsineur: the captain hired a number of men and several lighters to lighten the ship and get her afloat again, which was soon done, but he was obliged to pay 500 dollars for their assistance. The expence being incurred to preserve both ship and cargo, the average must consequently be general. When the ship arrived at Boston, the captain immediately made a protest and an average-bill; he then went to the merchant to whom his goods were addressed, to have it signed, and to know the value of each man's property.

Average accruing to the ship Sea-Horse, from Riga to Boston, in 1798, for assistance in getting off the Strand of Elsineur.

			D.	C.
To sundry charges paid at the Sound for lighters and assistance in getting the ship off			500	00
Protest and postage			6	00
			506	00
Should the ship arrive at Boston, she will make freight			3000	00
Wages, for all the people, 3 months and 10 days	620	00	1110	00
Victuals for ditto	490	00		
Freight to contribute			1890	00
Ship Sea Horse valued at			16000	00
Freight valued at			1890	00
F. J. for value of hemp, as per invoice			22710	00
D. N. for value of flax			4000	00
T. R. for value of iron			1400	00
Dollars			46000	00

If 46000 dolls. loss give 506 dolls. what will 100 dolls. loss give?

Answer, 1 doll. 10 cents, per cent.

	D.	C.
The ship must bear 16000 dolls. at 1 doll. 10 cents (which the insurers return)	176	00
Freight, 1890 dolls. at 1 doll. 10 cents per cent.	20	79
F. J. pays the captain for 22710 dolls. at the same rate	249	81
D. N. pays the same for 4000 dollars	44	00
T. R. pays the same for 1400 dollars	15	40
Dollars	506	00

The Mary, captain T. partly laden with goods, sailed in May, 1798, from Boston, bound to St. Petersburgh. She sailed the 3d of that month, and after an agreeable passage arrived at Elsineur on the 10th of June, whence she sailed the same day with a fair wind for St. Petersburgh; the next day a heavy gale of wind arose contrary, insomuch that it obliged the captain to bear away for Elsineur again; but night coming on and the gale increasing, it being so dark that it was unsafe to continue running in such a dangerous place, thickly beset with many sands and having a strong current, the captain judged it best to bring the ship to an anchor, which he accordingly did, in 15 fathoms water. Before the ship had been at anchor half an hour she began to drive; and as she still kept driving, with both anchors a-head, and the wind blowing stronger and stronger, they found it impossible to purchase their anchors; then the captain and ship's company judged it safest to cut the cables in order to save their own lives and the ship and cargo, and take their chance in running for the Roads; luckily they got safe in; and the weather abating, they brought up with a small anchor.

The Mary then wanted cables and anchors before she could proceed to St. Petersburgh; the master, therefore, went directly on-shore, bought them, and paid the following sums:

	D.	C.	D.	C.
Protest — — —			2	50
Two new cables and buoy-ropes — —	360	00		
One-third always deducted for new — —	120	00		
			240	00
Two anchors and two buoys — — —			148	00
Charges in getting them on-board, &c. — —			8	50
Dollars			399	00

As the cables were cut away for preservation of ship and cargo, it must be a general average, and both must contribute to pay the damages sustained. The captain made the following average-Bill, on his arrival at St. Petersburgh, in order to recover the damages.

Average accrued to the Mary, for the loss of her Anchors and Cables, in Prosecution of her voyage from Boston to St. Petersburgh, 1798.

	D.	C.
Ship Mary valued at — — —	4100	00
Freight (after wages and victuals deducted) valued at —	250	00
O. P.'s value of goods — — —	3000	00
V. R.'s value of goods — — —	900	00
T. T.'s value of goods — — —	150	00
	8400	00

If 8400 Dolls. loss give 399 Dolls. what will 100 Dolls. give?

Answer, 4 D. 75 C. *per cent.*

The ship must bear 4100 Dolls. at 4 D. 75 C. *per cent.* —	194	75
The freight must bear 250 Dolls. at the same rate —	11	88
O. P. must pay the captain, at St. Petersburgh, for 3000 Dolls. at the same	142	50
V. R. must pay, for 900 Dolls. at the same — —	42	75
T. T. must pay, for 150 Dolls. at the same — —	7	12
Dollars	399	00

Having received 192 Dolls. 37 Cents at St. Petersburgh, the captain sends his protest and average-bill to his owner, to receive of the underwriters their shares of the loss upon the ship and freight.

Capt. T. of the Sea Adventure, bound from London to Virginia, in ballast, was riding at anchor in the Downs, with a large fleet of ships, in a gale of wind. She had not been at anchor long before she began to drive; and the captain, perceiving her to be in great danger of being on-shore, or else foul of the other vessels, judged it safest to cut his cables, as he must have been driven on shore if he had not. After the gale was over, he went to Dover, bought new anchors and cables, and drew upon his owner for the amount of them, as follows:

	Dolls.	*Cts.*
Two anchors and buoys — —	140	00
Rope-makers bill for new cables, &c. — —	150	00
Protest — — —	2	50
Charges in getting them on-board — —	7	50
Dollars	300	00

The captain then sent the charges of reinstating the cables and anchors cut away, and of the protest, to his owner, that he might recover of the insurers the damage sustained.

State of the Sea-Adventure's Average.		Dolls.	Cts.
Two anchors and two buoys — — —		140	00
Rope-maker's bill — —	D. 150 00		
One-third always deducted for new —	50 00		
		100	00
Protest . — — — —		2	50
Charges in getting the anchors, &c. on board — —		7	50
		250	00

Ship valued at 8000 *Dollars*,

If 8000 *dolls.* loss give 250 *dolls.* what will 100 *dolls.* loss give?

Answer, 3 *dolls.* 12½ *cts. per cent.*

Observe, if a ship had been riding in a gale of wind, and the cables had parted, that loss would have fallen upon the owners, for the underwriters are not liable to pay for wear and tear.

This may serve as a similar case of all ships in ballast that have cut away their masts, cables, &c. for preservation.

A loaded ship met with such exceeding bad weather, that the master and mariners found it impossible to save her without throwing part of her cargo overboard, which they are authorized to do for preservation. Being thus necessitated, they threw such goods overboard as lay nearest at hand, and lightened the ship of 10 casks of hard-ware and 30 hogsheads of sugar, which they judged sufficient to keep her from sinking. Soon after that, the ship arrived at her destined place, and then an average bill was immediately made, in order to adjust the loss, and to pay the proprietors of those goods which were thrown overboard for the good of the whole.

Average accrued to the ship——for Goods thrown overboard, for preservation of the ship, freight, and charge.	Dolls.	Cts.
Ship valued at — — —	8000	00
Freight (wages and victuals deducted) — —	800	00
J. R's value of goods — — —	25000	00
J. P's value of goods — — — —	1200	00
R. F's value of goods — — —	6000	00
A. W. for 30 hogsheads of sugar — — —	3800	00
L. L. for 10 casks of hard-ware — — —	5200	00
Dollars	50000	00

If 50,000 *dolls.* loss give 9000 *dolls.* what will 100 *dolls.* loss give?

Answer, 18 *dolls. per cent.*

	D.	C.
Mr. A. W's goods, thrown overboard, were valued at —	3800	00
Mr. L. L's ditto. — — —	5200	00
Dollars	9000	00

The ship must pay to A. W. and L. L. for 8000 dolls. at 18 dolls. *per cent.*	1440	00
The freight, 800 dolls, at 18 dolls, *per cent.* — —	144	00
J. R. for 25000 dolls. at the same — —	4500	00
J. P. for 1200 dolls. at the same — — —	216	00
R. F. for 6000 dolls. at the same — —	1080	00
Dollars	7380	00

A. W. and L. L. receive, of the owners of the goods saved, and of the ship's owners or captain, 7380 dollars for their value of the goods thrown overboard; which they divide thus:

If 9000 dolls. receive 7380 dolls. what will 3800 dolls. receive? *Ans.*	3116	00
Insurers pay for 3800 dolls. at 18 dolls. *per cent.* — —	684	00
Dollars	3800	00

A. W. receives of the underwriters 18 dollars *per cent.* for the sum he insured, and of the owners of what was saved 3116 dollars which is equal to the loss he sustained by his property being thrown overboard.

	D.	C.
L. L. receives, of the owners of the ship and goods preserved, —	4264	00
And the insurer, for the 5200 dolls. which he had insured, at 18 dolls. *per cent.*	936	00
Value of L. L's property — — —	5200	00

It is usual for the owners of goods preserved, and also for the owner of the ship, to pay their average to the sufferers on receipt of their goods and on delivery of the ship; their redress being upon the insurers, who must return the same.

The Mary, captain Thompson, at Leghorn, bound to Boston, sailed with a fair wind, which continued for some days, when she was boarded by pirates, who forcibly took away six large guns, two cables, two anchors, much cabin-furniture, and one compass, leaving the ship without other damage. A violent storm afterwards arose, which disabled the ship so much, that the men who labored hard at the pumps, could scarcely keep her from sinking. This continued so long, that the men, wearied out, gave themselves up for lost, and discontinued their labor. The captain supplied them with wine, and, to animate them, promised a gratuity of one hundred dollars to each man if they brought the ship safe into port. This gave the men such spirits, that though they lost all their masts, they brought the ship safe to Boston under jury-masts, &c.

Here was a *general* and a *particular* average. But although the gratuity given to the seamen was to preserve both ship and cargo, and was admitted into a general average, it was done so only as a matter of favor, and not of right. What the pirates stole, and other damages done to the ship, must make a particular average.

The sloop Christians and Betsey, captain Watson, on her passage from St. Ubes to New-York, met with a very heavy gale of wind, the sea breaking over her, and the vessel making much water; the captain determined on *cutting away* the jib, as he could not take it in; but before that could be done, a sea struck the vessel, and *broke the bowsprit*. The wreck of the bowsprit, jib, &c. broke the lashing of the larboard anchor, and carried it and the cable overboard; in order to preserve the ship and cargo, he cut the whole of this wreck away. During the said gale of wind, the masts having lost great part of their support in the loss of the bowsprit, he prevailed on one of his men, for a gratuity of twenty dollars, to go aloft, and cut away the top-sail, top-gallant-sail, yards, mast and rigging; and at last the vessel reached her port of delivery.

Had the jib been *cut away*, it would have been general average; and it was only under the particular circumstance of being carried away, while that was in contemplation, it was allowed as a particular average on the ship, as was likewise the bowsprit. The entangling with the anchor and cable, though a consequence of the above, yet being *cut away*, came into general average, as did the topmast, &c. The gratuity to the seaman was not allowed, on the principle that a seaman is bound, by his duty and wages, to do *all* in his power for the good of the ship, and he can therefore earn no more.

General Average.

	D.	C.
Blocks for topmast rigging	10	50
Running rigging	42	25
Topsail yard	6	25
Topsail	36	50
Top-gallant-sail	22	00
Cable	92	50
	210	00
One third off	70	00
	140	00
Surveyor 14 dolls. protest 6 dolls.	20	00
Anchor	40	00
Anchor Stock	3	50
Postages		55
Dollars	204	05

	Dolls.			
Ship	2000			
Cargo	1400			
Nett Freight	310			
	3710	at 5 Dolls. 50 Cts. *per cent.* is Dollars	204	05

N. B. No deduction is made from the value of an anchor.

Particular Average on the Ship.

	Dolls.	Cts.
Block maker's bill — — —	5	50
Rope maker's account for Stays, &c. — —	48	50
Bowsprit, &c. — — —	33	12
Jib — — — —	45	38
Carpenter's and Smith's bill — — —	23	27
Postages — — —		23
	156	00
One third off	52	00
Dollars	104	00
Ship 2000 Dolls. at 5 Dolls. 20 Cts. *per cent.* is *Dollars*	104	00

N. B. The custom in America (in general) is, that when the loss does not amount to five *per cent.* nothing is allowed by the underwriters, but the common practice in the English Insurance Offices, is to allow all losses above *three per cent.*

Coasters are not generally allowed an average unless the loss amount to *ten per cent.*

VIII. SALVAGE.

Salvage is an allowance made for saving a ship, or goods, or both, from the dangers of the seas, fire, pirates, or enemies. This allowance is not precisely determined by our law; but our courts always give what is just and reasonable under all the circumstances of any particular case.

The wearing apparel of the master and seamen is always excepted from the allowance of salvage.—Lex Mercatoria, 147.

The valuation of a ship, in order to ascertain the rate of salvage, may be determined by the policy of insurance, if there is no reason to suspect she is undervalued; and the same rule may be observed as to goods, where there are policies upon them. If that, however, should not be the case, the saivers may insist upon proof of the real value, which may be done by the merchant's invoices, and they must be paid for accordingly.—Lex Mercatoria, 147.

The insured may recover from the insurer the expenses of salvage; yet he cannot receive a double satisfaction for the same loss. Thus, if the insurer should have paid to the insured the expenses arising from salvage, and afterwards, on account of some particular circumstance, the loss should be repaired by some unexpected means, the insurer shall stand in the place of the insured and receive the sum thus paid to atone for the loss.—Randall *v.* Cockran, 1 Vez. 98.

IX. ABANDONMENT.

The insured, before he can demand a recompence from the underwriter for a *total loss*, must cede or *abandon* to him his right to all the property that may chance to be recovered from shipwreck, capture or any other peril, stated in the policy.

The right to abandon must arise upon the object of the insured being so far defeated, that it is not worth his while to pursue it: such a loss as is equally inconvenient to him as if it had been total. For instance, if the voyage be absolutely lost or not worth pursuing; if the salvage be very high, *suppose a half*; if farther expense be necessary; if the insurer will not engage at all events to bear that expense, though it should exceed the value, or fail of success; under these and many other like circumstances, the insured may disentangle himself, and abandon, notwithstanding there has been a recapture.—2 Burr. 1209.

There may be circumstances in which it would be unjust to suffer the insured to abandon; for a ship might be taken, and escape immediately, which would be no hindrance at all to the voyage; or she might be taken and instantly ransomed, which would amount only to a partial loss; in which cases, the insured shall not be allowed to demand a recompence for a total loss. —2 Burr. 697, 1213.

The right to abandon must depend upon the nature of the case at the time of the action brought, or at the time of the offer to abandon.—Burr. 1214.

The owner cannot abandon, unless, at *some* period or other of the voyage, there has been a total loss; and therefore, if neither the thing insured nor the voyage be lost, and the damage sustained shall be found, upon computation, not to amount to a moiety of the value, the owner shall not be allowed to abandon.—Term Rep. Easter Term, 26 Geo. III. p. 191.

These principles will be confirmed by the judgments in the following cases.

In Pringle *v.* Hartly in Chancery, 1744. 3 Atk. 195. The defendant had insured the ship *Success* from London to Bermudas, and so to Carolina; the ship was taken by a Spanish privateer, and afterwards retaken by an English privateer, and carried into Boston, when no person appearing to give security, or to answer the moiety the recaptors were entitled to for salvage, she was condemned, and sold in the court of Admiralty; the recaptors had their moiety, and the overplus-money remained in the hands of the officers of that court.

It was contended for the underwriter the insured ought not to recover more on the policy than a moiety of the loss, as the act of the 13. Geo. II. c. 4. s. 18. gives the thing saved to the owner, and he is intitled to receive it from the officers of the Admiralty: and that the underwriter ought to be obliged to pay no more than the loss actually sustained, which cannot be ascertained till after the insured shall have received the part that might have come to him upon the salvage.

The insured was willing to relinquish his interest to the underwriter in the benefit of the salvage.

Upon this Lord Chancellor Hardwick said: I take it when the insured is willing to relinquish his interest in the salvage, he ought to recover the whole money insured. It would be mischievous, if it were otherwise, for then, upon a recapture, a man would be in a worse situation than if the ship were totally lost.

Cazalet and others *v.* Barbe, 1 Term Rep. p. 187. This was an action on a policy of insurance upon the ship Friendship, from Wyburgh to Lynn, subscribed by the defendant for 100*l.* at two guineas *per cent.* The defendant pleaded a tender, and paid 48*l.* into court. The cause was tried at Guildhall, before Mr. Justice Buller, when a case was reserved for the opinion of the court, stating, that the *damages sustained by the ship, in the voyage insured, did not exceed* 48*l. per cent.* which sum the defendant had paid into court upon pleading in the action. That, when the ship arrived at the port of Lynn, she was not worth repairing. The question for the opinion of the court was, whether the plaintiffs had a right to abandon.

This case came on to be argued when Lord Mansfield was absent, and the three other judges were unanimous in opinion for the defendant.

Mr. Justice Buller said, "nothing can be better established than that the owner of a ship can only abandon in case of a total loss. But *there is no instance where the owner can abandon, unless, at some period or other of the voyage, there has been a total loss.* No such event has happened here; for the jury have expressly found, that the loss amounted only to 48*l. per cent.* Even allowing *total loss* to be a technical expression, yet the manner in which the plaintiff's counsel has stated it, is rather too broad. It has been said, that the insurance must be taken to be on the ship as well as on the voyage; but the true way of considering it is this: *it is an insurance on the ship for the voyage.* If either the ship or the voyage be lost, that is a total loss; but here neither is lost."

Suppose a neutral ship is arrested and detained by a foreign prince by an embargo, the owner, immediately upon hearing this accident, would have a right to abandon, because no man is bound to wait the event of an embargo. But if the same ship that brings the account of the embargo, should also inform him, that the embargo was taken off, that the ship had only been detained two or three days, that very trifling or no damage has arisen, then it is impossible to say that the merchant may abandon; because, as we have seen, it is a principle of good sense, that a man cannot make his election, whether he will abandon or not, till he receive advice of the loss; and if, by the same conveyance, it appears that the peril is over, and the thing insured is in safety, he has lost his election entirely; because he has, and can have, no right to abandon when his property is safe.

It has been settled also, by a solemn decision of the Court of King's Bench, in Manning *v.* Newnham, Trin. 22, Geo. III. in what cases a loss should be deemed to be total, after an accident by perils of the sea. A policy was effected in London upon the ship Grace, her "*cargo* and *freight*, at and from Tortola to London, warranted to depart on or before the first of August, 1781. The ship valued at 2470*l.* the freight at 2250*l.* and the cargo at 12400*l.* at a premium of 25 guineas *per cent.* to return 10*l. per cent.* if she departed the West-Indies with a convoy for England and arrives." At the head of the subscriptions is the following declaration, viz. *On ship, freight, and goods, warranted free of particular average.* This ship, with her cargo, was a Dutch prize, taken by a privateer of Tortola, and was there condemned: during the whole of her stay at Tortola (four or five months) she was never unloaded. On the first of August the whole fleet of merchantmen got under way under the convoy of the Cyclops, &c. but not being able to get clear of the islands that day, they cast anchor during the night, and the next day got clear of the islands. About 10 o'clock on the 2d. of August, several squalls of wind arose, which occasioned the ship to strain and make water so fast, that the crew were obliged to work both pumps; and on the third, the captain made a signal of distress; in consequence of which, she was obliged to return to Tortola, under protection of one of his majesty's ships. The captain made his protest, and a survey was had, by which the ship was declared unable to proceed with her cargo, and that she could not be repaired in any of the English islands in the West-Indies; and that many of the sugars in the bilge and lower tier were washed out, and several of the casks broke and in bad order. The ship and the whole of the cargo were sold at Tortola accordingly. The assured claim a total loss of ship, cargo and freight, which the jury thought right, and found accordingly. A motion was made for a new trial, which upon full consideration was refused.

Lord Mansfield, after stating the evidence, and that his prejudices at the trial were in favor of the underwriters, proceeded thus: But, notwithstanding this inclination of my opinion, upon full consideration we think the jury have done right. If by a peril insured the voyage is lost, it is a total loss; otherwise not. In this case the ship has irreparable hurt within the policy; this drives her back to Tortola, and there is no ship to be had there which could take the whole cargo on board. There were only two ships at Tortola, and both could not take in the cargo. To shew how completely the voyage was lost, that no ship could be got, the assured have not been able to send that part of the goods which they purchased, forward to London. It is admitted there was a total loss on the freight, because the ship could not perform the voyage. The same argument applies to the ship and cargo. It is a contract of indemnity; and the insurance is that the ship shall come to London. Upon turning it in every view, we are of opinion that the voyage was totally lost, and that is the ground of our determination.

From what has been said in the preceding part of this subject, it appears, that the insured has a right to call upon the underwriter for a total loss, and of course to abandon, as *soon as he hears* of such a calamity having happened, his claim to an indemnity not being at all suspended by the chance of a future recovery of part of the property lost: because, by the abandonment, that chance devolves upon the underwriter; by which means the intention of the contracting parties is fully answered, and complete justice is done.

In a very modern decision it has been held, by the court of King's Bench, that as soon as the insured receive accounts of such a loss as entitles them to abandon, they must, in the first instance, make their election whether they will abandon or not; and, if they abandon, they must give the underwriters notice in a reasonable time, otherwise they wave their right to abandon, and can never afterwards recover for a total loss. Mitchell *v.* Edie, 1 Term, Rep. 608.

But if the insured, hearing that his ship is much disabled and has put into port to repair, express his desire to the underwriters to abandon, and be dissuaded from it by them, and they order the repairs to be made; they are liable to the owner for all the subsequent damages occasioned by that refusal, though it should amount to the whole sum insured. Da Costa *v.* Newnham, 2 Term. Rep. 407.

X. FRAUD IN POLICIES.

The insurers and insured are equally bound to disclose circumstances that are within their knowledge; and therefore if the insurer, at the time he underwrites, can be proved to have known that the ship was safe arrived, the contract will be equally void as if the insured had concealed from him some accident which had befallen the ship.

It is necessary to consider this in three divisions. *1st. The allegation of any circumstances or facts, to the underwriter, which the person insured knows to be false:—2dly. The suppressions of any circumstances which the insured knows to exist; and which if known to the underwriter, might prevent him from undertaking the risk at all, or, if he did, might entitle him to demand a larger premium: and, lastly, a misrepresentation.* Of each of these in order.

In a case before Lord Chief Justice Holt, in the reign of William and Mary, that learned judge held, that, if the goods were insured as the goods of an Hamburgher, who was an ally, and the goods were, in fact, the goods of a Frenchman, who was an enemy, it was a fraud, and that the insurance was not good.—Skinner, 327.

A *false assertion* in a policy will vitiate the contract; even though the loss happen in a mode not affected by that falsity.—3 Burr. 1419.

The second species of fraud, which affects insurances, is the concealment of circumstances, known only to one of the parties entering into the contract. The facts, upon which the risk is to be computed, lie, for the most part, within the knowledge of the insured only. The underwriter must therefore rely upon him for all necessary information; and must trust to him, that he will conceal nothing, so as to make him form a wrong estimate. If a mistake happen, without any fraudulent intention, still the contract is annulled, because the risk is not the same which the underwriter intended.

One, having a doubtful account of his ship, that was at sea, namely, that a ship, described like his, was taken, insured her, without giving any notice to the insurers of what he had heard, either as to the hazard or the circumstances, which might induce him to believe that his ship was in great danger, if not actually lost.

Lord Chancellor Macclesfield.—The insured has not dealt fairly with the insurers in this case; he ought to have disclosed to them what intelligence he had of the ship's being in danger, and which might induce him, at least, to fear that it was lost, though he had no certain account of it. For, if this circumstance had been discovered, it is impossible to think that the insurers would have insured the ship at so small a premium as they have done, but either would not have insured at all, or would have insisted on a larger premium, so that the concealment of this intelligence is a fraud. Whereupon the policy was decreed to be delivered up with the costs, but the premium to be paid back, and allowed out of the costs.—Da Costa *v.* Scandret, 2 Peere Williams, 170.

In another case it appeared, that, on the 25th of August, 1740, the defendant underwrote a policy from Carolina to Holland. It came out in evidence, that the agent for the plaintiff had, on the 23d of August (two days before the policy was effected) received a letter from Cowes, dated the 21st of August, wherein it is said, "On the 12th of this month I was in company with the ship Davy, (the ship in question) at twelve at night lost sight of her all at once; the captain spoke to me the day before that he was leaky; and the next day we had a hard gale." The ship however continued her voyage till the 19th of August, when she was taken by the Spaniards; and there was no pretence of any knowledge of the actual loss at the time of the insurance, but it was made in consequence of a letter received that day from the plaintiff abroad, dated the 27th of June before.

Lord Chief Justice Lee declared, that as these are contracts upon chance, each party ought to know all the circumstances. And he thought it not material, that the loss was not such an one as the letter imported; for those things are to be considered in the situation of them at the time of the contract, and not to be judged of by subsequent events. He therefore thought it a strong case for the defendant. The jury found accordingly.—Seamen *v.* Fonnereau, 2 Stra. 1183.

But although the rule is laid down thus generally, that one of the contracting parties is bound to conceal nothing from the other, yet it is by no means so general as not to admit of an exception. There are many matters as to which the insured may be innocently silent.

Our ideas on this topic, the argument of Lord Mansfield, in Carter *v.* Boehm, 3 Burr. 1905, will completely regulate The facts of that case are not material; but we shall only give the reasoning of Lord Mansfield, upon the general doctrine of what is not necessary to be revealed.

His lordship said, insurance is a contract upon speculation. The special facts, upon which the risk is to be computed, lie most commonly in the knowledge of the insured only. The underwriter trusts to his statement, and proceeds upon confidence, that he does not keep back any circumstances within his knowledge, to mislead the underwriter into a belief that the circumstance does not exist, and to induce him to estimate the risk as if it did not exist. The keeping back such circumstances is a fraud, and therefore the policy is void. Although the suppression should happen through mistake, without any fraudulent intention, yet still the underwriter is deceived, and the policy is void; because the risk run is really different from the risk understood and intended to be run at the time of the agreement. The policy would equally be void against the underwriter if he concealed any thing; as, if he insured a ship on her voyage, which he privately knew to be arrived; and an action would lie to recover the premium. The governing principle is applicable to all contracts and dealings. Good faith forbids either party, by concealing what he privately knows, to draw the other into a bargain, from his ignorance of that fact, and his believing the contrary. But either party may be innocently silent as to the grounds open to both to exercise their judgments upon. There are many matters as to which the insured may be innocently silent; he needs not mention what the underwriter knows. An underwriter cannot insist that the policy is void, because the insured did not tell him what he actually knew, what way soever he came to the knowledge. The insured needs not mention what the underwriter ought to know; what he takes upon himself the knowledge of; or what he waves being informed of. The underwriter needs not be told what lessons the risk agreed and understood to be run by the express terms of the policy. He needs not be told general topics of speculation; as, for instance, the underwriter is bound to know every cause which may occasion natural perils; as the difficulty of the voyage; the kind of season; the probability of lightning, hurricanes, and earthquakes. He is bound to know every cause which may occasion political perils, from the rupture of states, from war, and the various operations of war. He is bound to know the probability of safety, from the continuance and return of peace; from the imbecility of the enemy, through the weakness of their councils, or their want of strength. If an underwriter insure private ships of war, by sea, and on shore, from ports to ports, and from places to places, any where, he needs not be told the secret enterprises, upon which they are destined; because he knows some expedition must be in view: and, from the nature of his contract, he waves the information, without being told. If he insure for three years, he needs not be told any circumstance to shew it may be over in two; or, if he insure a voyage with liberty of deviation, he needs not be told what tends to shew there will be no deviation. Men argue differently, from natural phenomena and political appearances; they have different capacities, different degrees of knowledge, and different intelligence. But the means of information and judging are open to both: each professes to act from his own skill and sagacity, and therefore neither needs to communicate to the other. The reason of the rule, which obliges the parties to disclose, is to prevent fraud, and encourage good faith; it is adapted to such facts as vary the nature of ths contract, which one privately knows, and the other is ignorant of, and has no reason to suspect. The question, therefore, must always be, "Whether there was, under all the circumstances, at the time the policy was underwritten, a fair statement, or a concealment: fraudulent, if designed; or, though not designed, varying materially the object of the policy, and changing the risk understood to be run."

3d. We come now to the third division, namely, to cases in which policies are void by *misrepresentation.* Before we proceed to state the cases under this head, it will be proper to distinguish between a warranty and a representation. A warranty or condition is that which makes a part of the written policy, and must be most litterally and strictly performed; and being a part of the agreement, nothing *tantamount* will do or answer the purpose. A representation is a state of the case, not a part of the written instrument, but collateral to it, and entirely independent of it; and it is sufficient that a representation be *substantially* performed. Warranties will be noticed hereafter. If there be a misrepresentation, it will avoid the policy, as a fraud, but not as a part of the agreement. Even written instructions, if they are not inserted in the policy, are only to be considered as representations; and in order to make them valid and binding, as a warranty, it is absolutely necessary to make them a part of the instrument, by which the contract of indemnity is effected. If a representation be false in any material point, it will avoid the policy; and if the point be not material, the representation can hardly ever be fraudulent. A few of the decisions will illucidate these principles.

Pawson *v.* Watson, Cowper, 785—Upon a rule to shew cause why a new trial should not be granted in this case, Lord Mansfield reported as follows.—This was an action upon a policy of insurance. At the trial it appeared in evidence, that the first underwriter had the following instructions shewn to him: "Three thousand five hundred pounds upon the ship Julius Cesar, for Halifax, to touch at Plymouth, and any port in America; *she mounts twelve guns and twenty men.*" These instructions were not asked for, nor communicated to the defendant; but the ship was only represented *generally to him as a ship of force:* and a thousand pounds had been done, before the defendant underwrote any thing upon her. The instructions were dated the 28th of June, 1776, and the ship sailed on the 23d of July, 1776; and was taken by an American privateer. That, at the time of her being taken, she had on board six four-pounders, four three-pounders, three one-pounders, six half-pounders, which are called swivels, and twenty-seven men and boys in all, for her crew: but of them, sixteen only were *men,* (not 20, as the instructions mentioned) and the rest boys. But the witness said, he considered her as being stronger with this force, than if she had twelve carriage guns and twenty men: he also said, (which is a material circumstance) that *there were neither men nor guns on board at the time of the insurance.* That he himself insured at the same premium, without regard or inquiry into the force of the ship. Other underwriters also insured at the same premium, without any other representation than that she was *a ship of force.* That to every four-pounder there should be five men and a boy. That, in merchant ships, boys always go under the denomination of men. This was met by evidence on the part of the defendant, saying, that guns mean *carriage-guns* not *swivels:* and men mean able *men,* exclusive of *boys.* The defence was, that these instructions were to be considered as a warranty, the same as if they had been inserted in the policy, though they were not proved to have been shewn to any but the first underwriter. If the court should be of opinion, that the instructions amounted to a warranty, then a new trial is to be had without costs; otherwise, the verdict which was for the plaintiff, is to stand.

Lord Mansfield.—There is no distinction better known to those who are at all conversant in the law of insurance, than that which exists between a *warranty* or condition, which makes a part of a written policy, and a representation of the state of the case. Where it is a part of the written policy it must be performed. As, if there be a warranty of convoy, there must be a convoy; for in the case of convoy it might be said, the party would not have insured without convoy. Therefore if there be fraud in a representation, it will avoid the policy on account of the fraud; but not on account of the non-compliance with any part of the agreement. So that there cannot be a clearer distinction than that which exists between a warranty, which makes part of the written policy, and a collateral representation, which, if false in a point *of materiality,* makes the policy void: but if it be *not* material, it can hardly ever be fraudulent. I have repeatedly, at Guildhall, cautioned and recommended it to the brokers, to enter all representations made by them in a book. That advice has been followed in London. The question then is, whether in this policy, the person insuring has warranted that the ship should positively and literally have *twelve carriage-guns and twenty men.* That is, whether the instructions given in evidence are a part of the policy. The answer to this is, read your agreement, read your policy. There is no such thing to be found there. It is replied, yes, but in fact there is, for the instructions upon which this policy was made contain that express stipulation. The answer again is, there never were any instructions shewn to the defendant; nor were any asked for by him. What colour then has he to say that those instructions are any part of *his* agreement? It is said, he insured upon the credit of the first underwriter. A representation to the first underwriter has nothing to do with that, which is the agreement, or terms of the policy. The representation amounts to no more than this: I tell you what the force will be, because it is so much the better for you. There is no fraud in it, because it is a representation only of what, in the then state of the ship, they thought would be the truth. And in real truth, the ship sailed with a larger force: for she had nine carriage-guns and six swivels. The underwriters, therefore, had the advantage by the difference. There was no stipulation about what the weight of metal would be. All the witnesses say that she had more force than if she had twelve carriage-guns, in point of strength, of convenience, and for the purpose of resistance. The supercargo, in particular, says, "he insured the same ship, and the same voyage, for the same premium, without saying a syllable about the force." Why then it was a matter proper for the jury to say, whether the representation was false, or whether it was in fact an insurance as of a ship without force. They have determined, and I think very rightly, that it was an insurance without force, and therefore there can be no new trial.

His Lordship was afterwards asked, whether it was the opinion of the court, that, to make written instructions valid and binding as a warranty, they must be inserted in the policy. Lord Mansfield answered, that most undoubtedly that was the opinion of the court: if a man warrant that a ship should depart with twelve guns, and it depart with ten only, it is contrary to the condition of the policy.

If a representation be made to the underwriter of any circumstance which was false, this, if it be in a material point, shall vacate the policy and annul the contract, although it happens by mistake, and without any fraudulent intention or improper motive on the part of the insured. The principle on which, in such a case, the contract is held to be void, is, that the insurer is led into error, and computes his risk upon circumstances not founded in fact; by which means, the risk actually run is different from that intended to be run, at the time the contract is made. * On this ground it is, that the contract is as much at an end as if there had been a wilful and false allegation, or an undue concealment of circumstances.

Macdowall *v.* Fraser, Doug. 247.—This was an action on a policy of insurance on the ship "the Mary and Hannah, from New-York to Philadelphia." At the time when the insurance was made, which was in London, on the 30th of January, the broker represented the situation of the ship to the underwriter as follows: "The Mary and Hannah, a tight vessel, sailed with several armed ships, and was seen safe in the *Delaware on the 11th of December*, by a ship which arrived at New-York." In fact, the ship was lost on *the 9th of December*, by running against a *chevaux de frise*, placed across the river. The cause came on to be tried before Lord Mansfield at Guildhall. This was held to be a material misrepresentation as to the time when the ship was seen; and the representation and the day of the loss being proved, the jury found for the defendant.

In a subsequent case, Lord Mansfield and the rest of the court were clearly of opinion, that if the broker at the time when the policy is effected, in representing to the underwriter the state of the ship, and the last intelligence concerning her does not disclose the whole, and what he *conceals* shall appear *material* to the jury, they ought to find for the underwriter, the contract in such case being void; although the concealment should have been *innocent*, the facts not mentioned having appeared *immaterial* to the broker, and having not been communicated merely on that account.—Skirley *v.* Wilkinson, Doug. Rep. 293.

In order to vitiate the contract, the thing concealed must be *material*, it must be *some fact*, and not merely a supposition or speculation of the insured; and the underwriter must take advantage of any misrepresentation the first opportunity, otherwise he will not be allowed to claim any benefit from it at a future period. If therefore the insured merely represent that he *expects* a thing to be done, the contract will not be void, although the event should turn out very different from his expectation.—Barber *v.* Fletcher, Doug. 292.

Wherever there has been an allegation of a falsehood, a concealment of circumstances, or a misrepresentation, it is immaterial, whether such allegation or concealment be the act of the person himself who is interested, or of his agent; for, in either case, the contract is founded in deception, and the policy is consequently void.—Fitzherbert *v.* Mather, 1 Term Rep. p. 12.

If the insured is supposed to be guilty of fraud, the proof of it falls upon the underwriter: Direct and positive proof is not necessary; but circumstantial evidence is all that can be expected; and, indeed, all that is necessary to substantiate such a charge.

XI. SEA-WORTHINESS.

Every ship insured must, at the time of the insurance, be able to perform the voyage, unless some external accident should happen; and if she have a latent defect, wholly unknown to the parties, that will vacate the contract; and the insurers are discharged. This doctrine is founded upon that general principle of insurance-law, that the insurers shall not be responsible for any loss arising from the insufficient or defective quality or condition of the thing insured.

But although the insured ought to know whether the ship was sea-worthy or not at the time she set out upon her voyage, yet he may not be able to know the condition she may be in after she is out a twelvemonth: and, therefore, whenever it can be made appear, that the decay to which the loss is attributable, did not commence till a period subsequent to the insurance, as she was sea-worthy at the time, the underwriter would be liable. In a late case, Eden *v.* Parkinson, Doug. 708, the same principle was much relied upon. Lord Mansfield said, "By an implied warranty every ship insured must be tight, staunch and strong; but it is sufficient if she be so at the time of her sailing. She may cease to be so in twenty-four hours after departure, and yet the underwriter will continue liable." Every case of this kind, it is true, must depend upon its own circumstances; but, when they are once ascertained, the rule of law is clear and decisive.

XII. ILLEGAL VOYAGES.

Whenever an insurance is made on a voyage expressly prohibited by the common statute, or maritime law of the country, the policy is of no effect.

Even if it be told to the underwriter that the voyage is illicit, he shall not be bound: because the contract is null and void.—Bynk, Quæst. Jur. Pub. l. i. c. 21.

If a ship, though neutral, be insured on a voyage prohibited by an embargo, laid on in the time of war, by the prince of the country in whose ports the ship happens to be, such an insurance also is void.

Though an insurance upon a smuggling voyage, prohibited by the revenue laws of this country, would be void under the principle above stated; yet the rule has never been supposed to extend to those cases where ships have traded, or intend to trade, contrary to the revenue laws of *foreign* countries, because no country takes notice of the revenue laws of another; in such cases, therefore, the policy is good and valid; and if a loss happens, the underwriter will be answerable.—Planche *v.* Fletcher, Doug. 238.

We may conclude the present subject with this principle; that all insurances upon a voyage generally prohibited, such as to an enemies garrison, or upon a voyage directly contrary to an express act of parliament, are absolutely null and void.

XIII. RE-ASSURANCE, AND DOUBLE INSURANCE.

Re-assurance may be said to be a contract which the first insurer enters into, in order to relieve himself from those risks which he has incautiously undertaken, by throwing them upon other underwriters, who are called re-assurers.

The re-assurer is wholly unconnected with the original owner of the property insured; and as there is no obligation between them originally, so none is raised by the subsequent act of the first underwriter. The risks of the insurer form the object of the re-insurance, which is a new independent contract, not all concerning the insured, who consequently can exercise no power or authority with respect to it.—Pothier, tit. Assurance, No. 96.

A *double insurance* is where the same man is to receive two sums instead of one, or the same sum twice over, for the same loss, by reason of his having made two insurances upon the same goods or the same ship. The first distinction between these two contracts is, that a re-assurance is a contract made by the first under-writer, his executor, or assigns, to secure himself or his estate: a double assurance is entered into by the insured. A re-assurance, except in the cases provided by the statute, is absolutely void: a double insurance is not void; but still the insured shall recover only one satisfaction for his loss. Where a man has made a double insurance he may recover his loss against which of the underwriters he pleases, but he cannot recover for no more than the amount of his loss. It being thus settled, that the insurer shall recover but one satisfaction, and that, in case of a double insurance, he may fix upon which of the underwriters he will for the payment of his loss, it is a principle of natural justice that the several insurers shall all of them contribute, in their several proportions, to satisfy that loss, against which they have all insured.

In the year 1763, it was ruled, by Lord Mansfield, chief justice, and agreed to be the course or practice, that, upon a double insurance, though the insured is not intitled to two satisfactions, yet upon the first action he may recover the whole sum insured, and may leave the defendant therein to recover a rateable satisfaction from the other insurers.—Newby *v.* Reed, Sit. in London in Easter Vacat. 1263. 1 Black. Rep. 416.

Thus also it was determined in a subsequent case at Guildhall.—Rogers *v.* Davis, Sittings in Mich. Vac. 17 Geo. III, before Lord Mansfield.

Although a man by making a double insurance should not be allowed to recover a double satisfaction for the same loss, yet various persons may insure various interests on the same thing, and each to the whole value, (as the master for wages, the owner for freight, one person for goods, another for bottomry,) and such a contract does not fall within the idea of a double insurance.—1 Burr. 496.

XIV. CHANGING THE SHIP.

Changing the ship, or, as it is commonly called, changing the bottom, will operate as a bar to the insureds recovering upon the policy of insurance against the underwriter. Except in some special cases of insurances upon a *ship or ships*, it is essentially requisite to render a policy of insurance effectual, that the name of the ship, on which the risk was to be run, should be inserted. That being done, it follows that the insured shall neither substitute another ship for that mentioned in the policy before the voyage commences, nor during the course of the voyage remove the property insured to another ship, without the consent of the underwriter or without being impelled by a case of *unavoidable necessity*.

And this doctrine, relative to changing the bottom of the ship, was alluded to by Lord Mansfield, when delivering the opinion of the court in the case of Pelly against the Royal-Exchange Assurance-Company. "One objection," said his lordship, "was formed by comparing this case to that of changing the ship or bottom, on board of which goods are insured, *which the injured have no right to do.*"

This is to be taken as a rule, subject to the exceptions of inevitable or urgent necessity; for, it has been held, that the owners of goods insured, by the act of shifting the goods from one ship to another, do not preclude themselves from recovering an average loss, arising from the capture of the second ship, if they act from necessity, and for the benefit of all concerned.—Plantamour *v.* Staples, 1 Term E. 611, note (a).

XV. DEVIATION.

Deviation means a *voluntary departure*, without necessity or any reasonable cause, from the regular and usual course of the specific voyage insured. Whenever a deviation of this kind takes place, the voyage is determined; and the underwriters are discharged from any responsibility. It is necessary to insert, in every policy of insurance, the place of the ship's departure, and also of her destination. Hence it is a condition on the part of the insured, that the ship shall pursue the most direct course, of which the nature of things will admit, to arrive at the destined port. If this be not done, if there be no special agreement to allow the ship to go to certain places out of the usual track, or if there be no just cause assigned for such a deviation, the underwriter is no longer bound by his contract. Nor is at all material, whether the loss be or be not in actual consequence of the deviation; for the insurers are in no case answerable for a subsequent loss in whatever place it happens, or to whatever cause it may be attributed. Neither does it make any difference, whether the insured was, or was not, consenting to the viation.

The plaintiff was a shipper of goods in a vessel bound from Dartmouth to Liverpool. The ship sailed from Dartmouth, and put into Loo; a place *she must of necessity pass by* in the course of the insured voyage. But, as she had no liberty given her by the policy to go into Loo, and, although no accident befel her in going into or coming out of Loo, (for she was lost after she got out to sea again,) yet Mr. Justice Yates held that this was a deviation, and a verdict was accordingly found for the underwriters.—Fox *v.* Black, Exeter assizes, 1767, before Mr. Justice Yates.

It was also held by Lord Chief-Justice Lee, that, if the master of a vessel put into a port not usual, or stay an unusual time, it is a deviation, and discharges the insurer.

These principles being once established, it follows, as a necessary consequence, that however short the time of deviation may be, if only for a single night, or even for an hour, the underwriter is equally discharged, as if there had been a deviation for weeks or months; for the condition being once broken, no subsequent act can ever make it good.

Whenever the deviation arises from necessity and a just cause, the underwriter still remains liable, although the course of the voyage is altered.—Rocus, n. 52.

The first ground of necessity, which justifies a deviation, is that of going into port to repair. If a ship is decayed, and goes to the *nearest place* to refit, it is no deviation; because it is for the general interest of all concerned, and consequently for that of the underwriters, that the ship should be put in a proper condition, capable of performing the voyage.—Motteux and others *v.* the London Assurance-Company, 1 Atk. 545; and Gilbert *v.* Readshaw, Sitt. in Lond. Hil. Vac. 1781.

The next excuse for leaving the direct course is *stress of weather*. Upon this point the rule is this; that, wherever a ship, in order to escape a storm, goes out of the direct course; or when, in the due course of the voyage, she is driven out of it by stress of weather, this is no deviation. It has also been held, that, if a storm drive a ship out of the course of her voyage, and she do the best she can to get to her port of destination, she is not obliged to return back to the point from whence she was driven.—Harrington *v.* Halkeld, Sitt. in Lond. Mich. Vac. 1778.

If a ship be driven out of her port of loading, by stress of weather, into another, and then does the best she can to get to her port of destination, it shall not be deemed a deviation, though she do not return to the port from whence she was driven.—Delaney *v.* Stoddart, 1 Term, Rep. p. 22.

A deviation may also be justified, if done to avoid an enemy; or seek for convoy; because it is in truth no deviation to go out of the course of a voyage, in order to avoid danger, or to obtain a protection against it.—Bond *v.* Gonsales, 2 Salk. 445.—Gordon *v.* Morley.—Campbell *v.* Bordieu, 2 Stra. 1265.

In the case of Bond against Nutt, in which the material question was, whether a warranty had or had not been complied with; the point of deviation for the purpose of procuring convoy also came under the consideration of the court. Upon that occasion, Lord Mansfield and the whole court held, that, if a ship go to the *usual place of rendezvous*, for the sake of joining convoy there ready, though such place be out of the direct course of the voyage, it is no deviation.—Cowp. Rep. 601.

And, in a more modern case, the only question was, whether there was a deviation or not. Lord Mansfield there directed the jury to find for the plaintiffs, if they believed that the captain fairly and *bona fide* acted according to the best of his judgment; that he had no other view or motive but to come the safest way home, and meet with convoy; for, that it was no deviation to go out of the way to avoid danger.—Enderby and another *v.* Fletcher, Sitt. in Lond. Trin. Vac. 1780.

If, by the usage of any particular trade, it is customary to stop at certain places, lying out of the direct course from A to B, it is not a deviation to stop there, because it is a part of the voyage; but, in order to justify the captain of a ship in quitting the straight and direct line from the port of loading to that of delivery, there must be a precise, clear, and established usage upon the subject, not depending merely upon one or two loose and vague instances.

But, though an actual deviation from the voyage insured is thus fatal to the contract of insurance, yet a deviation, merely *intended*, but never carried into effect, is considered as no deviation, and the insurer continues liable. Thus, in case of an insurance from Carolina to Lisbon, and at and from thence to Bristol, it appeared, that the captain had taken in salt, which he was to deliver at Falmouth, before he went to Bristol; but the ship was taken in the direct road to both, and before she came to the point where she would have turned off to Falmouth. Lord Chief-Justice Lee held, that the insurer was liable; for, it is but an *intention to deviate*, and that was held not sufficient to discharge the underwriters.—Foster *v.* Wilmer, 2 Stra. 1249.

In the case of Carter *v.* the Royal-Exchange Assurance Company, where the insurance was from Honduras to London, and a consignment to Amsterdam, a loss happened before she came to the dividing point between the two voyages, for which the insurers were held liable to pay. —2 Stra. 1249.

If, however, it can be made appear, by evidence, that it never was intended or came within the contemplation of the parties to sail upon the voyage insured; if all the ship's papers and documents be made out for a different place from that described in the policy, the insurer is discharged from all degree of responsibility, even though the loss should happen before the dividing point of the two voyages. This distinction was very properly taken by the court of King's-bench, in Woolbridge *v.* Boydel, Dougl. 16.

In a still later case, the same doctrine was advanced, namely, that if a ship be insured from a day certain, from A to B, and before the day, sail on a different voyage from that insured, the assured cannot recover; even though the ship afterwards fall into the course of the voyage insured, and be lost after the day on which the policy was to have attached.—Way *v.* Modigliani, 2 Term Rep. 50.

From the proposition just established, namely, that a mere *intention to deviate*, will not vacate the policy, it follows, as an immediate consequence, that whatever damage is sustained before *actual* deviation will fall upon the underwriters.

Thus it was held by Lord Chief-Justice Holt, who said, that if a policy of insurance be made to begin from the departure of the ship, from England, until, &c. and after the departure a damage happens, &c. and then the ship *deviates*; though the policy is discharged from the time of the deviation, yet for the damages sustained before the deviation the insurer shall make satisfaction to the insured.—Green, *v.* Young 2 Ld. Raym. 840. 2 Salk. 444. S. C.

In cases of deviation, the premium is not to be returned; because, the risk being commenced, the underwriter is entitled to retain it.

XVI. NON-COMPLIANCE WITH WARRANTIES.

A warranty in a policy of insurance is a condition or contingency, that a certain thing shall be done, or happen; and, unless that is performed, there is no valid contract. It is perfectly immaterial for what view the warranty is introduced; but, being once inserted, it becomes a binding condition on the insured; and unless he can shew that he has *literally* fulfilled it, or that it was *literally* performed, the contract is the same as if it had never existed.—1 Term Rep. p. 345.

But as a warranty must be *strictly* complied with in favor of the underwriter, and against the insured, equal justice demands, that if a strict and literal compliance with the warranty will support the demand of the insured, the decision ought to be in his favor; especially when, by such a decision, *all* the words in the policy will have their full operation.

In an action on a policy on goods, dated the 9th of December, 1784, *lost or not lost, warranted well this 9th day of December*, 1784; it appeared, that the warranty was at the foot of the policy; that the policy was underwritten between the hours of one and three in the afternoon of the 9th of December; that the ship was well at six o'clock in the morning, but was lost at eight o'clock the same morning.

Upon a motion to set aside a non-suit which had been entered, Lord Kenyon, chief justice, Ashhurst, Buller, and Grose, justices, was clearly of opinion that the warrantry was sufficiently complied with, if the ship were well at any time that day; that the nature of a warranty goes to determine the question; for, as it is a matter of indifference whether the thing warranted be or be not material, and yet must be literally complied with, still, if it be complied with, that is enough: that their was good reason for inserting these words, because they protected the underwriter from losses before that day, to which he would otherwise have been liable, as the policy was on the goods from the lading; and thus too, the words *lost or not lost* have also their operation.—Blackhurst *v.* Cockell, 3 Term Rep. 360.

In order to make written instructions valid and binding as a warranty, they must appear on the face of the policy itself: even though a written paper be *wrapt up in the policy*, when it is brought to the underwriters to subscribe, and shewn to them at that time: or even though it be *wafered to the policy*, at the time of subscribing; still it is not in either case a *warranty*, or to be considered as part of the policy itself, but only as a *representation*. Both these instances have occurred before Lord Mansfield, in Pawson *v.* Barnevelt, Dougl. 12. and in Bize *v.* Fletcher, Dougl. 12.

It being thus settled, that a warranty must appear on the face of the instrument, it has likewise been determined that a warranty written in the margin of the policy, was to be considered equally binding, and subject to the same strict rule of construction, as if inserted in the body of the policy itself.—Doug. 10 and 271.

The warranties which most frequently occur, and upon which the greatest questions have arisen, may be reduced to three clases: *warranty as to the time of sailing*, *warranty as to convoy*, and *warranty as to neutrality*.

1st.—*As to the time of sailing*. It has been held that when a ship has been warranted to sail on a particular day, though the ship be delayed for the best and wisest reasons, or even though she be detained by force, the warranty has not been complied with, and the insurer is discharged from his contract.—Hare *v.* Whitmore, Cowp. 784.

If the warranty be to sail *after* a specific day and the ship sail before, the policy is equally avoided as in the former case; because the terms of the warranty are as much departed from in the one case as in the other.—Vezian *v.* Grant, before Mr. Justice Buller, Guildhall, East. Vac. 1779.

But when a ship is warranted to sail on or before a particular day, if she sail from her port of loading, *with all her cargo and clearances on board*, to the usual place of rendezvous at another part of the same island, merely for the sake of joining convoy, it is a compliance with the warranty, though she be afterwards detained there by an embargo beyond the day. The ground is, than when a ship leaves her port of loading, when she has a full and complete cargo on board, and has no other object in view but the safest mode of sailing to her port of delivery, her voyage must be said to commence from her departure from that port. If, indeed, her cargo was not complete, it would not have been a commencement of the voyage.—Bond *v.* Nutt. Cowp. 601.

The second species of warranty, which most frequently occurs in insurances, is that of *sailing under the protection of convoy*. Upon this subject it is material to consider what is deemed *a convoy*. It has been settled, by the court of King's Bench, that it is not every *single man of war*, which chooses to take a merchant ship under its protection, that will constitute such a convoy as a warranty means; but it must be *a naval force under the command of a person appointed by the government of the country to which they belong*.—Hibbert *v.* Pigou, B. R. East. 23 Geo. III. 1783.

From that case of Hibbert and Pigou, we likewise collect this, that a convoy appointed by the admiral, commanding in chief upon a station abroad, is a convoy appointed by government.

Having seen what shall be deemed a convoy, let us proceed to consider what shall be a *departure* with convoy, within the meaning of a warranty *to depart with convoy*. The rule on this point is short and clear, that such a warranty implies, that the ship shall go with convoy from the usual place of rendezvous at which the ships have been accustomed to assemble; at Spithead, or the Downs, for the port of London; and Bluefields, for all the ports in Jamaica. And from the particular port to such usual place of convoy, the ship is protected by the policy. —Lethulier's case, 2 Salk. 443, and Gorden *v.* Morley, 2 Stra. 1265.

Although the words commonly used are "to *depart* with convoy," or "to sail with convoy," yet they extend to sailing with convoy throughout the whole of the voyage, as much as if those words were inserted. If therefore the convoy is to go only a part of the way, that is not a compliance with the warranty; and the insurer is discharged from his engagements. —Lilly *v.* Ewer, Dougl. 72.

But, although is has been thus settled, that a ship must depart with convoy for the whole of the voyage, yet an *unforeseen* separation is an accident to which the underwriter is liable.— Jefferey *v.* Legendra, 3 Lev. 320.

Even where the ship has by tempestuous weather, been prevented from joining the convoy at all, at least, of receiving the orders of the commander of the ships of war, if she do every thing in her power to effect it, and it shall be deemed a sailing with convoy, within the terms of the warranty.—Victoria *v.* Cleeve, 2 Stra. 1250.

The third species of warranty is that of *neutrality*; or, that the ship or goods insured are neutral property. If the ship and property are neutral at the time when the risk commences, this is a sufficient compliance with a warranty of neutral property; because it is impossible for the insured to be answerable for the consequences of a war breaking out during the voyage.—Eden and another *v.* Parkinson, Dougl. 705. And this doctrine has been since confirmed, in the case of Tyson *v.* Gurney, 3 Term Rep. 477.

XVII. RETURN OF PREMIUM.

The next object of our inquiry is, in what cases, and under what circumstances, there shall be *a return of premium.*

The principle upon which the whole of this doctrine depends, is simple and plain. The risk or peril is the consideration for which the premium is to be paid; if the risk be not run, the consideration for the premium fails; and equity implies a condition, that the insurer shall not receive the price of running a risk, if in fact he runs none.—3 Burr. 1240.

Accordingly, in an action brought by the plaintiff, for 5*l.* received by the defendant to the plaintiff's use, where it appeared in evidence, that one Barkdale had made a policy of insurance upon account, for 5*l.* premium, in the plaintiff's name, and that he had paid the same premium to the defendant, and that Barkdale had no goods then on board, and so the policy was void. Lord Chief Justice Holt said, the money is not only to be returned by the custom but the policy is made originally void, the party, for whose use it was made, having no goods on board; so that by this discovery, the money was received without any *reason, occasion,* or *consideration,* and consequently it was received originally to the plaintiff's use. And so judgment was given for the plaintiff.—Martin *v.* Sitwell, 1 Shower. 156.

Clauses are frequently inserted in policies of insurance, containing conditions on the performance or non-performance of which the premium is returnable.

By the law of England, is has been clearly settled, that, whether the cause of the risk not being run is attributable to the *fault, will* or *pleasure,* of the insured, still the premium is to be returned.—Cowp. 668.

The French, in the famous ordinances of Lewis XIV. have inserted an article, declaring that if the voyage is intirely broken up, before the departure of the ship, *even by the act of the insured,* the insurance shall be void, and the underwriter shall return the premium, reserving one half *per cent.* for his trouble. Accordingly, in England, it has always been the custom, when the policy is cancelled, to return the premium, deducting one half *per cent.*—Molloy, l. 2. c. 7. s. 12.

In the English law there are two general rules established which govern almost all cases,—The first is, that where the risk has not been run, whether that circumstance was owing to the fault, the pleasure, or will, of the insured, or to any other cause, the premium shall be returned. Another rule is, that, if the risk has *once* commenced, there shall be *no* apportionment or return of premium afterwards. Hence, in cases of deviation, though the underwriter is discharged from his engagement, yet, the risk being once commenced, he is entitled to retain the premium.

Where, however, from the nature of the agreement between the parties, or the nature of the voyage, the contract becomes divisible, "a part of the premium shall be retained for the risk run, and part shall be returned as the risk has never commenced."

The first time in which this doctrine was considered at any length was in a case which came before the court of King's Bench, in the year 1761. It was an insurance upon a ship, at five guineas *per cent.* lost or not lost, *at and from London to Halifax, in Nova-Scotia, warranted to depart with convoy from Portsmouth,* for the voyage, that is to say, the Halifax or Louisburgh convoy. Before the ship arrived at Portsmouth the convoy was gone. Notice of this was immediately given by the insured to the underwriter; and at the same time he was also desired either to make the long insurance or to return part of the premium. The jury found that the usual settled premium, from London to Portsmouth, was one and a half *per cent.* They also found, that it *is usual* for the underwriter, in such like cases, to return part of the premium; but the *quantum* is uncertain: (and the *quantum* must in its nature be uncertain, because it depends upon certain circumstances.) It was stated that the plaintiff made an offer to the defendant of allowing him to retain one and a half *per cent.* for the risk he had run on such part of the voyage as was performed under the policy, viz. from London to Portsmouth.

Lord Mansfield—I had not at the trial, nor have now, the least doubt about this question myself These contracts are to be taken with great latitude: the strict letter of the contract is not so much regarded as the object and intention of it. Equity implies a condition, "that the insurer shall not receive the price of running a risk, if he runs none." This is a contract without any consideration, as to the voyage from Portsmouth to Halifax; for he intended to insure that part of the voyage as well as the former part of it, and has not. Consequently, the insured received no consideration for this proportion of his premium; and then this case is within the general principle of actions for money had and received to the plaintiff's use. I do not go upon the usage; for the usage found is only that, in like cases, it is usual to return a part of the premium, without ascertaining what part. If the risk is not run, though it is by the neglect, or even the fault of the party insuring, yet the insurer shall not retain the premium. It has been objected, that the voyage being *begun*, and part of the risk being already run, the premium cannot be apportioned. But I can see no force in the objection. This is not a contract so entire, that there can be no apportionment; for there are two parts in this contract; and the premium may be divided into two distinct parts, relative, as it were, to two distinct voyages. The practice shews, that it has been usual, in such like cases, to return a part of the premium, though the *quantum* be not ascertained. And, indeed, the *quantum* must vary as circumstances vary; so that it never can have been fixed with any precise exactness. But though the *quantum* has not been ascertained, yet the principle is agreeable to the general sense of mankind. Stevenson *v.* Snow, 3 Burr. 1237.

Some years afterwards, the principle established in the foregoing case was attempted to be applied to one which it did not at all resemble. That was in an insurance for twelve months at 9*l.* *per cent.* and, because the ship was captured within two months after the contract was made, a return of premium was demanded. But the contract in this case was entire; the premium was a gross sum stipulated and paid for twelve months; and the parties when they made the contract, had no intention or thought of a subsequent division, or apportionment, and therefore there could be no return of premium.—Tyrie *v.* Fletcher, Cowp. 666.

In a subsequent case, the Court of King's-Bench adopted the same rule of decision, where the ship was insured for twelve months, and the risk ceased at the end of two. A distinction was attempted to be made, because, in this case, the whole premium, 18*l.* was acknowledged to be received from the insured *at the rate of fifteen shillings per month*; and this, it was insisted, evidently shewed the parties intended the risk to continue only from month to month. This objection was, however, over-ruled; the court being of opinion, that the case last mentioned decided this; and that the fifteen shillings per month was only a mode of computing the gross sum.—Loraine *v.* Thomlinson, Dougl. 564.

The two last cases, were insurances upon time; but it seems perfectly clear, that when the contract is entire, whether it be for a *specific time*, or *for a voyage*, there shall be no apportionment or return, if the risk has *once commenced*. And, therefore, where the premium is entire in a policy on a voyage, where there is no contingency at any period, out or home, upon the happening or not happening of which the risk is to end, nor any usage established upon such voyages, although there be several distinct ports, at which the ship is to stop, yet the voyage is one, and no part of the premium shall be recoverable.—Bermon *v.* Woodbridge, Dougl 751.

The last case upon this subject was also an action for a return of the premium. The policy was "at and from Jamaica to London, warranted to depart with convoy for the voyage, and to sail on or before the 1st of August, upon goods on board a ship called the Jamaica, at a premium of twelve guineas *per cent.*" The ship sailed from Jamaica to London on the 31st of July, 1782, but without any convoy for the voyage. At the trial, before Lord Mansfield, the jury found a verdict for the plaintiff, subject to the opinion of the court, upon a case, stating the facts already mentioned. In addition to which, they *expresly* find, "that it is the constant and invariable usage in an insurance, at and from Jamaica to London, warranted to depart with convoy, or to sail on or before the 1st of August, when the ship does not depart with convoy, or sails after the 1st of August, to return the premium, deducting one half *per cent.*"

Lord Mansfield.—An insurance being on goods warranted to depart with convoy, the ship sails without convoy; and an action is brought to recover the premium. The law is clear, that, if the risk be commenced, there shall be no return. Hence questions arise of distinct risks insured by one policy or instrument. My opinion has been to divide the risks. I am sometimes aware that there are great difficulties in the way of apportionments, and, therefore, the court has sometimes leaned against them. But where an express usage is found by the jury, the difficulty is cured. They offer to prove the same usage as to the West-Indies in general; but I stopt them, and confined the evidence to Jamaica. The court, therefore, decided for the plaintiff.—Long *v.* Allen, Easter Term, 25 Geo. III.

From the tenor of all these cases, it should seem, as my Lord Mansfield said, that so many difficulties occur in apportioning the premium, that the courts are often obliged to decide against it, unless there be some usage upon the subject.

XVIII. BOTTOMRY AND RESPONDENTIA.

Bottomry is in the nature of a mortgage of a ship, when the owner of it borrows money to enable him to carry on the voyage, and pledges the keel, or *bottom* of the ship, as a security for the repayment; and it is understood, that if the ship be lost, the lender also loses his whole money; but, if it return in safety, then he shall receive back his principal, and also the premium or interest stipulated to be paid, however it may exceed the usual or legal rate of interest. When the ship and tackle are brought home, they are liable as well as the person of the borrower, for the money lent. But when the loan is not made upon the vessel, but upon the goods and merchandises laden thereon, which, from their nature, must be sold or exchanged in the course of the voyage, then the borrower only is *personally* bound to answer the contract; who, therefore, in this case, is said to take up money at *respondentia*. In this consists the difference between *bottomry* and *respondentia*; the one is a loan upon the ship, the other upon the goods; in the former, the ship and tackle are liable, as well as the person of the borrower; in the latter, for the most part, recourse must be had to the *person* only of the borrower. Another observation is, that in a loan upon bottomry, the lender runs no risk, though the *goods* should be lost; and upon respondentia, the lender must be paid his principal and interest, though the ship perish, provided the goods are safe. In all other respects, the contract of bottomry and that of respondentia are upon the same footing.

These terms are also applied to another species of contract, which does not exactly fall within the description of either; namely, to a contract for the re-payment of money, not upon the ship and goods only, but upon the mere hazard of the voyage itself; as if a man lend 1000*l.* to a merchant to be employed in a beneficial trade, with a condition to be repaid with extraordinary interest, in case a specific voyage named in the condition shall be safely performed.

The contract of bottomry and respondentia seems to deduce its origin from the custom of permitting the master of a ship, when in a foreign country, to hypothecate the ship, in order to raise money to refit. Such a permission is absolutely necessary, and is impliedly given him in the very act of constituting him master, by the marine law, which in this respect is reasonable; for, if a ship happen to be at sea, and spring a leak, or the voyage is likely to be defeated for want of necessaries, it is better that the master should have it in his power to pledge the ship and goods, or either of them, than that the ship should be lost or the voyage defeated. But he cannot do either for any debt of his own; but merely in cases of *necessity*, and for *completing the voyage*. Although the master of the vessel has this power while abroad, because it is absolutely necessary for the purpose of commerce and navigation; yet the very same authority, which gave that power in those cases, has denied it when he happens to be in the same place where the owners reside. All the cases which have been determined upon the subject, seem to require, that the ship should be *abroad*, as well as in a *state of necessity*, to justify the captain or master in taking money on bottomry. Molloy, in express terms, declares, that a master has no power to take up money on bottomry in places where his owners dwell; otherwise, he and his estate must be liable thereto.—Molloy, l. 2. c. 11. f. 11. If, indeed, the owners do not agree in sending the ship to sea, the majority shall carry it, and then money may be taken up by the master on bottomry for their proportion who refuse, although they reside on the spot, and it shall bind them all.

It is of the essence of a contract of bottomry, that the lender run the risk of the voyage; and that both principal and interest be at hazard; for, if the risk go only to the interest of premium, and not to the principal also, though a real and substantial risk be inserted, it is a contract against the statute of usury, and therefore void. This has been frequently so determined in our courts of law.

As the hazard to be run is the very basis and foundation of this contract, it follows, that, if the risk is not run, the lender cannot be entitled to the extraordinary premium; for that would be to open a door to means by which the statute of usury might be evaded. This was so decided in the court of chancery.

This case was upon a bottomry-bond, where the plaintiff was bound, in consideration of 400*l.* as well to perform the voyage within six months, as at the six months end to pay 400*l.* and 40*l.* premium, in case the vessel arrived safe, and was not lost in the voyage. It happened that the plaintiff never went the voyage, whereby the bond became forfeited, and he now preferred his bill to be relieved. Upon the former hearing, as the ship lay all the time in the port of London, and there was no hazard of losing the principal, the lord-keeper thought fit to decree, that the defendant should lose the premium of 40*l.* and be contented with his principal and *ordinary interest*. And now, upon a rehearing, he confirmed his former decree.—Deguilder *v.* Depeister, 1 Vern. 263.

It remains to be shewn what those risks are to which the lender undertakes to expose himself. These are, for the most part, mentioned in the condition of the bond, and are nearly the same, against which the underwriter, in a policy of insurance, undertakes to indemnify. These accidents are, tempests, pirates, fire, capture, and every other misfortune, except such as arise either from the defects of the thing itself, on which the loan is made, or from the misconduct of the borrower.

Capture here does not mean a mere temporary taking, but it must be such a capture as to occasion a total loss. And therefore, if a ship be taken and detained for a short time, and yet arrive at the port of destination within the time limited, (if time be mentioned in the condition) the bond is not forfeited, and the obligee may recover.—Joyce *v.* Williamson, B. R. Mich. Term, 23 Geo. III.

A lender on bottomry, or at respondentia, is neither intitled to the benefit of salvage nor liable to contribute in case of a general average.—Walpole *v.* Ewer, Sitt after Trin. 1789.

It has been said, that if the accident happen by default of the borrower or of the captain, the lender is not liable, and has a right to demand the payment of the bond. If, therefore, the ship be lost by a wilful deviation from the track of the voyage, the event has not happened upon which the borrower was to be discharged from his obligation.—Western *v.* Wildy, Skin. 152.

OF BILLS OF EXCHANGE.

Of Foreign Bills.

A BILL of Exchange is a piece of paper, on which is written a short order, given by a banker, &c. for paying to such a person, or his order, a certain sum of money.

In order to understand this subject, it will be necessary to explain the terms used in bills of exchange.

The *drawer* is the person who draws the bill of exchange.

The *drawee* is the person upon whom it is drawn; and he is so called *before* he accepts the same; but, after he has accepted he is then called the *acceptor*.

An *indorser*.—Every person, before he can pay away, or pass, a bill of exchange, must write his name on the back of the bill; and he is therefore called an *indorser*.

An *indorsee* is any person who is in possession of a bill of exchange in consequence of its having been indorsed to him.

The *payee* is the person in whose favour a bill is drawn; as, if A. draws a bill upon B. directing him "*pay to C. or order*," C. is called the payee; and, before C. can pass away the same, he must *indorse* it.

If the drawee refuse to accept or pay the bill, the payee must cause it to be protested.

A protest signifies, to the drawer, that the party upon whom he drew his bill was unwilling, not to be found, or insolvent; and let him (the drawer) have timely notice thereof; and also to enable the party to recover against the drawer, and also against the acceptor, as far as he can pay, if the bill be accepted.

A foreign bill must be protested on the last day of the three days of grace allowed; (after the time expressed upon the bill;) and, if not paid upon the last of the three days, the party ought immediately to protest the bill and return it: but, if the last of the three days be a great holiday, the day before is the day of payment.

Bills of exchange must be sued for within six years after their becoming due.

If two or three bills are drawn for the same sum, they shall carry a condition with them that only one should be paid; and, in a declaration on one of them, it is not necessary to aver that the other bills were not paid.

If A. sells goods to B. and B. is to give a bill in satisfaction, B. is so far discharged, that he cannot be sued for the goods, though the bill be never paid; for the bill is payment; but he is liable to be sued for the bill.

A note, or bill, is no absolute payment, though agreed to be such, if the giver of it knows the person upon whom it is drawn to be in a failing condition.

Of what shall be deemed a Bill of Exchange.

The custom prescribes the form of a bill, and raises a contract.

It is not requisite to observe the same nicety in a bill of exchange as in deeds or wills.

A bill, payable out of a particular fund, is no bill of exchange.

Pray pay out of my growing subsistence—is no bill of exchange.

Bill, payable out of the fifth payment, as it shall become due, is not good.

Pray pay, J. S. or order, at my quarterly half-pay per advance, is a negociable bill.

Bill, payable to *me* or my order, is a good bill, if accepted.

Of the Acceptance.

The acceptance of a bill of exchange is such an act, by the drawee, as will make him liable to pay the same. It is usually made by signing his name or initials at the bottom of the bill, when it is presented to him by the bearer.

A very small matter will amount to an acceptance; and any words will be sufficient for that purpose which shew the party's assent or agreement to the bill; as,

Writing the day of the month on the bill is sufficient acceptance.

Leave your bill with me and call to-morrow, and it shall be accepted, is a sufficient acceptance.

Leave your bill with me, I will look over my book and accounts between the drawer and me, and call to-morrow, and the bill shall be accepted, is not a sufficient acceptance.

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When the bill was returned for non-acceptance, the drawee said, *that, if it came back again, he would pay it*; it was ruled to be a good acceptance.

Verbal acceptance is sufficient; and an action lies against the acceptor thereon, as to the principal, but not for interest and costs. But there must be a witness. These words, "The two bills of exchange which you sent me, I will pay, in case the owners of the queen Anne do not," are a sufficient acceptance.

Acceptance, to pay when the goods are sold, is a good acceptance.

Acceptance, to pay half in money, half in bills, is good.

Acceptance, to pay, according to the tenor of the bill, after the day of payment is past, is good.

A bill may be accepted for part, and the sum accepted for is good against the acceptor.

Acceptance of a bill, drawn upon two partners, by one of them, binds both if it concerns the joint trade.

Acceptance of a servant usual transacting business for his master, is good: yet the servant should express such acceptance to be for his master, or he is liable himself.

Of the Protest.

A protest is absolutely necessary on a foreign bill, where it is refused acceptance or payment, in order to charge the drawer.

The payee must demand acceptance from the drawee before protest.

If a payee dies, there can be no protest before probate or administration.

If a bill left for acceptance, be lost, the drawee must give a note for the payment thereof; otherwise it may be protested.

If a bill be lost, and no new one can be had, and the drawee does not insist on having the original, but refuses payment on another account, a protest made on a copy is sufficient.

A protest is good evidence of non acceptance or non payment, until the contrary is proved.

A protest on a foreign bill is necessary to recover, against the drawer, not only interest and costs, but also principal; and such protest must be made in due time, and timely notice given to the drawer. What is a *timely* notice must be determined by the customs of the merchants. Convenient notice must be given to the drawer of an inland bill; which notice, as to time, must also rest upon custom and the verdict of a jury.

But, in case of non-payment of either foreign or inland bills, the safest way is to give as early notice, to the person of whom it was received, as possible; that is, by the first post, or rather, to send the bill to a correspondent, to tender it to the drawer or indorser. Where they refuse to accept the bill, it may be protested, before the day of payment, for better security but not for non-payment.

Of Indorsements.

Every man, who writes his name upon the back of a bill, becomes bound to the next holder for the amount thereof; it matters not whether he has received any value for the bill, or does it to serve a friend. The indorsement of his name implies him to have received the value of the bill, and the law will compel him to be answerable for the same to the holder thereof.

Of who shall pay the Money.

Every drawer, indorser, and acceptor, of a bill of exchange, is separately liable to the payment thereof.

On non-payment, the payee (the person to whom it is to be paid) may sue the acceptor and drawer; but he can have but one satisfaction, that is, he can only recover from them jointly the amount of the bill in his hands.

He, who accepts for the honor of the drawer, is liable to the payment, although he may have no effects. The acceptance is an undertaking for the payment, and the law will oblige him.

If a bill be indorsed to the drawer of it, he may maintain an action, as the indorsee, against the drawee, if the latter had effects of the drawer at the time of drawing the bill; otherwise not.

The holder of a bill must tender it before the three days grace are expired.

If the indorsee indulges the acceptor after the bill is due in course of payment, it is at his own risk; and, if the acceptor fails, he has no remedy against the drawer, or person who paid him the bill.

The last indorser of a bill of exchange may maintain an action against any of the former indorsers, and so any indorser may against all that precede him.

An indorser of a bill, who has paid it, must prove payment in an action against the acceptor.

The indorser of a foreign bill of exchange may be charged, without first resorting to the drawer.

If the indorsee receive a sum, in part, of the acceptor, he has no remedy against the drawer or any indorser for the remainder, but against the acceptor only.

A man cannot be sued in England, Scotland or Ireland, on his acceptance of any bill of exchange abroad, after he has been discharged by the laws of that country.

It is not necessary to prove the hand of the drawer in an action against the acceptor, nor can the acceptor set up the forgery of the bill.

The assignee of the indorsee may sue, on a general indorsement, to the latter only.

The winner shall not recover, on a bill of exchange, for money won at play, against the acceptor, otherwise than in the case of an indorsee.

If A. draws a bill, payable to B. for the use of C. and B. indorses it to D. D. may bring an action for the money.

If a bill be assigned for a just debt, equity will not relieve, though the bill was at first given without consideration.

Bill upon B. payable to D. is accepted by B. and indorsed by C. to D. B. is discharged of any payment as to C.

Stamp Duties on Bills of Exchange.

By the laws of the United States, bills of Exchange are subject to the following stamp-duties, viz. Inland bills, where the sum shall amount to

	20 dollars,	and not exceeding	100 dollars—	10 cents.
Above	100 dollars,	and not exceeding	500 dollars—	25 cents.
Above	500 dollars,	and not exceeding	1000 dollars—	50 cents.
Above	1000 dollars,			75 cents.

Foreign bills are chargeable with twenty cents on every bill, without respect to the number contained in each sett.

Stamp Duties on Promissory Notes.

Where the sum amounts to	20 dolls.	and not exceeding	100 dollars—	10 cents.
Above	100 dolls.	and not exceeding	500 dollars—	25 cents.
Above	500 dolls.	and not exceeding	1000 dollars—	50 cents.
Above	1000 dolls.			75 cents.

Provided, that if any of these notes are payable at or within 60 days, they shall be liable to only two-fifths of the duty.

The following directions, to the several parties to a bill of exchange, may prevent the inconveniences to which they may be liable through inexperience.

The Drawer of Bills

Should be well satisfied that they will be accepted and duly honored before he draws: to this end, it is requisite that he be assured of having effects in the hands of the person drawn upon, and also that he be a man of integrity and punctuality, who will not dishonor his paper but pay it regularly as it is due.

The Acceptor

Should be careful to accept no bill but what he has effects in his hand to answer:—To insist upon his correspondent advising of each bill, as soon as drawn, specifying the number, date, sum, time, and to whom payable; for, if he should accept or pay a forged draft, the loss will fall on himself: To adjust and balance all accounts of this nature at least once in three months, and oftener if the drafts are large and continual.

The Bill-Holder

Should exchange no drafts for a stranger, where he is not convinced of the validity thereof from the *writing* of the drawer or acceptor; if not, offer to send the bill to one of the parties, and, when in cash, that he will account with him for the value.

See that the bill be drawn upon a proper stamp: and make the person, paying the bill to you, indorse his name on the back. Take a regular copy of the particulars of the bill in a book.

If the bill be not already accepted, present it for acceptance. If the person it is drawn upon will not accept, and also adds he will not pay it when due, you had best return it to the indorser or drawer immediately, taking a good bill or cash for the same.

But, if the drawee says he may pay it when due, wait till that day, present it for payment, and, if refused then, have it protested, and for the amount call upon the indorser. But as you have at present the indorser and drawer as your security, be cautious how you give up the bill to either for their single security, if doubtful.

When you remit a bill, indorse, on the back thereof, "Pay the contents to A. B. of C. or order D. E." This will prevent the bill being negotiated, should it fall into bad hands.

If the bill be payable to bearer, write, upon the face thereof, "Sent by Post, August, 1800, to A. B. of C. D. E," in red ink.—Indorse no bill until you pay it away.

OWNERS OF SHIPS.

If goods are spoiled by default of a master of a ship employed by the owners, the owners are liable; but the action must be brought against all the part-owners, who make but one master.

If several part-owners wish to send a ship on a voyage, but two or three other part-owners refuse their consent, the former may send her on the voyage, but they must enter into a recognizance in the admiralty for her return.

A part-owner of a ship sued the other owners for his share of the freight on finishing her voyage; but the other owners had fitten her out, in which the complainant would not join, whereupon the other owners complained in the admiralty; and, by order there, they gave security, if the ship perished in the voyage, to make good to the plaintiff his share, or to that effect; in such a case, by the law marine and course of the admiralty, the plaintiff was to have no share in the freight. It was referred to Sir Lionel Jenkins to certify the course of the admiralty, who certified accordingly, and that it was so in all places, for otherwise there would be no navigation; whereupon the plaintiff's bill was dismissed.

If the owner of a ship lets it to another, he is still liable for a loss of gold sent by that ship. The defendant, in an action of this kind, was sole owner of a ship, which he let to one Fletcher for a voyage, for a certain sum, and Fletcher was to have the benefit of carrying goods. The plaintiff sent a quantity of moidores, and had bills of lading signed by the captain; and many of the moidores not being delivered according to consignment, an action was brought against the defendant, the owner of the ship, to make him liable as far as the ship and freight were worth, according to 7 Geo. II. c. 15.

For the defendant it was insisted, that, though the ship was his property, yet he was not so owner as to be liable to the plaintiff, and that Fletcher is for this purpose the owner. But it appearing the defendant had covenanted for the condition of the ship, and the behavior of the master, the chief-justice held he was liable to the plaintiff; and the freight he had in general from Fletcher was sufficient, though the identical freight for the gold belonged to the other; and Fletcher had only the use of the ship, but no ownership.

If a ship be repaired in the river Thames, and fitted out there with new rigging and apparel, the ship itself is not liable, but the owners. If she be repaired at sea, the ship is liable, and the master may hypothecate (or pawn) her for payment of the charges.

The repairer of a ship may sue either the master, who employs him, or the owners; but if he undertakes it on a special promise from either, the other is discharged.

If the master of a ship buys provisions for her, and has money from the owners to pay for the provisions, but fails without paying the money, the owners are liable to pay, in proportion to their respective shares in the ship, the master being but a servant to the owners.

An action was brought by a ship-wright for repairing the defendant's ship in his dock. About three hours before the ships repairs were finished, a fire happened and she was burnt. Notwithstanding which, the court held that the owner was liable to pay for the repairs that had been done.

Lord Mansfield, in delivering the opinion of the court in the case of Farmer and another against Davis, where goods were ordered for a ship by the owner before the appointment of the captain, and some of which goods were delivered after his appointment, said, "Where a captain contracts for the use of a ship, the credit is given to him, in respect of his contract; it is given to the owners, because the contract is on their account; and the tradesman has likewise a specific lien on the ship itself. Therefore, in general, the tradesman, who gives that credit, debits both the captain and the owners. Now, what is this case? The captain made no contract personally: the owners contracted for their ship: the credit was given to them only; and there is not a shadow of colour to charge the captain for any part or these goods."

Wilkins and others, assignees of Brooke, a bankrupt, against Carmichael. The question in this case was, whether a captain, having paid for stores supplied, and repairs done, to a ship in England, and having wages due to him, has such a lien on the ship as to be entitled to keep her till he is paid.

Lord Mansfield said, notwithstanding the strongest inclination that the defendant (the captain) should have full satisfaction, we are not able to find ground on which we can give judgment in his favour. 1. He has set up a lien upon two sorts of claim, viz. wages and stores and repairs. As to wages, there was no particular contract, that the ship should be a pledge; there is no usage in trade to that purpose: nor any implication from the nature of the dealing: On the contrary, the law has always considered the captain as contracting personally with the owner: and the case of the captain has, in that respect, been distinguished from that of all other persons belonging to the ship: this rule of law may have its foundation in policy, and the benefit of navigation; for, as ships may be making profit and earning every day, it might be attended with great inconvenience, if, on the change of a captain for misbehaviour, or any other reason, he should be entitled to keep the ship till he is paid. As to stores and repairs, it is a strong answer to that claim, that when the demand was made by the assignees the captain had not paid the tradesmen's bills. But if there was any lien originally, it was in the carpenter. The captain could not, by paying him, be in a better situation than he was, and he had parted with the possession, so that he had given up his lien, if he ever had one: the other creditors had none. If the defendant is liable to the tradesmen, it is by his own act. Work done for a ship in England, is supposed to be done on the personal credit of the employer; in foreign parts, the captain may hypothecate the ship. The defendant might have told the tradesmen that he only acted as an agent, and that they must look to the owner for payment. Judgment for the plaintiff.

Rich, executor, versus Coe and another.—The plaintiffs, being rope-makers, supplied the ship Henry and Thomas with cables to the value of 5*l.* 8*s.* 3*d.* by the order of Thomas Harwood, the captain; and made Harwood, and the owners of the ship (the defendants) debtors, in the usual manner, without naming the owners, or knowing particularly who they were.—The ship Henry and Thomas had been let by the defendants to Harwood upon certain articles, in which it was mutually covenanted between them as follows:—1st. The owners covenanted with Harwood, that on his performance of the covenant stipulated on his part, he should have the sole management of the ship, and employ her for his own sole benefit and advantage for the space of eleven years, if he should so long live, and the ship should not be lost. The covenants on the part of Harwood were (amongst others) to pay a yearly rent of 36*l.* per cent. at stated periods; that he would at all times, at his own cost and charge, repair, maintain, and keep, the vessel and her rigging, &c. in good and sufficient repair. The plaintiffs had no notice of this contract at the time they furnished Harwood, the captain, with the goods. The question was, whether the defendants were liable to this debt?

Lord Mansfield, in delivering judgment, said, This case was reserved not with a view to the particular matter in dispute or the parties now before the court, but in consideration of a general anxiety in the owners of ships, employed in this trade, to know how far they are by law liable for the acts of their respective lessees. In that point of view, we have considered the cases very particularly; and after the fullest deliberation, we think it impossible to say that the plaintiffs are not entitled to recover. Whoever supplies a ship with necessaries, has a treble security. 1. The person of the master. 2. The specific ship. 3. The personal security of the owners, *whether they know of the supply or not.*—1. The master is personally liable as making the contract. 2. The owners are liable in consequence of the master's act, because they choose him; they run the risk, and they say whom they will trust with the appointment and office of master. Suppose the owners in this case had delivered the value of the goods in question, in specie, to the master, with directions for him to pay it over to the creditors, and the master had embezzled the money, it would have been no concern of the creditors; for they trust specifically to the ship, and generally to the owners. In this case, the defendants are the owners; and there happens to be a private agreement between them and the master, by which he is to have the sole conduct and management of the ship, and to keep her in repair, &c. But how does that effect the creditors, who, it is expressly stated, were total strangers to the transaction? and that is an answer to the observation, that the plaintiff must have known the real situation of the master, in this case, from the general usage and custom of the country in that respect. To be sure, if it appeared that a tradesman had notice of such a contract; and, in consequence of it gave credit to the captain individually, as the responsible person, particular circumstances of that sort might afford a ground to say, he meant to absolve the owner, and to look singly to the personal security of the master; but here it is stated, that the plaintiff had no notice whatever of the contract. The owners themselves are aware of their being liable at the time: they choose a master to whom they agree to let the ship, and trust for their security to the covenants which they oblige him to enter into: these covenants are, that he shall keep the ship in repair, and deliver her up at the end of the term, in as good condition as when delivered to him. This is not all; for they indemnify themselves against the private debts of the master; and against his being taken in execution: for if he does not perform all and every the covenants in the agreement, (except in case of the loss of the ship) the consequence (beside their remedy against him upon the covenant) is that the contract and agreement is to be absolutely at an end, and they are to take possession of the ship.

Suppose the ship had been impounded in the admiralty court, and that happened at the end of the term: or, suppose the captain had broken a covenant which had put an end to the agreement, the defendant could never have taken the ship out of the court, without paying the debt for which the ship was impounded. We are all of opinion, therefore, that under these circumstances, there is no colour to say that the creditors should be stript of the general security they are, by law, entitled to against the owners.

MASTERS OF SHIPS.

NOTHING more materially concerns the master of a ship, than to know what degree of responsibility is attached to his situation, and what privileges it invests him with: and it is the design of this chapter to explain them.

Masters of ships are as responsible for goods, committed to their charge, as hoymen or carriers by land are; for the law makes no distinction between carriers by land and carriers by water: and for whatever losses, that arise from the neglect of persons employed under them, they are answerable: whatever cases, therefore that are contained in this chapter, relative to carriers by land, must be understood to be equally applicable to carriers by water, or masters of ships.

In the case of Mors *v.* Sluce, it was adjudged that the master of a ship was liable for the goods of which the ship was robbed in the river: and the reasons given were, 1. Because he was an officer known: 2. Because he received his salary out of that which was paid for the freight. But the master may reimburse himself out of the mariners' wages for a loss happening by their neglect.

The law charges persons entrusted to carry goods (such as common carriers, hoymen, and masters of ships) to carry them against all events but acts of God, and public enemies.

The plaintiff puts goods on board the defendants hoy, who was a common carrier. Coming through bridge, by a sudden gust of wind, the hoy sunk, and the goods were spoiled. The plaintiff insisted that the defendant should be liable, it being his carelessness in going through at such a time; and offered some evidence, that if the hoy had been in good order, it would not have sunk with the stroke it received; and thence inferred, the defendant was answerable for all accidents, which would not have happened to the goods in case they had been put in a better hoy. But the chief-justice held the defendant not answerable, the damage being occasioned by the act of God; for though the defendant ought not to have ventured to shoot the bridge if the general bent of the weather had been tempestuous, yet this, being only a sudden gust of wind, has entirely differed the case: and no carrier is obliged to have a new carriage for every journey; it is sufficient if he provides one which (without any extraordinary accident, such as this was) will probably perform the journey.

In the case of Forward against Pittard, the plaintiff had delivered goods to the defendant, who was a common carrier; and which goods were afterwards destroyed by accident of fire. The question was, whether the defendant was answerable for them?

Lord Mansfield said, It appears from all the cases, for 100 years back, that there are events for which the carrier is liable independent of his contract. By the nature of his contract he is liable for all due care and diligence; and, for any negligence, he is suable on his contract. But there is a farther degree of responsibility, by the custom of the realm, that is, by the common law: a carrier is in the nature of an insurer. It is laid down that he is liable for every accident, except by the act of God or public enemies: now, what is the act of God? I consider it to be something in opposition to the act of man; for every thing is the act of God that happens by his permission; every thing by his knowledge. But, to prevent litigation, collusion, and the necessity of going into circumstances impossible to be unravelled, the law presumes *against* the carrier, unless he shews it was done by public enemies, or by such act as could not happen by the intervention of man, as storms, lightning, and tempests.

If an armed force come to rob the carrier of the goods, he is liable: and the reason is, for fear it may give room for collusion, that the master may contrive to be robbed on purpose, and share the spoil.

In this case, it does not appear but that the fire arose from the act of some man or other; it certainly did arise from some act of man; for it is expressly stated not to have happened by lightning. The carrier, therefore, is liable, inasmuch as he is liable for inevitable accident.—Judgment for the plaintiff.

What acceptance makes a carrier liable. *Per* King, C. J. If a box be delivered generally to a carrier, and he accepts it, he is answerable, though the party did not tell him there was money in it. But, if the carrier asks, and the other says no, or if he accepts it conditionally, providing there is no money in it; in either of these cases, I hold, the carrier is not liable; and so it was afterwards determined in the court of king's-bench, in the case of Gibson *v.* Poynton and another.

If goods are lost after the owner of them has taken them from the ship into a lighter, it is his own loss: but it is otherwise if the goods are sent from the ship by the ship's boat, which is considered as part of the ship and voyage. Yet, if the owner of any goods send his servant with them, the carrier or lighterman is not liable if they be lost.

If any passenger die on-board, the master is obliged to inventory his effects; and, if no claim be made to them within a year, the master becomes proprietor of the goods, but answerable for them to the deceased's legal representatives.

If a captain die, leaving money on board, and the mate becoming captain, shall improve the money, he shall, on allowance for his care, account both for interest and profits.

FACTORS AND AGENTS.

MASTERS of ships by the customs and practice in this country very frequently have the consignment of their cargoes, and become the factors and agents of their owners. Their duty in this capacity is totally distinct from that of masters of ships; and the law on this subject forms a very important branch in the system of mercantile jurisprudence. It has been therefore thought best to state in this chapter the general rules and leading principles of law under this head, and to explain for the use both of merchants and factors their respective rights and duties.

If a factor sell the goods of a person beyond sea, he may maintain an action in his own name for the price; for the promise shall be presumed to be made to him; and so if he buys goods, the seller may have an action against *him*, for the credit shall be presumed to be given to him; and particularly because it is for the benefit of trade.

This seems clearly to be the case where there is no interposition of the owner of the goods sold, as to whom, it seems, "That the factor's sale creates a contract between the buyer and the owner of the goods; and therefore if the factor sells for payment at a future day, if the owner gives notice to the Buyer to pay him, and not the factor, the buyer is not justified in paying the factor." This doctrine was recognized and confirmed in the case of Escot *v.* Milward, Sittings after Mich. 24 Geo. 3.

The case was this: In the month of June 1783, a cargo of wheat was consigned to the plaintiffs from *Ostend*, and they employed one *Farrer* as their factor to sell it. It was proved, that the factors in this trade have a *del credere* commission beside factorage, and never, except in case of the failure of the factor, make the purchaser's names known to the owners. On the 9th of June *Farrer* sold two hundred quarters of this wheat to the defendant. On the 16th of June, *Farrer* handed over to the plaintiffs the wheat then remaining in his hands, and the names of those who had purchased the rest: and among others that of the defendant *Milward*. On the 20th of the same month, *Farrer* stopt payment, and compounded with his creditors, who executed to him a deed to that purpose On the 21st of June, the plaintiffs delivered to the defendant a bill of parcels of the wheat sold by *Farrer*, and demanded payment by his acceptance of a bill to the amount at a month's date. The defendant refused, and insisted that he had a right to set it off against a debt due by *Farrer* to him. The plaintiffs brought their action; and the above doctrine was laid down to the jury by Justice *Buller* as the clear law on the subject; and the jury found accordingly for the plaintiffs.

"But the doctrine of this case only applies *where nothing is due to the factor himself*: for he has a lien upon the money in the hands of the buyer for any monies due, or for any engagement he enters into on account of the principal; for he may bring an action for the price against the buyer; and it would be no defence for *him* to say, that the principal (the owner of the goods) was indebted to him (the buyer) to the amount of them; for the factor has a prior right.

This was the law as held by Lord *Mansfield* in the following case: In *assumpsit* for goods sold and delivered, by the plaintiffs as assignees of one *Dowding*, a bankrupt. It appeared that Dowding was a clothier, and employed one Jefferies as his factor, who sold to the defendant Goodwin the clothes in question, marked *J Dowding*, before the act of bankruptcy. *Goodwin knew Jefferies to have sold the goods as factor, and he had notice from the assignees not to pay Jefferies:* notwithstanding which he did pay him, and this action was now brought to make him pay the value again to the assignees. It appeared in evidence, that Dowding wanting money to buy cloths, that Jefferies had joined him in bonds for the purpose of raising it, *on the security of the cloth being sent to him*. It was adjudged by the court that Jefferies had a lien upon the cloth and the money in the hands of the buyer, on account of the money so raised (Jefferies having paid the amount of the bonds;) and that therefore the plaintiffs could not recover.

Every factor ought to sell for ready money, unless the usage of trade is otherwise; and if *he sell upon trust, without usage to warrant him, he alone is chargeable in case of a loss*: but if the usage be to give credit, then, in case he sells to a person in good credit, if such person fails, the factor is discharged; but it is otherwise, though the usage to sell is so, if he sells to a person notoriously discredited at the time of the sale; for then in case of a loss he is liable; and so he should sell in market overt, or there is no change of property.

As a factor has a lien upon goods consigned to him for his own demands; and as also, if goods consigned to him as factor remain in specie, they are not subject to his bankruptcy; so where *bills* have been remitted to a factor for a special purpose, if not disposed of or paid away at the time of his bankruptcy, they shall still be considered as belonging to the principal, and be recovered in this action; but subject however to any lien the factor himself may have on them.

In a trial concerning the delivery of goods according to agreement, *the factor who made the agreement* was admitted as a good witness, *though he was to have a shilling in the pound on the sale*; for he was a mere go-between the buyer and seller, and so might be a good witness for either, as having no interest more on one side than the other.

If goods are *not delivered* to a factor or agent, but he is only *impowered to sell* by the principal, this shall not preclude the principal himself from selling them.

For where the defendant, being owner of a great quantity of malt, then being on board a vessel, impowered one Smith, a broker to sell *it*: before Smith sold it, the defendant himself had sold it, but Smith had no notice; afterwards Smith sold it to the plaintiff, who brought trover for it against the defendant; it was at first doubtfu whether Smith the broker would not be liable to the plaintiff, as he could not perform his bargain, though it was without his default, so that his sale ought for that reason to be held valid; but afterwards, *Rolle, Chief Justice*, held, That the owner's sales should prevail against that of his factor, *who had but a bare authority*, and that the broker's sale should have been conditional, if the owner had not sold before; but he said that neither the broker nor his vendees should be liable to any action for detaining the goods, if they had no notice of the sale by the owner.

A factor has only power to *sell* the goods of his principal, and thereby bind him; he cannot bind or affect his principal's property, by *pledging* them as a security for his own debt, though there is the formality of a bill of parcels and a receipt.

If there is an authority ever so general by indorsement of the bill of lading, without disclosing that the indorsee is factor, the owner (as between him and the factor) retains a lien till the delivery of the goods, and until they are actually sold, and turned into money.

But if the goods are *bona fide* sold by the factor while at sea, such sale shall be good, and shall bind the owner, because the goods were *bona fide* sold, and by the owner's own authority.

And if a factor to whom a bill of lading is indorsed *generally*, but in fact to him *as factor*, though that is not expressed, indorses it over as his own property; such indorsement shall be good, if for a fair and valuable consideration and without notice; otherwise, if only a spurious one to defraud the owner.

Goods consigned to factors merely for sale, are not liable to their bankruptcy. For if a merchant consigns goods to a factor, and he become a bankrupt, the goods still remaining in his possession, they shall still be deemed the property of the merchant, and he may recover them in this action.

So if the factor had sold the goods consigned to him, and received the money, and died indebted in debts of a higher nature, if it could be proved that the money so received had been invested in other goods, these shall be deemed to belong to the merchant's estate, not to the factor's; but if the money had remained in specie, it had belonged to the factor's estate, and gone to answer the debts of an higher nature; for the money has no mark to be followed by.

But where the factor had for the merchant's goods taken *notes*, instead of money, the court of Common Pleas held, That the merchant should have the notes, as they could be traced.

And so if the factor had sold the goods consigned to him, and become a bankrupt, the merchant must come in as a creditor under the commission; though if he had *laid out the money in other goods* for the merchant, the merchant shall have them: so if the factor had sold for payment at a future day, the merchant shall have the money.

As where the plaintiff, living in Ireland, employed B. in London, to sell goods for him: B. sold them to J. S.; the plaintiff at the time was ignorant to whom they were sold, and J. S. was ignorant whose property they were; B. became a bankrupt, and J. S. paid the money to the defendants, his assignees; the plaintiff brought an action for the money against the assignees, and recovered; for though it was agreed, that a payment by J. S. to B. was a discharge for him against the plaintiff his principal, yet the debt was not in law to him, but to the plaintiff whose goods were sold; and therefore was not assigned to the defendants under the general assignment of all their debts, but remained due to A. as it was before; that being paid to the defendant who had no right to it, that it was a payment under a mistake, and so was recoverable from them.

And where the factor had a *del credere* commission, the same point was decided by the chancellor.

A factor has a lien upon goods consigned to him, not merely for what is due for those goods, but for the *balance of a general account*, and for which he may detain them. So he has a lien on the money in the hands of the buyer.

And though in this case, goods had been consigned to a factor by a trader, and *the factor knew the trader was in insolvent circumstances*, but he, nevertheless, advanced him money on the credit of the goods, it was adjudged, That he was entitled to a lien against them for the money he had advanced, and should hold them against the assignees of the consignor.

An action for money had and received will not lie against a known agent, or receiver, for money paid *voluntarily* to such agent *for the use of the principal*, unless he had paid it over after notice not to do it: for it would be unjust to suffer such an action to proceed, and to leave him to be defended or deserted as the principal thought fit; and especially if the action is brought for the purpose of trying any right of the principal.

For where a man receives money for another as his agent, under a pretence of right (*ex gr.* for tithe) the court will not suffer the principal's right to be tried in an action against the agent, if the defendant can shew the least colour of right in his principal: as in this case, by having been some time in possession.

So where money has been paid to an agent or receiver *by mistake*, he shall not be liable to refund it if *he has paid it over to his principal*; for he should not suffer for another's mistake, but the payer should resort to the principal himself: but if he has not paid it over to his principal, but *has it in his hands*; or *only given credit for it to his principal in his books, or on an account between* them: in these cases he shall be personally liable, though not paid over: but if any new credit had been given to the principal by the agent on receiving the money, it would be proper evidence to leave to the jury, Whether the agent might not, or had not received any prejudice thereby? and so vary the case.

"But as to how far the principal shall be bound by the act of his agent, a distinction is to be observed between *a general and a particular agent*."

A *general agent* shall bind his principal *by all his acts*, even though he exceeds his authority; as if a stable-keeper having an horse to sell, directs his servant not to warrant him, notwithstanding which he does, the master will nevertheless be liable on the warranty, because the servant was acting within the scope of his authority; and the public cannot be supposed to be cognizant of any private conversation between the master and the servant: but where a person is made a *particular agent*, and under a circumscribed authority, there he can only bind his principal *as far as he acts within his authority*, for that would be to enable one man to bind another against his will.

FREIGHT, CHARTER-PARTY, AND DEMURRAGE.

FREIGHT is the sum agreed on for the hire of a ship or carriage of goods, and must be paid in preference to all other debts, for the payment of which the goods stand engaged; but, as the goods are obliged to the ship for hire, so is the ship to the owner of the goods, in case of damage or waste through any defect of the vessel or sailors.

Charter-party is the same in the civil law with an indenture at the common law; it settles the agreement, as the bills of lading do the contents, of the cargo; and binds the master to deliver them well conditioned at the place of discharge, according to the agreement; and, for performance, the master obliges himself, ship, tackle and furniture.

The taking a ship to freight is the hiring her of her master or owners, either in part or the whole, and either by the month, for an entire voyage, or by the ton; and the contract, reduced into writing, commonly called a charter-party, executed between the freighter and the person who lets the ship, must express the different particulars agreed on.

The master or owners generally covenant to provide a sufficiency of tackle and mariners, and to fit the ship in every respect for performing the voyage. The merchant, on his part, stipulates to comply with the payment promised for freight on delivery of his goods; and both oblige themselves in penalties for non-compliance.

If, by the time appointed in the charter-party, the ship is not ready to take in, or the merchant (after the days of demurrage commonly granted) not ready to load, the parties are at liberty, and the suffering one hath his remedy against the other, by action, to recompense the damage.

If part of the loading be on board, and some intervening misfortune prevent the merchant from shipping the whole in time, the master is at liberty to contract with another, and shall have freight by way of damage for the time that those goods were on board after that limited; for such agreements, being of a conditional nature, and preceding a failure as to a complete loading, will determine the same unless afterwards *affirmed by consent*; and, though it be no prudence for every merchant or master to depart from the contract on non-compliance of articles, yet it is the highest justice that ships and masters should remain free; for otherwise, by the bare lading of a cask or bale, they might be defeated of the opportunity of passage, or the season of the year.

So, on the other hand, if the vessel be not ready, the merchant may ship the remainder of his goods on board another, and discharge the first, and recover damages against the master or owners for the rest; this being grounded on the like reason as the former.

Atkinson contracted with Buckle for the carriage of a hundred quarters of barley, and promised to deliver unto him the hundred quarters of barley on ship-board at Barton-Haven, in the county of York, to carry them for him, and for the carriage thereof did promise to pay him so much; and Buckle promised to carry the same for him, and accordingly brought his ship to the said haven, expecting there the delivery of the hundred quarters of barley; but Atkinson came not to deliver the same unto him; whereupon Buckle brought his action of the case upon the promise; and, upon *non assumpsit* pleaded, had a verdict and judgment, which was affirmed upon a writ of error.

If goods are fully laden on board, and the ship hath *broken ground*, and the merchant, on after-consideration, determines again to unload them, and not prosecute the adventure, by the *marine law* the freight is due.

And, if the ship in her voyage becomes unable without the master's fault, or that the master or ship be arrested by any foreign prince or state in her voyage, the master may either *mend his ship or freight another*; but, if the merchant will not consent thereto, then the *freight* becomes due for so much as the ship hath *earned*: otherwise the master is liable for all damages that shall happen: and therefore, if that ship, to which the goods were translated, perish, the master shall answer; but, if both the ships perish, then he is discharged. But, in case of extreme necessity, as that the ship would be in a sinking condition, and an empty ship is passing by or at hand, he may translate the goods; but, if that ship sinks or perishes, he is there excused; but then it must be apparent that that ship seemed *probable* and *sufficient*.

If a master shall weigh anchor and sail after the time covenanted or agreed for his departure, if any damage happens at sea after that time, he shall refund and make good all such misfortune. Yet, if a *charter-party* be made, that the plaintiff shall sail from London to Lisbon with the first wind and opportunity, &c. in consideration of which the merchant did covenant to pay so much for freight, and the ship departs not with the first wind and opportunity, yet afterwards *breaks ground* and arrives at her port, the freight in this case has become due; and there is nothing can debar the ship of her freight but non-departure; for only that in law is material to avoid the payment of the freight; but to say the ship did not depart with the next wind is but a circumstance, which, in strictness of law, is not necessary to be denied.

If it be agreed, that the master shall sail from London to Leghorn in two months, and freight accordingly is agreed on, if he begins the voyage within two months, though he does not arrive at Leghorn within the time, yet the freight is become due.

The East-India company might, by charter-party, keep a ship they had freighted a long time in India, and did so keep her until she was unfit for service, and could not come home; they were obliged in Chancery to pay the damage, though by the charter-party it was payable at the return of the ship.

So, where no freight was to be paid for the cargo *outwards*, but freight for the cargo *homewards*, and the factor abroad had no goods to load her homewards, payment of the freight was decreed.

And, if a ship is freighted to go to any place to load, and on arrival there the factor cannot or will not put any thing on board him, after the master has lain the days agreed on by charter-party, and made his regular protests, he shall be paid empty or full.

If a ship is freighted from one port to another, and thence to a third, a fourth, and so home to the port whence she first sailed, (commonly called a *trading voyage*) this is all but one and the same voyage, so as it be in conformity to the charter party.

A contract is made, between a merchant and master of a ship, that, if he carries the merchant's goods to such a port, he will then pay him so much money for freight. In making the voyage, the ship is robbed by pirates, and part of her loading lost, and afterwards the remainder is brought to the port of discharge. Here the sum agreed on for freight is not due, the agreement not being performed on the part of the master; and this is a conditional contract. But it is otherwise by the civil law; for thereby the same is a danger of the seas, which if not expressed in naval agreements, is naturally implied; and there was no default in the master or his mariners; and had these goods, which the pirates carried away, been thrown over-board in stress of weather, it would not have worked a disability in the master to receive the sum agreed on; because, both by the common law and law marine, the act of God, or that of an enemy, shall not have an effect to work a wrong in actions private; and a pirate is esteemed an enemy in our law.

If a ship be freighted by the ton, and she is full laden according to the charter party, the freight is to be paid for the whole; otherwise but for so many tons as the lading amounted to.

If freight be contracted for the lading certain cattle, or the like, from Dublin to West-Chester, and some of them happen to die before the ship's arrival, the whole freight is become due, as well for the dead as the living.

But, if the freight be contracted for the transporting at so much *per* head, if death happens, there ariseth due no more freight than only for such as are living at the ship's arrival at her port of discharge, and not for the dead.

When cattle or slaves are sent on board, without any previous agreement about lading or transporting them, but generally, then freight shall be paid as well for the dead as the living; and, if freight be contracted for the transporting of women, and they happen in the voyage to be delivered of children, no freight becomes due for the infants.

A master of a ship is not bound to answer freight to the owners for passengers, where it appears they are not able to pay.

If goods are sent on board ship, generally, the freight must be according to that commonly paid for the like accustomed voyages.

If a ship shall be freighted, and named to be of such a burthen, and, being freighted by the ton, shall be found less, there shall be no more paid than only by the ton for all the goods that were laden on board.

And, if a ship be freighted for two hundred tons or thereabouts, the addition of *thereabouts* is commonly reduced to be within five tons, more or less, as the moiety of the number ten, whereof the whole is compounded.

If a ship be freighted by the great, and the burthen of it is not expressed, yet the sum certain is to be paid.

If a freighter, by loading prohibited or unlawful goods, occaſion the ſhip's detention, or otherwiſe impedes her voyage, he ſhall pay the freight contracted and agreed for.

When a ſhip is freighted *out* and *in*, (or *out* and home) there is no freight due till the whole voyage is performed; ſo that, if ſhe be caſt away coming home, the freight *outwards* as well as *inwards* becomes loſt.

If a maſter lets out his ſhip, and afterwards ſecretly takes in other goods, unknown to the firſt freighter, by law marine he loſes his freight; and, if it ſhould ſo fall out that any of the freighter's goods ſhould, for ſafety of the ſhip, be caſt overboard, the reſt ſhall not become ſubject to average, but the maſter ſhall make the damage good; though if the goods are brought into the ſhip ſecretly and unknown to him, it is otherwiſe, and goods ſo brought in may be ſubject to what freight the maſter thinks fit.

When a ſhip puts into any port than that ſhe was bound to by agreement, the maſter ſhall anſwer all damages that ſhall accrue thereby: but, if ſhe was forced in by ſtorm, enemies, or pirates, he muſt afterwards proceed to that he was obliged to by contract.

In conſtruction of law, the lading of the ſhip is *tacitly* obliged for the freight, the ſame being, in point of payment, preferred before all other debts to which the goods ſo laden are liable, though ſuch debts, as to time, were *precedent*, to the freight; for the goods remain as it were, bailed for the ſame, nor can they be *attached* in the maſter's hands, though it is commonly conceived otherwiſe.

As ſhips deſerve wages like a labourer, the actions touching the ſame are, in the eye of the law, generally conſtrued favourably for the ſhip and owners; and therefore, if four parts in five of them ſhall make up their accounts with the freighters, and receive their proportions, yet the fifth may ſue ſingly, by himſelf, without joining with the reſt, and this as well by the common law as the law marine.

If a ſhip in her voyage happens to be taken by an enemy, and afterwards is re-taken by another ſhip, in amity, and reſtitution is made, and ſhe proceeds on her voyage, the contract is not determined, though the taking by the enemy diveſted the property out of the owners; yet, by the law of war, that poſſeſſion was defeaſible, and being recovered in battle afterwards the owners become reinveſted; ſo the contract, by fiction of law, became as if ſhe never had been taken, and ſo the entire freight becomes due.

It was covenanted, by a charter-party, that the ſhip ſhould return by a certain time within the river Thames (the danger of the ſea excepted) and afterwards in the voyage, and within the time of the return, the ſhip was taken upon the ſea by enemies unknown to the covenanter, and, being detained by them, could not return within the river Thames within the time mentioned by the covenant. *Reſolved*, This impediment was within the exception; for theſe words intend as well any danger, upon the ſea, by pirates or men of war, as dangers of the ſea by ſhipwreck, tempeſt, or the like.

If freight be taken for a hundred tons of wine, and twenty of them leak out, ſo that there is not above eight inches from the bulge upwards, yet the freight becomes due; but, if they be under eight inches, ſome conceive it then to be in the election of the freighters to fling them up to the maſter for freight, but moſt think otherwiſe; for if all had leaked out, if there was no fault found in the ſtowage, after proper ſurvey, there is no reaſon the ſhip ſhould loſe her freight; for, the freight ariſes from the tonnage taken, and, if the leakage was occaſioned through ſtorm the ſame perhaps may come into an average. Maſters ſhould take care to make their regular proteſts after a ſtorm, as they may ſuffer ſeverely by omitting it.

If a ſhip, freighted by the great, be caſt away, the freight is loſt; but if by the ton or parcels, and part thereof is ſaved from the wreck, *doubted* whether, *pro rata*, ſhe ought not to be anſwered her freight.

If a ſhip by charter party reciting to be of the burthen of 200 tons, is taken to freight for a ſum certain, to be paid at her return, the ſum certain is to be paid though the ſhip amounts not to that burthen.

In caſe a ſhip is freighted after the rate of 20*l.* for every month that ſhe ſhall be out, to be paid after arrival at the port of London; the ſhip is caſt away going up from the Downs, but the lading is all preſerved, in which caſe the freight is become due; for, the money ariſes ſo monthly by the contract, and the place mentioned is only to ſhew where payment is to be made; for the ſhip deſerves wages like a mariner who ſerveth by the month; and though he dies in the voyage, yet his executors are to be anſwered *pro rata*. Beſides, the freight becomes due by intendment on the delivery, or bringing up of the commodities to the port of London, and not of the ſhip.

If a man freight a ſhip out, and covenants that the ſhip ſhould ſail out of the port to Cadiz with the firſt fair wind and opportunity, and the freighter covenants, that, for the freight of all the premiſes, he would pay unto the maſter 184*l.* if the maſter doth not ſhew that the ſhip arrived at the port of Cadiz, he cannot maintain an action againſt the freighter.

If the maſter enter into a *charter-party* for himſelf and owners, the maſter, in that caſe, may releaſe the freighters without adviſing with the owners. But if the owners let the ſhip out to freight, whereof J. J. is maſter, though the maſter covenant in the ſame *charter-party*, and subscribe, yet his release in that case will not bind the owners; but the owners' release, on the other hand, will include the master, and the reason is, for that the master is not made a proper party in the indenture.

If an indenture of *charter-party* made between A. and B. owners of a ship, of the one part, and C. and D. merchants, of the other part; and A. only seals the deed of the one part and C. and D. of the other part; but in the indenture it is mentioned, that A. and B. covenant with C. and D. and C. and D. covenant with A. and B. In this case, A. and B. may join in an action against C. and D. though that B. never seals the deed, for he is party to the deed, and C. and D. have sealed the other part of B. as well as to A.

If a factor freight a ship by order and for account of another, out and home, and a *charter-party* is accordingly made and indented between him and the master, the factor is liable for the freight, and performance of all the covenants. But if the ship be only freighted outwards, and loaded by the factor, the goods shipped are only liable for the freight, and no demands to be made on the freighters in virtue of the *charter-party*, but the person who receives the goods is to pay it, according to the tenor of the bill of lading.

If a ship is freighted out and home, and after having delivered her cargo at the place agreed on, there are no goods provided for her re-loading, the master must stay the days of demurrage agreed on by *charter-party*, and make his regular protest for his freighter's non-compliance, who will, in this case, be obliged to pay him, empty or full; though should the master not wait the time stipulated, or omit to make his protest, he will lose his freight: and in case the master, on his finding no goods provided by his freighter, should determine to load some on his account, as salt, or the like, this will not prevent his recovering his freight; for if the ship had been laden only with salt by the merchant, which (it may be) would not pay half the freight, yet the shipper, or proprietor, may at pleasure abandon the same to the master for his freight, and he can demand no more by the *charter-party*. But if the master take in such salt, on his own account, before the days of demurrage are expired, and that, by some condition with the freighter, he may claim freight, then this latter is to have the benefit of the salt in deduction of the said freight.

CHARTER-PARTY OF ASSIGNMENT.

THIS *Charter Party* indented, made, concluded and agreed upon, the——day of—— in the year of our Lord, &c. between A. B. of, &c. master and owner of the ship or vessel called —— of the burthen of, &c. of the one part, and C. D. of, &c. of the other part, *witnesseth*, That the said A. B. for the consideration herein after mentioned, *hath* granted and to freight letten, and by these presents *doth* grant and to freight let, unto the said C. D. his executors, administrators and assigns, the whole tonnage of the hold, stem, sheets, and half deck of the said ship or vessel, from the port of —— to the port of —— in a voyage to be made with the said ship in the manner following (that is to say) the said A. B. is to sail with the first fair wind and weather that shall happen, next after the —— day of —— or before the —— day of —— next, from the said port of —— with the goods and merchandizes of the said C. D. his factors or assigns, on board, to —— aforesaid, there to be delivered and discharged of her said cargo, within fifteen days next after her arrival for the end of the said voyage: *In consideration* whereof, the said C. D. for himself, his heirs, executors and administrators, doth covenant, promise, grant and agree, to and with said A. B. his executors, administrators and assigns, and every of them by these presents, that he the said C. D. his executors, administrators, factors or assigns, shall and will well and truly pay or cause to be paid, unto the said A. B. his executors, administrators and assigns, for the freight of the said ship or goods, the sum of, &c. (*Or thus*, 20s. a ton, for loading or unloading and taking in goods at —— and —— ports) within one and twenty days after the said ship's arrival, and goods discharged at —— aforesaid, for the end of the voyage; and also shall and will pay for demurrage, if any shall be by the default of him the said C. D. his factors or assigns, the sum of three dollars a day, daily and every day, as the same shall grow due: And the said A. B. for himself, his heirs, executors and administrators, doth covenant, promise, grant and agree, to and with the said C. D. his executors, administrators and assigns, and every of them, by these presents, that the said ship or vessel shall be ready at the said port of —— at —— key, to take in goods, by the said —— day of —— next coming; and within ten days after the said ship shall be ready at the said key as aforesaid, the said C. D. doth grant, promise and agree to have his goods ready and put on board the said ship, in order that she may proceed on her said voyage. And the said A. B. doth also covenant, promise, grant and agree, to and with the said C. D. his executors, administrators and assigns, that the said ship or vessel now is, and at all times during the said voyage shall be, to the best endeavour of the said A. B. his executors and administrators, at his and their own proper costs and charges, in all things made and kept stiff, staunch and strong, and will furnish and provide as well with men and mariners sufficient and able to sail, guide, and govern the said ship, as with all manner of rigging, boats, tackle, apparel, furniture, provision and appurtenances fitting and necessary for the said men and mariners, and for the said ship, during the voyage aforesaid. *In witness, &c.*

CHARTER-PARTY OF AFFREIGHTMENT.

THIS charter party of affreightment, indented, made and fully concluded upon this ——— day of ——— in the year of our Lord ——— between A. B. of, &c. owner of the good fhip called the ——— of the burthen of —— tons, or thereabouts, now lying in the harbour of —— whereof ——— is at prefent mafter, on the one part, and C. D. of, &c. on the other part, *Witneffeth*, That the faid A. B. for the confideration hereafter mentioned, hath letten to freight ——— the aforefaid fhip with the appurtenances to her belonging, for a voyage to be made by the faid C. D. to ——— and back again to ——— where fhe is to be difcharged (the danger of the feas excepted) and the faid A. B. doth by thefe prefents covenant and agree with the faid C. D. in manner following, *That is to fay*, That the faid fhip in and during the voyage aforefaid, fhall be tight, ftaunch, and ftrong, and fufficiently tackled and apparelled with all things neceffary for fuch a veffel and voyage; and that it fhall and may be lawful for the faid C. D. his agent or factors, as well at ——— as at ——— to load and put on board the faid fhip ——— loading of fuch goods and merchandize as they fhall think proper. Contraband goods always excepted. *In confideration whereof*, the faid C. D. doth by thefe prefents agree with the faid A. B. well and truly to pay or caufe to be paid unto him, in full for the freight or hire of his faid fhip and appurtenances, the fum of ——— and fo in proportion for a lefs time, as the faid fhip fhall be continued in the aforefaid fervice in ——— days after her return to ——— and the faid C. D. doth agree to pay ——— the charges of victualling and manning the faid fhip and ——— port charges and pilotage during faid voyage, and to deliver faid fhip on her return to ——— to the owner aforefaid or his order.

To the true and faithful performance of all and fingular the covenants, payments and agreements aforementioned, each of the parties aforenamed binds and obliges himfelf, his executors and adminiftrators, in the penal fum of —— firmly by thefe prefents. In witnefs whereof, the parties aforefaid have hereunto interchangeably fet their hands and feals the day and year aforewritten.

Signed, fealed and delivered,
in prefence of us, &c.

The following is the Form of a Charter-Party, whereby the Owners of one Moiety of a Ship let to Freight their fhare to the Owners of the other Moiety.

THIS charter-party, indented, made, and fully concluded, this —— day of, &c. between A. B. and C. D. of Bofton, merchants, owners of one moiety, or half part, of the good fhip, or veffel, called the Neptune, of the burthen of two hundred tons, with the like moiety of all the fails, mafts, tackle, apparel, furniture, ordnance, and appurtenances, thereunto belonging, riding at an anchor in the harbor of Bofton, of which the faid C. D. is mafter of the one part, and E. F. and G. H. of Bofton, merchants, owners of the other moiety and refidue of the faid fhip, with the mafts, fails, tackle, ordnance, furniture and apparel, thereunto belonging, on the other part, *witneffeth*, that the faid A. B. and C. D. have granted and letten to freight, and by thefe prefents, do grant and let to freight, all their faid part and moiety of the faid fhip and premifes, unto the faid E. F. and G. H. for a voyage with her (by God's grace) to be made in the manner and form following:

That is to fay, That the faid A. B. and C. D. for them, their executors, adminiftrators and affigns, do hereby covenant and grant, to and with the faid E. F. and G. H. for them, their, and either of their executors and adminiftrators, by thefe prefents, that the faid fhip (being already laden) fhall, with the firft good wind and weather after the date thereof (God permitting) fail directly from the harbour of Bofton to the port of Leghorn in Italy, (the perils and dangers of the feas excepted) and there difcharge fuch goods and merchandizes as fhall be directed and appointed by the faid E. F. and G. H. or one of them, their, or one of their, factors or affigns; and thence fhall fail, and take her direct courfe, as wind and weather fhall ferve, with as much fpeed as may be, (the perils and dangers of the fea excepted) to Venice, and there fhall ftay and abide the fpace of forty working days next after her firft arrival there, to unlade all fuch goods and merchandizes as fhall remain on board for account of E. F. and G. H. after her delivery at Leghorn as aforefaid; and to re-lade fuch goods, wares and merchandizes, as the faid E. F. and G. H. or either of them, their, or either of their factors and affigns, fhall think fit to charge and re-lade on-board, and into the faid fhip, that is to fay, fo much as the faid fhip can conveniently carry, over and above her victuals, tackle, ammunition, apparel, and furniture.

And the faid fhip with her faid loading, fhall, with the firft good wind and weather after the expiration of the faid forty days, fail and proceed from the faid harbor of Venice to Bofton. And the faid E. F. and G. H. for themfelves and either of them, their and either of their executors and adminiftrators, do covenant, promife and grant, to and with the faid A. B. and C. D.

and either of them, their and either of their executors, adminiſtrators, and aſſigns, by theſe preſents, that they, the ſaid E. F, and G. H. or one of them, or their or one of their executors, adminiſtrators, or aſſigns, ſhall and will well and truly pay, or cauſe to be paid, to the ſaid A. B. and C. D. or one of them, their or one of their executors or adminiſtrators, within the ſaid town of Boſton, for every ton of ſuch wares and merchandizes, as ſhall be laden or unladen in the ſaid ſhip during the ſaid voyage, the ſum of, &c. [counting the tonnage according to cuſtom, or if a certain ſum is agreed on for the voyage out and home, or ſo much per month,] for the part and intereſt of the ſaid A. B. and C. D. in the ſaid ſhip, and for and in reſpect of, the freight and hire of their part of her : which ſaid money is to be paid in manner and form following ; that is to ſay, one third part thereof upon the right diſcharge of the ſaid ſhip, and another third part thereof within the ſpace of ſix weeks then next following, and the remaining third part thereof within the ſpace of two months next enſuing after the end and determination of the ſaid ſix weeks.

And the ſaid A. B. and C. D. for them and either of them, their and either of their executors and adminiſtrators, do covenant and grant to and with the ſaid E. F. and G. H. their executors and adminiſtrators, by theſe preſents, that the ſaid ſhip, for their part, ſhall be ſtrong and ſtaunch, and well and ſufficiently tackled and apparelled with ſails, ſail-yards, anchors, cables, ropes, gun-ſhot, artillery, gun-powder, and all other inſtruments tackle and apparel; needful and neceſſary for ſuch a ſhip and for ſuch a voyage, together with an able maſter and ſufficient number of mariners.

And, in the performance of all and every the covenants, grants, articles, and agreements, on the parts, and behalfs of every of the ſaid parties, truly to be holden, performed and kept, in all things as is aforeſaid, the ſaid parties to theſe preſents do bind themſelves to one another ; that is to ſay, the ſaid A. B. and C. D. do, by theſe preſents, bind themſelves, and either of them, and their ſeveral executors and adminiſtrators, goods, and their part and intereſt in the ſaid ſhip, with the furniture thereof, to the ſaid E. F. and G. H. and to their executors and adminiſtrators ; and the ſaid E. F. and G. H. do, in like manner bind themſelves, and either of them, their and either of their executors adminiſtrators, and aſſigns, and all their goods and intereſt in the ſaid ſhip, to the ſaid A. B. and C. D. their executors and adminiſtrators, in the ſum or penalty of five thouſand dollars, lawful money of the United States of America, by the party or parties infringing the ſaid covenants, or any of them, to the other party or parties truly obſerving, to be paid by the virtue of theſe preſents. *In Witneſs, &c.*

If before the departure of the ſhip there ſhould happen an embargo, occaſioned by war, repriſals, or otherwiſe, with the country to which the ſhip is bound, ſo that ſhe cannot proceed on her voyage, the *charter-party* ſhall be diſſolved without damages or charges to either party, and the merchant ſhall pay the charges of unlading his goods ; but if the reſtraint ariſes from a difference between the parties themſelves, the *charter-party* ſhall ſtill remain valid in all points.

If the ports be only ſhut, and the veſſels ſtopped for a time, the *charter-party* ſhall ſtill be valid, and the maſter and merchant ſhall be reciprocally obliged to wait the opening of the ports, and the liberty of the ſhips, without any pretenſions for damages on either ſide.

However, the merchant, at his own charges, may unload his goods during ſhutting up of the port, upon condition either to relade them, or indemniſy the maſter.

The great variety of circumſtances occaſioned by different voyages naturally produce a correſpondent diverſity in charter-parties, all the different forms of which it would be impracticable and unneceſſary to introduce here, as the preceding may be varied to ſuit any purpoſe.

MERCANTILE FORMS.

A bill of lading is a writing wherein maſters of ſhips acknowledge the receipt of goods on board, and oblige themſelves to deliver the ſame in good order and condition at the place where they are conſigned to. There muſt always three to be made out, and muſt be on ſtamped paper, otherwiſe they are invalid ; of which one ſhould be remitted, by the firſt poſt after ſigning, to the perſon the goods go to ; another be ſent him by the ſhip ; and the third remain with the ſhipper ; beſides which, a fourth ſhould be made out, on an unſtamped paper, to be given to the maſter for his government.

If the goods are to be exported from one diſtrict to another diſtrict in the United States, not being in the ſame State, the bill of lading muſt have a four cent ſtamp. If from the United States to any foreign port or place, a ten cent ſtamp. And theſe duties are chargeable on every bill, without reſpect to the number contained in each ſet.

Upon delivering the goods at the port of deſtination to the ſhipper's factor or aſſigns, giving up the bill of lading ſent to the factors or aſſigns is a ſufficient diſcharge, but the maſter may inſiſt on a receipt.

BILL OF LADING.

Shipped in good order by A. B. on the good ship *Washington*, A. B. master, now riding at anchor in the *Bay of Funchal*, and bound for *Boston*, to say,

C D No. 1 a 50 — 50 *quarter casks of wine.*
C D No. 1 a 4 — 4 *pipes wine.*

being marked and numbered as in the margin, and are to be delivered in the like good order (dangers of the seas and enemies excepted) at the aforesaid port of Boston, unto C.D. or his assigns; he or they paying freight for the said goods, with primage and average accustomed. In witness whereof the master of said ship hath affirmed to three Bills of Lading, of this tenor and date, the one of which being accomplished, the other two to be void. A. B.

Funchal, Nov. 12, 1801.

BILL OF EXCHANGE.

Exchange for £.100 Sterling.

Six weeks after date [or six weeks sight] this my first of exchange (second and third of the same tenor and date not paid) pay to C. D. or order, One hundred pounds sterling, with or without farther advice, From your humble servant, E. F.

Mr. G. N. Merchant, London:

SEAMEN's RECEIPT.

Received of A. B. master of the ship Washington, of Boston, fifty dollars, in full for wages, and in satisfaction for all other demands against the owners, master, or officers of the said ship.

Dols. 50. Boston, July 16, 1801. Z. Y.

RECEIPTS.

Dols. 26. Boston, July 16, 1801.

Received of A. B, by the hands of C. D. twenty-six dollars on account. E. F.

Dols. 45 68. Boston, July 16, 1801.

Received of A. B. by the hands of C. D. forty-five dollars sixty-eight cents, which is endorsed on his note of June 16, 1801. E. F.

NOTES OF HAND.

Dols. 256. Boston, June 15, 1801.

Value received, I promise to pay to A. B. or order, two hundred and fifty-six dollars, on demand, with interest. C. D.

Attest. E, F.

Dols. 26 86. Boston, July 14, 1801.

Value received, we jointly and severally promise to pay to A. B. or order, twenty-six dollars and eighty-six cents, on demand, with interest. A. D.

Attest. S. M. A. E.

DISBURSEMENTS AND OTHER ACCOUNTS.

THE method of Book-Keeping is the art of placing our accounts in such an easy manner, that the whole, or any part, of the money received and advanced may, with the greatest clearness, be attained in a very little time.

Whatever is paid upon a ship's account, the ship must be Dr. for it.

Whatever is received upon a ship's account, the ship must have credit for the same.

It is recommended to every captain to keep a small memorandum-book, to set down the money as he lays it out, both for himself and his ship; likewise the money which he receives, lest at any time it slip his memory and be forgotten: then these accounts can be easily entered into a larger book at leisure. By this method he can easily tell whether any thing has been omitted or not, by adding up the money paid, and taking it from the money received; if what remains is equal to the cash he has on hand, nothing has been forgotten; if they do not agree, then it is plain something has been omitted.

Many loſſes have frequently fallen upon owners of ſhips, for want of proper care being taken by their captains in ſigning bills of lading. When there is the leaſt reaſon to ſuſpect the quantity is not right, or that there is any damage in the goods, always write,

(If hemp, flax, bars of iron, &c.)

Quantity and conditions unknown; and three bundles of hemp in diſpute; if on-board, to be delivered. STEPHEN HOLLAND.

(If linen, yarn, bales, hardware, &c.)

Inſides and contents unknown to STEPHEN HOLLAND.

(If tar, wines, brandy, turpentine, &c.)

Contents and conditions unknown; not to be accountable for leakage: and it is agreed that freight ſhall be paid for the quantity ſhipped. STEPHEN HOLLAND.

The following accounts and examples will be ſufficient for any voyage whatſoever, to render a captain's accounts and tranſactions conciſe and pleaſant to himſelf, notwithſtanding they are are limited to one voyage only.

SALES of ſundry Merchandize at Funchal, on account of C. D. Merchant, of Boſton; being part of the Cargo of the Ship Waſhington.

			Dols.	Cents.
100 barrels of Beef	at 16 Dols.		1600	00
50 barrels Pork	18 Dols.		900	00
10,000 feet of Boards	20 Dols.		200	00
			2700	00
EXPENSES.				
Boat hire	Dols.	5 20		
Cooperage		3 00		
Commiſſions 5 per ct.		135 00	143	20
	Net Sales		2556	80
Funchal, April 1801. Errors excepted, A. B.				

Invoice of Wines ſhipped at Funchal, on board the ſhip Waſhington, by A. B. maſter of ſaid ſhip, on account and riſk of C. D. a native citizen of the United States, reſident at Boſton, and conſigned to him.

Marks.				Dols.	Cents.
CD					
No. 1 *a* 50	50 quarter caſks of Wine,	at 30 Dols.		1500	00
CD. No. 1 *a* 4	4 pipes Wine,	120 Dols.		480	00
	EXPENSES.			1980	00
	Commiſſions 2½ per ct.		49 50		
	Boat hire for ſhipping Wine		1 60	51	10
				2031	10
	Funchal, April 1801. Errors excepted, A. B.				

Diſburſements of the ſhip Waſhington, paid by A. B. Maſter.

1801.	*At Boſton.*	Dols.	Cts.
March 20	To a ſhipping paper	0	60
21	To ballaſt	12	00
22	To blockmaker's bill	14	00
	To blackſmith's bill	16	00
23	To ſhip chandler's bill	16	15
24	To butcher's bill	11	11
		69	86

	At Madeira.	Dols.	Cts
April 12	To freſh meat and vegetables	3	12
	To one caſk of wine for ſhip's uſe	15	00
		18	12

Dr. C. D. owner of the Ship Washington, in Account Current with A. B. Cr.

1801.		Dols.	cts	1801.		Dols	cts
March 24	To disbursements of the ship Washington, at Boston	69	36	April 11	By net sales of merchandize at Funchal	2556	80
April 11	To ditto at Funchal	18	12		By balance to new account	6	72
	To Wine as per invoice	2031	10				
	To a bill of exchange for £.100 sterling drawn by E. F. merchant of Funchal, on G. N. merchant of London, at par	444	44				
		2563	52			2563	52
April 12	To balance old account	6	72				

Funchal, April 12, 1801. Errors excepted,

A. B.

Dr. John Codline, mate of the Ship Washington. Contra Cr.

1801.		Dols.	cts	1801.		Dols	cts
April 12.	To one quarter cask of Wine	30	00	Ap. 12	By two barrels beef sold for 16 dols. each,	32	00
	To cash to balance	2	00				
		32	00				

ERRATA.

In addition to the errors published in the last page of Table IV. are the following printed only in a *few copies*.

Page 104, col. 1.—*For* Theo. VI. *read* Theo. I. Page 136, line 12—*For* H *read* F. Page 158—The asterisk (*) should have been placed at the end of the first paragraph, 6th line. Table I.—For 2¼ points, dist. 58, *For* 59.7 *read* 49.7. Table IV. last page, col. 1. *For* Sandwich Islands *read* Sandwich Island. Col. 2.—Furneaux Island is in the long. of 143.2 Col. 3.—*For* Rocka *read* Rock, and *for* Avdscha *read* Avatscha. Table X. precepts, page 2, line 35—*for* the and minutes, *read* the odd minutes.

After a careful perusal of the mathematical part of this work, the above errors, *only*, were discovered. Since Table IV. was printed, the latitudes and longitudes of several places have been obtained, which we shall here insert, as an

Addition to Table IV.

An island was discovered by captain Israel Gardner, of the ship Diana, in her outward passage from New-Bedford to Manilla, on the 3d of January, 1801, in the latitude of 1° 0′ S. longitude 168° 45′ E.—On the chart N°. 47, of the collection of Laurie and Whittle, published at London in 1801, there is an island marked "Pleasant Island, discovered in 1798," which is nearly in the same place, being in the latitude of 0° 25′ S. longitude 167° 10′ E.

The latitude of the Cape of Good Hope, given by Capt. James Cook, and others, is 34° 23′ S. False Cape 34° 12′ S.

Capt. Jonathan Carnes, of Salem, has politely furnished us with the following table of the latitudes of several places on the western coast of Sumatra, and the islands adjacent. The charts of that coast being very defective, induces us to publish, in this place, his useful table.

	°	′		°	′
Kings Point near Acheen Head	5	38N	Ipce	3	12N.
Acheen	5	24	Catoun	3	25
Daya	4	50	Pulo Matt	3	30N.
Analaboo	4	10	Verkin's Island, North end	3	20
Ujonmelm, or Cape Felix	3	42	South end	2	45
Soofo	3	37	Pulo Dua	2	54
Libonajee	3	32	Pulo Bangeuck, North end	2	38
Tallon Baque, or Muccat	3	25	South end	2	9
Tampatuan Point	3	18	Pulo Sink	1	18
Sinkle	2	20	Pulo Nyas, middle	1	15
Barros River	2	8	Pulo Batoa	0	24
Tapponooly	1	36	Pulo Mintao, middle	0	5
Natal	0	37	Good Fortune Island, North end	0	42S.
Ayer Bungey	0	24	South end	1	40
Priaman	0	24S	Our Island, is a small island, lying west from Verkin's Island		
Padang	0	49	18 or 20 legues distant.		
Indrapour	2	3	There is a good passage between the north end of Good Fortune-		
Moco-moco	2	58	Island and the south end of Mintao, 30 miles wide.		

The latitudes here given are more correct than those published in Table IV.

A list of Errors in Hutton's *Logarithms.*

IN making the calculations of the preceding work, the following errors were discovered in Hutton's Logarithmic Tables, edition 2d. London, 1794, and edition 3d. London, 1801.—Those errors marked S, are in the second edition—those with T, are in the third, and those with S and T, are in both the second and third editions.

The first edition was not examined, as no copy of it could be procured.

In Table I.

Page 82—Natural number 4826, read 4836 S.

Table III.

Log. of 101009 for 00836 &c. read 00436 &c.

In Table X.

Log. Sine	10° 60′	For	9.2705988	read	9.2805988	S.
Log. Covers.	11° 52′	—	9.8990202	—	9.9000202	S. T.
Log. Secant	12° 54′	—	10.0110118	—	10.0111018	S. T.
Log. Vers. Sine	14° 15′	—	8.4871034	—	8.4881147	S.
Nat. Sine	16° 48′	—	2880318	—	2890318	S. T.
Log. Vers. Sine	22° 2′	—	8.8633265	—	8.8635265	S. T.
Log. Co-sine	35° 1′	—	9.9182760	—	9.9132760	T.
Log. Secant	35° 60′	—	10.0910424	—	10.0920424	T.
Nat. Tangent	40° 0′	—	8490996	—	8390996	T.
Nat. Tangent	40° 1′	—	8495955	—	8395955	T.
Log. Co-sine	40° 25′	—	9.8815542	—	9.8815842	S. T.
Log. Covers.	41° 27′	—	9.5208601	—	9.5289601	S.
Log. Vers. Sine	43° 60′	—	9.4471808	—	9.4481808	S. T.

Table XI.

A number of small errors were discovered in this table, both in the second and third editions, the correct values are as follows:

Course. Points.	Course. Degs.	Dist.	Lat.	Dep.
	4	8		0.5581
½		3		0.2941
¾		10		1.4673
	11	10	9.8163	
1		5		0.9755
	13	5	4.8719	
	13	7		1.5747
	14	3	2.9109	
	18	8	7.6085	
	20	7	6.5778	
2		3		1.1481
2		9		3.4442
	23	10		3.9073
	24	2	1.8271	
	27	5		2.2700
2½		4		1.8856
	30	2	1.7321	
	30	6	5.1962	
	31	7		3.6053
	32	3		1.5898
	32	8	6.7844	
3		5		2.7779
	35	8		4.5886
3¼		7	5.6225	
	38	10		6.1566
	41	5	3.7735	
3¾		9	6.6686	
	43	2	1.4627	
	44	2		1.3893
	44	6		4.1680

Errors in Hutton's *Logarithms continued.*

TABLE XII.

Arch of	115°	For	1.0071286	read	2.0071286 S. T.
	116	—	1.0245819	—	2.0245819 S. T.
	117	—	1.0420352	—	2.0420352 S. T.
	118	—	1.0594885	—	2.0594885 S. T.
	119	—	1.0769418	—	2.0769418 S. T.
	120	—	1.0943950	—	2.0943951 S. T.
	167	—	2.9146997	—	2.9146999 S. T.
	172	—	2.0019662	—	3.0019663 S. T.
	173	—	2.0194195	—	3.0194196 S. T.
	174	—	2.0368728	—	3.0368729 S. T.
	175	—	2.0543261	—	3.0543262 S. T.
	176	—	2.0717794	—	3.0717795 S. T.
	177	—	2.0892327	—	3.0892328 S. T.
	178	—	2.1066860	—	3.1066861 S. T.
	179	—	2.1241393	—	3.1241394 S. T.
	180	—	2.1415927	—	3.1415927 S. T.

And the numbers correſponding to the following degrees in edition ſecond and third, muſt be increaſed by an unit in the laſt decimal place, viz. from 97° to 100°, from 107° to 112°, from 121° to 127°, from 137° to 140°, from 147° to 153°, from 157° to 166°, and from 168° to 171° incluſively.

TABLE XIII.

The numbers correſponding to the following logs. in edition ſecond and third, muſt be increaſed by unity, viz. .06, .81, .82, 83, .84, .85, .92, .93, .94, .95; and the following muſt be decreaſed by unity .16, .26, .36, .37, .46, .47, .48, .56, .57, .58, .59, .66, .67, 68, .69.

Beſides theſe errors in the tables, there are ſeveral in the precepts, but as they are eaſily corrected by the reader, I ſhall not inſert them, but only add the following remarks.

In page 158, Ed. 2, or page 157, Ed. 3, it is ſaid that "The ſign > ſignifies *greater than*, and < *leſs*," but by examining the table of ſolutions, page 159, Ed. 2, or page 158, Ed. 3, it appears, that they are uſed with a contrary ſignification: For, in Caſe 5, it is ſaid that "H is > or < 90° as B is *like* or *unlike* P.—but by ſpherics it is well known that when H repreſents the hypotenuſe, and B, P, the ſides of a right-angled ſpheric triangle, the hypotenuſe H will be *leſs* or *greater* than 90° according as the ſides B, P, are *like* or *unlike*: therefore the ſign > is, in this caſe, uſed inſtead of "leſs than," and < inſtead of greater than, which is contrary to the ſignification before given, and is different from the general uſe of theſe ſigns by mathematicians.

The rule for the quadrantal triangle, page 159, Ed. 2, or page 158, Ed. 3, line 12, et ſeq. requires a little alteration. For if for H we take its ſupplement, we muſt read the terms *like* and *unlike* as in the table; but if we take the real value of H, we muſt change the terms *like* and *unlike*.

By calculating as in Prob. XVIII. page 166, Ed. 2, or page 165, Ed. 3. you will obtain two of the ſought ſides of the given triangle, and the ſupplement of the other. In ſolving this problem, you may take the ſupplement of either of the given angles, inſtead of being confined to the ſupplement of the greateſt angle, as in the rule given by Mr. Hutton.

Errors in Taylor's *Logarithms, London,* 1792.

Page 33, line 2. In the denominator of the value of N. for L. M. read L. m.

—— line 5. Dele t in the exponent of the denominators $1+r$.

—— line 22. For $m = p. \overline{1+r}|^n$ read $m' = p. \overline{1+r}|^n$.

Page 48, line 10. Caſe 1. For $Z \frac{1}{2} > ACB$ read $Z > \frac{1}{2} ACB$.

—— line 12. Caſe 2. For $\frac{1}{2} \overline{A+B} > 90°$ read $\frac{1}{2} \overline{A+B} < 90°$.

—— For $Z > \frac{1}{2} ACB$, read $Z < \frac{1}{2} ACB$.

Page 59. In the ſolution of Problem XIII. it is ſaid that B can exceed 90°, only in the ſecond ſemi-circle of right aſcenſion. But it is evident that when the ſtar has ſouth declination, and the arch A is greater than the complement of the obliquity of the ecliptic, the angle B will be greater than 90°. This caſe ought to have been noted in the latter part of the rule. There is a ſimilar neglect in Problem XIV.

Page 62, line 11. For 13. 29. 42. read 13. 20. 42.

In the laſt page of the book. For the Log. of 2.3025, &c. inſtead of 0.3622149, read 0.3622157.

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Naval Songster; Forecastle Companion (just published); Dibdin's Songs; Columbian Songster; Vocal Companion, and various other Song Books.

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Elegant CIRCULAR INSTRUMENTS, to be used as Sextants, over which they possess a decided superiority. By the means of two moveable Indices, any inaccuracy in the divisions of any part of the limb (to which the best instruments are liable) may be obviated by observing in any other part. The want of parallelism in the glasses, if it should occur, is corrected by the manner of using these instruments. They are not (from their form)

ment of the courſe, which being taken together, make always eight points or 90 degrees.

In conſtructing figures relating to a ſhip's courſe, let the upper part of the paper, or what the figure is drawn upon, always repreſent the north; the lower part will be the ſouth; the right hand eaſt, and the left weſt.

Draw the north and ſouth line to repreſent the meridian of the place the ſhip ſails from; then, if the ſhip's courſe is to the ſouthward, mark the upper end of the line for the place ſailed from; but if the courſe is northward, mark the lower end for that place.

When the courſe is eaſterly, deſcribe the arch, and lay off the courſe and departure on the right-hand ſide of the meridian; but when weſterly, on the left-hand ſide.

When the courſe is given in degrees, the degrees expreſſing it muſt be taken from the line of chords; but when in points, from the line of rhumbs; and is always to be laid off upon the arch, beginning at the meridian.

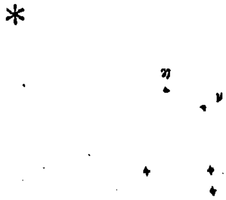
When the courſe is given in points, it may be ſet down with its correſponding logarithm in points in the calculation, as found in the firſt page of the logarithms, without reducing it into degrees.

In all caſes, wherever the complement of courſe, or co-ſine, &c. is uſed, the degrees or points put down is the courſe itſelf; yet the logarithm belonging to the complement, or co-ſine, &c. of that courſe is taken.

A Table of the Angles which every Point of the Compaſs makes with the Meridian.

North.	South.	Points.	D.M.	North.	South.
		¼	2.49		
		½	5.37		
		¾	8.26		
N. by E.	S. by E.	1	11.15	N. by W.	S. by W.
		1 ¼	14. 4		
		1 ½	16.52		
		1 ¾	19.41		
N. N. E.	S. S. E.	2	22.30	N. N. W.	S. S. W.
		2 ¼	25.19		
		2 ½	28. 7		
		2 ¾	30.56		
N. E. by N.	S. E. by S.	3	33.45	N. W. by N.	S. W. by S.
		3 ¼	36.34		
		3 ½	39.22		
		3 ¾	42.11		
N. E.	S. E.	4	45. 0	N. W.	S. W.
		4 ¼	47.49		
		4 ½	50.37		
		4 ¾	53.26		
N. E. by E.	S. E. by E.	5	56.15	N. W. by W.	S. W. by W.
		5 ¼	59. 4		
		5 ½	61.52		
		5 ¾	64.41		
E. N. E.	E. S. E.	6	67.30	W. N. W.	W. S. W.
		6 ¼	70.19		
		6 ½	73. 7		
		6 ¾	75.56		
E. by N.	E. by S.	7	78.45	W. by N.	W. by S.
		7 ¼	81.34		
		7 ½	84.22		
		7 ¾	87.11		
	Eaſt.	8	90. 0	Weſt.	

SPICA.



E. S. E. from Regulus, at the diſtance of 54°, lies the ſtar Spica, of the firſt magnitude, with no bright ſtar near it: S. W. of this ſtar, at the diſtance of about 16°, are five ſtars of the third and fourth magnitude, ſituated as in the adjoined figure; the two northernmoſt of theſe ſtars η, ν, form a ſtraight line with the ſtar Spica, and by this mark it may be eaſily diſcovered. A line drawn from the northern polar ſtar, through the middle ſtar of the tail of the Great bear, will paſs near to Spica.

ANTARES.

E. S. E. from Spica, at the diſtance of 46 degrees, lies the ſtar Antares, in 26 degrees of ſouth declination; it is a remarkable ſtar, of a reddiſh colour; on each ſide of it, to the W. N. W. and S. S. E. about 2° diſtant, is a ſtar of the third or fourth magnitude, forming an obtuſe angle with it, no bright ſtar being near.

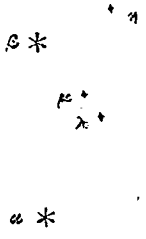
α AQUILÆ.

N. E. from Antares, at the diſtance of 60°, lies the very bright ſtar α Aquilæ; N. N. W. of which, at 2° diſtance, is a ſtar of the third magnitude, and S. S. E. of it, at 3° diſtance, another ſtar of a leſſer magnitude, forming a ſtraight line with it. The ſtar α Aquilæ is nearly of the ſame colour as Antares.

FOMALHAUT.

S. E. from α Aquilæ, at the diſtance of 60°, lies the ſtar Fomalhaut, which is a bright ſtar of high ſouthern declination, its altitude in northern latitudes being ſmall, never exceeding 20° in the latitude of 40°. It bears nearly ſouth from the ſtar α Pegaſi, diſtant 45 degrees. A line drawn from the pointers, through the northern polar ſtar, and continued to the oppoſite meridian, will paſs very near to α Pegaſi and Fomalhaut.

α PEGASI.



E. by N. from α Aquilæ, at the diſtance of 48°, and weſt from α Arietis, at the diſtance of 44°, lies the ſtar α Pegaſi, which may be known by means of four ſtars of different magnitudes, ſituated as in the adjoined figure, in which α repreſents α Pegaſi, β a ſtar of the ſecond magnitude bearing north of it diſtant 13°; the others are of leſſer magnitude, and two of them, η, μ, form a ſtraight line with the ſtar α Pegaſi, and by this mark it may be eaſily diſcovered.

General obſervations on the taking of a Lunar Obſervation.

The accuracy of a lunar obſervation depends chiefly on the regulation of the watch, and on the exact meaſurement of the diſtance of the moon from the ſun or ſtar; a ſmall error in the obſerved altitudes of thoſe objects does not much affect the reſult of the calculation.

The beſt method of regulating a watch at ſea, is by taking an altitude of the ſun when it changes quickeſt, or when it bears nearly eaſt or weſt, and noting the time by the watch. With this altitude, the latitude of the place, and the sun's declination, find the apparent time of observation by either of the preceding methods; the difference between this time and that shewn by the watch, will show how much the watch is too fast or too slow. A single observation taken with care will generally be exact enough; but if greater accuracy is required, the mean of a number of observations may be taken. If the distance of the sun and moon be observed when the sun is three or four points distant from the meridian, the apparent time of observation may be deduced from the altitude of the sun taken at the precise time of measuring the distance; this will render the use of a watch unnecessary, and will prevent any irregularity in its going from affecting the result of the observation. If a night observation is to be taken, the watch should be regulated by an altitude of the sun taken the preceding evening, and its going examined by means of another observation taken the next morning; for the time found by an altitude of a star cannot be so well depended upon, as the atmosphere in the night is precarious, and the horizon generally ill-defined; but the altitude may be sufficiently exact for finding the correction used in determining the angular distance.

Although all the instruments used in these observations ought to be well adjusted, yet particular care ought to be taken of the sextant used in measuring the distance of the moon from the sun or star, since an error of 1′ in this distance will make an error of nearly 30′ in the longitude deduced therefrom. When a great angular distance is to be measured, the adjustment of the parallelism of the telescope is of primary importance; but when the distance is less than 50°, the telescope may be dispensed with, using a simple sight tube, taking care, however, that the eye and point of contact of the objects on the horizon glass be equally distant from the plane of the instrument.

Whilst one person is observing the distance of the objects, two others ought to be observing their altitudes; and the watch either suspended near one of the observers, or put into the hands of a fourth person appointed to note the times. The observer who takes the angular distance giving previous notice to the others to be ready with their altitudes by the time he has finished his observation, which being done, the time, altitudes, and distance should be carefully noted; and other sets of observations taken, which must be done within the space of 15 minutes, and the mean of all these observations must be taken and worked as a single one.

When a ship is close hauled to the wind, with a large sea, or when sailing before the wind, and rolling considerably, it is difficult to measure the distance of the objects; but when the wind is enough upon the quarter to keep her steady, it is easy to do it, especially in small distances, which are much more easily measured than large ones, and are not so liable to error from an ill adjustment of the telescope: an observer would therefore do well to choose those times for his observations when the distance of the objects is less than 70°. An observation of the sun and moon is generally much easier to take when the altitude of the moon is less than that of the sun, because the sextant will be held in a more natural and easy manner. When the moon is near the zenith the observation is generally difficult to make, because the observer is forced to place himself in a disagreeable posture. For the same reason an observation of the moon and a star is generally much easier to take when the star is lower than the moon. This situation of the objects may in most cases be obtained by making the observations at a proper time of the day. But it must be observed that neither of the objects ought to be at a less altitude than 10°, upon account of the

3 HOURS.									
M.	S.	Log ½ elap. Time.	Log Mid Time.	Logarith Rising.	M.	S.	Log ½ elap. Time.	Log Mid Time.	Logarith Rising
0	0	0.15051	5.15051	4.46671	10	0	0.13237	5.16866	4.51109
	10	0.15020	5.15083	4.46747		10	0.13208	5.16895	4.51181
	20	0.14988	5.15115	4.46823		20	0.13179	5.16924	4.51253
	30	0.14957	5.15146	4.46899		30	0.13150	5.16953	4.51324
	40	0.14926	5.15177	4.46975		40	0.13121	5.16982	4.51396
	50	0.14894	5.15209	4.47051		50	0.13093	5.17010	4.51467
1	0	0.14863	5.15240	4.47127	11	0	0.13064	5.17039	4.51539
	10	0.14832	5.15271	4.47203		10	0.13035	5.17068	4.51610
	20	0.14800	5.15303	4.47278		20	0.13007	5.17096	4.51681
	30	0.14769	5.15334	4.47354		30	0.12978	5.17125	4.51753
	40	0.14738	5.15365	4.47430		40	0.12950	5.17153	4.51824
	50	0.14707	5.15396	4.47505		50	0.12921	5.17182	4.51895
2	0	0.14076	5.15427	4.47580	12	0	0.12893	5.17210	4.51966
	10	0.14645	5.15458	4.47656		10	0.12864	5.17239	4.52037
	20	0.14614	5.15489	4.47731		20	0.12836	5.17267	4.52107
	30	0.14583	5.15520	4.47806		30	0.12808	5.17295	4.52178
	40	0.14552	5.15551	4.47881		40	0.12779	5.17324	4.52249
	50	0.14521	5.15582	4.47956		50	0.12751	5.17352	4.52319
3	0	0.14490	5.15613	4.48031	13	0	0.12723	5.17380	4.52390
	10	0.14460	5.15643	4.48106		10	0.12695	5.17408	4.52461
	20	0.14429	5.15674	4.48180		20	0.12666	5.17437	4.52531
	30	0.14398	5.15705	4.48255		30	0.12638	5.17465	4.52601
	40	0.14368	5.15735	4.48330		40	0.12610	5.17493	4.52672
	50	0.14337	5.15766	4.48401		50	0.12582	5.17521	4.52742
4	0	0.14307	5.15796	4.48479	14	0	0.12554	5.17549	4.52812
	10	0.14276	5.15827	4.48553		10	0.12526	5.17577	4.52882
	20	0.14246	5.15857	4.48627		20	0.12499	5.17604	4.52952
	30	0.14215	5.15888	4.48701		30	0.12471	5.17632	4.53022
	40	0.14185	5.15918	4.48776		40	0.12443	5.17660	4.53092
	50	0.14155	5.15948	4.48850		50	0.12415	5.17688	4.53162
5	0	0.14124	5.15979	4.48924	15	0	0.12387	5.17716	4.53231
	10	0.14094	5.16009	4.48998		10	0.12360	5.17743	4.53301
	20	0.14064	5.16039	4.49071		20	0.12332	5.17771	4.53371
	30	0.14034	5.16069	4.49145		30	0.12305	5.17798	4.53440
	40	0.14004	5.16099	4.49219		40	0.12277	5.17826	4.53510
	50	0.13974	5.16129	4.49293		50	0.12240	5.17854	4.53579
6	0	0.13944	5.16159	4.49366	16	0	0.12222	5.17881	4.53648
	10	0.13914	5.16189	4.49440		10	0.12195	5.17908	4.53718
	20	0.13884	5.16219	4.49513		20	0.12167	5.17936	4.53787
	30	0.13854	5.16249	4.49586		30	0.12140	5.17963	4.53856
	40	0.13824	5.16279	4.49660		40	0.12113	5.17990	4.53925
	50	0.13794	5.16309	4.49733		50	0.12085	5.18018	4.53994
7	0	0.13765	5.16338	4.49806	17	0	0.12058	5.18045	4.54063
	10	0.13735	5.16368	4.49879		10	0.12031	5.18072	4.54132
	20	0.13705	5.16398	4.49952		20	0.12004	5.18099	4.54201
	30	0.13676	5.16427	4.50025		30	0.11977	5.18126	4.54269
	40	0.13646	5.16457	4.50098		40	0.11949	5.18154	4.54338
	50	0.13617	5.16486	4.50170		50	0.11922	5.18181	4.54407
8	0	0.13587	5.16516	4.50243	18	0	0.11895	5.18208	4.54475
	10	0.13558	5.16545	4.50316		10	0.11868	5.18235	4.54544
	20	0.13528	5.16575	4.50388		20	0.11842	5.18261	4.54612
	30	0.13499	5.16604	4.50461		30	0.11815	5.18288	4.54680
	40	0.13470	5.16633	4.50533		40	0.11788	5.18315	4.54749
	50	0.13441	5.16662	4.50605		50	0.11761	5.18342	4.54817
9	0	0.13411	5.16692	4.50677	19	0	0.11734	5.18369	4.54885
	10	0.13382	5.16721	4.50750		10	0.11708	5.18395	4.54953
	20	0.13353	5.16750	4.50822		20	0.11681	5.18422	4.55021
	30	0.13324	5.16779	4.50894		30	0.11654	5.18449	4.55089
	40	0.13295	5.16808	4.50966		40	0.11628	5.18475	4.55157
	50	0.13266	5.16837	4.51038		50	0.11601	5.18502	4.55225

TABLE XXI. For finding the Latitude by two Altitudes of the Sun.

3 HOURS.									
M.	S.	Log ½ela Time.	LogMid Time.	Logarith Rising.	M.	S.	Log ½ela Time.	LogMid Time.	Logarith Rising.
20	0	0.11575	5.18528	4.55293	30	0	0.10053	5.20050	4.59244
	10	0.11548	5.18555	4.55360		10	0.10029	5.20074	4.59308
	20	0.11522	5.18581	4.55428		20	0.10005	5.20098	4.59372
	30	0.11495	5.18608	4.55496		30	0.09981	5.20122	4.59436
	40	0.11469	5.18634	4.55563		40	0.09957	5.20146	4.59500
	50	0.11443	5.18660	4.55630		50	0.09933	5.20170	4.59564
21	0	0.11416	5.18687	4.55698	31	0	0.09909	5.20194	4.59627
	10	0.11390	5.18713	4.55765		10	0.09885	5.20218	4.59691
	20	0.11364	5.18739	4.55832		20	0.09861	5.20242	4.59755
	30	0.11338	5.18765	4.55900		30	0.09837	5.20266	4.59818
	40	0.11312	5.18791	4.55967		40	0.09813	5.20290	4.59882
	50	0.11285	5.18818	4.56034		50	0.09789	5.20314	4.59945
22	0	0.11259	5.18844	4.56101	32	0	0.09765	5.20338	4.60008
	10	0.11233	5.18870	4.56168		10	0.09741	5.20362	4.60072
	20	0.11207	5.18896	4.56235		20	0.09718	5.20385	4.60135
	30	0.11181	5.18922	4.56301		30	0.09694	5.20409	4.60198
	40	0.11156	5.18947	4.56368		40	0.09670	5.20433	4.60261
	50	0.11130	5.18973	4.56435		50	0.09647	5.20456	4.60324
23	0	0.11104	5.18999	4.56501	33	0	0.09623	5.20480	4.60388
	10	0.11078	5.19025	4.56568		10	0.09599	5.20504	4.60450
	20	0.11052	5.19051	4.56635		20	0.09576	5.20527	4.60513
	30	0.11027	5.19076	4.56701		30	0.09552	5.20551	4.60576
	40	0.11001	5.19102	4.56767		40	0.09529	5.20574	4.60639
	50	0.10975	5.19128	4.56834		50	0.09506	5.20597	4.60701
24	0	0.10950	5.19153	4.56900	34	0	0.09482	5.20621	4.60765
	10	0.10924	5.19179	4.56966		10	0.09459	5.20644	4.60827
	20	0.10899	5.19204	4.57032		20	0.09435	5.20668	4.60890
	30	0.10873	5.19230	4.57098		30	0.09412	5.20691	4.60952
	40	0.10848	5.19255	4.57164		40	0.09389	5.20714	4.61015
	50	0.10822	5.19281	4.57230		50	0.09366	5.20737	4.61077
25	0	0.10797	5.19306	4.57296	35	0	0.09343	5.20760	4.61139
	10	0.10772	5.19331	4.57362		10	0.09319	5.20784	4.61202
	20	0.10746	5.19357	4.57428		20	0.09296	5.20807	4.61264
	30	0.10721	5.19382	4.57493		30	0.09273	5.20830	4.61326
	40	0.10696	5.19407	4.57559		40	0.09250	5.20853	4.61388
	50	0.10671	5.19432	4.57625		50	0.09227	5.20876	4.61450
26	0	0.10646	5.19457	4.57690	36	0	0.09204	5.20899	4.61512
	10	0.10620	5.19483	4.57755		10	0.09181	5.20922	4.61574
	20	0.10595	5.19508	4.57821		20	0.09158	5.20945	4.61636
	30	0.10570	5.19533	4.57886		30	0.09136	5.20967	4.61698
	40	0.10545	5.19558	4.57951		40	0.09113	5.20990	4.61760
	50	0.10520	5.19583	4.58017		50	0.09090	5.21013	4.61822
27	0	0.10496	5.19607	4.58082	37	0	0.09067	5.21036	4.61883
	10	0.10471	5.19632	4.58147		10	0.09044	5.21059	4.61945
	20	0.10446	5.19657	4.58212		20	0.09022	5.21081	4.62006
	30	0.10421	5.19682	4.58277		30	0.08999	5.21104	4.62068
	40	0.10396	5.19707	4.58342		40	0.08977	5.21126	4.62129
	50	0.10371	5.19732	4.58407		50	0.08954	5.21149	4.62191
28	0	0.10347	5.19756	4.58471	38	0	0.08931	5.21172	4.62252
	10	0.10322	5.19781	4.58536		10	0.08909	5.21194	4.62313
	20	0.10298	5.19805	4.58601		20	0.08886	5.21217	4.62375
	30	0.10273	5.19830	4.58665		30	0.08864	5.21239	4.62436
	40	0.10248	5.19855	4.58730		40	0.08842	5.21261	4.62497
	50	0.10224	5.19879	4.58794		50	0.08819	5.21284	4.62558
29	0	0.10199	5.19904	4.58859	39	0	0.08797	5.21306	4.62619
	10	0.10175	5.19928	4.58923		10	0.08775	5.21328	4.62680
	20	0.10151	5.19952	4.58988		20	0.08752	5.21351	4.62741
	30	0.10126	5.19977	4.59052		30	0.08730	5.21373	4.62802
	40	0.10102	5.20001	4.59116		40	0.08708	5.21395	4.62863
	50	0.10078	5.20025	4.59180		50	0.08686	5.21417	4.62923

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