May 13 1942

	cp cal/gm	μ	k	μ/k	$c_p\mu/k$	$(c_p\mu/k)^{0.4}$	ρ	T	$\frac{\Delta^{0.8}}{\Delta}$ 0.5 cm
Air	7/30	3×10^{-4}	$0.82\,10^{-4}$ T=300°C	3.66	0.85	0.94	6.7×10^{-4}	300°C	1.15
He(1)	5/4	3.5×10^{-4}	$6.3\,10^{-4}$	1.9/3.4	0.7	0.87	0.9×10^{-4}	300	1.15
He(10)	5/4	3.5×10^{-4}	$6.3\,10^{-4}$	1.9/3.4	0.7	0.87	$9\,10^{-4}$	300	1.15
H_2O	1	55×10^{-4}	14.5×10^{-4}	3.8	3.8	1.7	1	50	1.15
Bi	3.6/100	146×10^{-4}	4.1/100	0.356	1.3/100	0.175	10	300	1.15

	$\Delta T\,(v_{cr})$	v_{cr}	$\frac{v\rho}{\mu}$	$\left(\frac{v\rho}{\mu}\right)^{0.8}$	h	$\overline{\Delta T}$	$\overline{\Delta T}\,h^{cal}$	kW/m²
Air	300	$7.67\,10^{3}$	$1.7\,10^{4}$	2,430	0.5×10^{-2}	250	1.2	51
He(1)	300	1.77×10^{4}	$4.55\,10^{3}$	844	$1.2\,10^{-2}$	250	3	126
He(10)	300	1.77×10^{4}	$4.55\,10^{4}$	5,325	$7.5\,10^{-2}$	250	18.7	785
H_2O	50	6.5×10^{3}	$1.2\,10^{6}$	73,000	4.65	25	116	4,870
Bi	300	3×10^{3}	$2.5\,10^{6}$	112,000	20.8	150	3120	131,000

~~multiply these with f~~

for v =	1/30	1/20	1/10	1/5	1/4	1/3	1/2 × V critical
f	1/15	1/12	1/6.3	1/3.6	1/3	1/2.4	1/1.74

$\overline{V_{cr}}$ gives 1/100 of transported heat = kinetic energy

1/2 cm diameter tube for data

on other side

GR5-1171
TR7-5895

Water

0.0013

Ether 0.0003

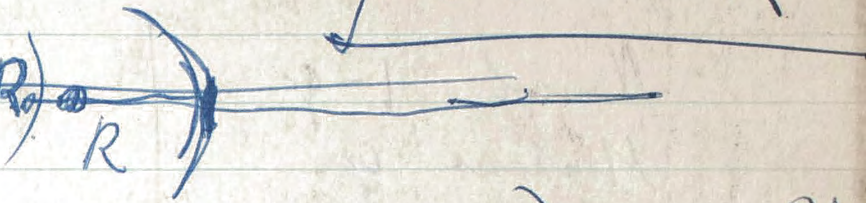
Biology

Nov 13 - 66

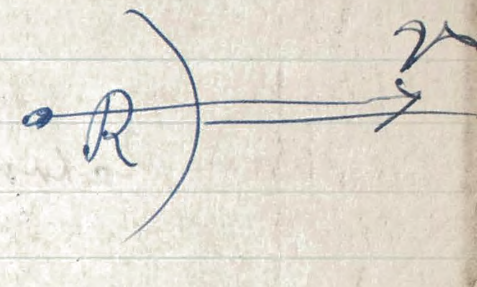
Diffusion

$\rho = 0 \quad r = R$

~~$r\rho = \rho_\infty (r - R)$~~



for



$r\rho = \rho_\infty (r - R)$

$\rho = \rho_\infty \left(1 - \frac{R}{r}\right)$

$\rho = \rho_\infty \left(1 - \frac{R}{r}\right)$

$\rho' = \rho_\infty \frac{R}{r^2}$

$r^2 \rho' = \rho_\infty R$

$D\, 4\pi r^2 \rho' = D\, 4\pi \rho_\infty R$ = Cons

What diffuses in is prop. to R

time for doubling mass.

$\frac{A R^2 t}{} = \frac{4\pi}{3} R^3$ would go with R^2

of for $R = \frac{10}{1000}$ m/m = 24 hours

of mass 1000 times less

R = 10 times less

$R^2 = 1/100$ time $\frac{24 \cdot 60}{100}$ min

15 min

Selection of mutants

		after irr
Normal	$1-q$	$e^{-Nt}(1-q)$
Mutant	q	$q\,e^{-MT}$

Ratio after irr. $\frac{M(t)}{N(t)} = \frac{q\,e^{-Mt}}{(1-q)\,e^{-Nt}}$

$$q\,e^{(N-M)t} = ~~q\ N\ M~~$$

$$= q\left(1 + (N-M)t + \frac{[(N-M)t]^2}{2!}\right.$$

H

Bench Nov 25th -46

Diffusion in $4\pi R^2 \rho' = 4\pi \rho_\infty R D$

assuming ~~[illegible]~~ that Nitrogen $= \frac{1}{f}$ of wet weight of algae; if $N = \frac{1}{5}$ of dry weight and dry weight $\frac{1}{5}$ of wet weight N about $\frac{1}{30}$ ~~[illegible]~~ $f = 30$

time for doubling from

$$4\pi \rho_\infty R D t \approx \frac{1}{f} 4\pi r^2 \frac{r}{3}$$

$$~~[illegible]~~ \quad t \sim \frac{R^2}{D} \frac{1}{3f} \frac{1}{\rho_\infty}$$

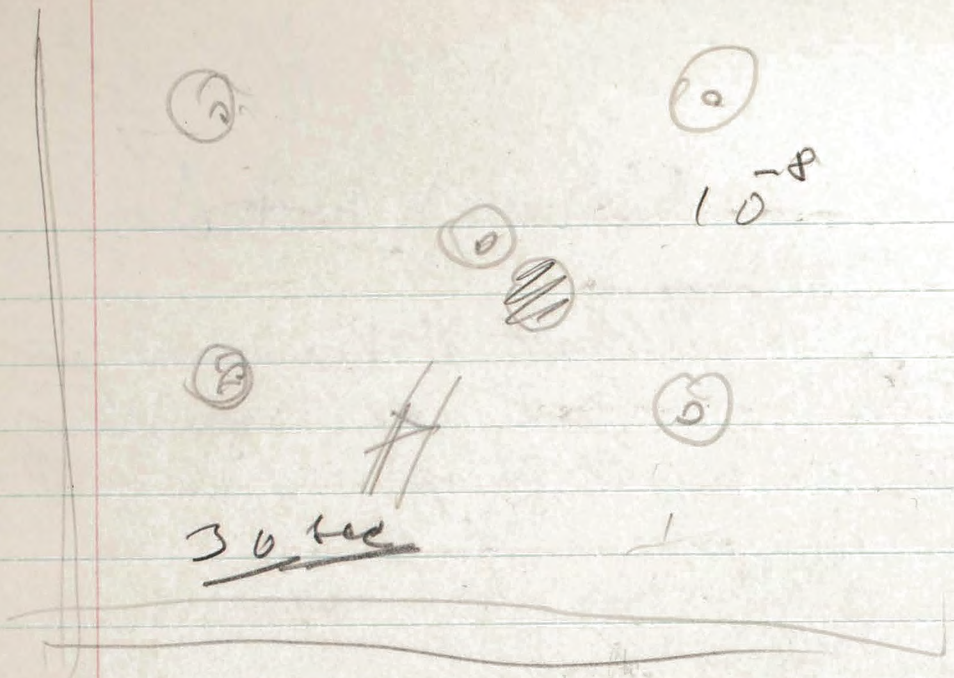
$$t^{\text{day}} \approx R^2 \frac{1}{3f} \frac{1}{\rho_\infty}$$

for $D = 1$

$\rho_\infty = \frac{30}{1000}$ gm/cm³ $= 3 \times 10^{-2}\ 10^{-6}$

for $R = \frac{10}{1000}$ mm $= 10^{-3}$ cm

$$t \approx \frac{10^{-6}}{3f} \frac{1}{3} 10^{8} = \frac{1}{3} \text{ day}$$



$\frac{3}{100}$

10 cm

0.34 cm/sec

2×10^{5} cm/sec

$2\sqrt{3}\, 10^{-1}$ cm/sec

$\boxed{\frac{v^2}{2}\,\frac{4}{3}\pi R^3} = \mu R \frac{\tau}{\cancel{x}}$ $\frac{\text{gm}}{\text{sec}}\ \frac{\text{gm}}{\text{cm}^2}$

μv

$\longrightarrow$

dynes/sec

12

$3\ 10$

$\sqrt{3}\ 10^{-6}$

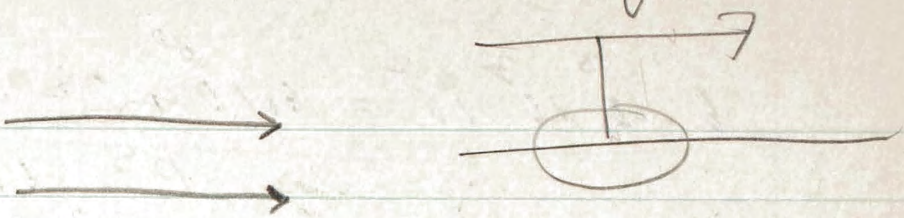
$\frac{1}{n\sigma} = \lambda$

$\frac{v}{\lambda} = \frac{1}{\tau}$

$\boxed{\tau = \frac{\lambda}{v}}$

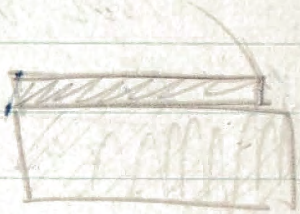
10^{-12} gm ‖ $6 \cdot 10^{23}$ | $\frac{1}{3} 10^{-23}$

3×10^{-24}



μ [illegible] $= m\,cm\,sec^{-2}\,sec$

gm cm sec^{-1}



$\frac{\cancel{5}4\pi R^3}{3}\,v = \mu R$ [illegible]

$\cancel{\theta} =$

$m\,cm\,sec^{-1}$ $m\,\cancel{cm}^{-1}\,sec^{-1}\,cm$ gm

10^7 / 30 sec

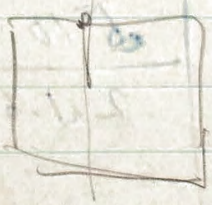
$\mu\,\frac{v}{cm} = \text{force}/cm^2 = m\,\frac{cm\,sec^{-2}}{cm^2} = m\,cm^{-1}\,sec^{-2}$

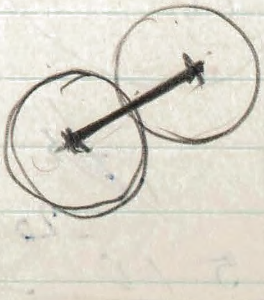
$\mu\,sec^{-1} = m\,cm^{-1}\,sec^{-2}$ [illegible]

$$\boxed{\mu = m\,cm^{-1}\,sec^{-1}}$$

10^{-12} gm 0.3 $= \frac{1}{100}\,10^{-4}\,\lambda$

10^{-6} cm





$\frac{100}{10^4}$

$6 . 10^3 10^3 10^2 = 6\times10^8$ cm $= R$

$R^3 \quad 6\times36, 10^{24}$

$R^3 = 2\times10^{26}$

4.10^{27} gm = mass

$M v R$

~~1~~. $\frac{40,000 \text{ meter}}{24\times60\times60}$ $\frac{4000\times100}{24\times36} = \frac{100\times100 \text{ cm}}{9\times24}$

$=$ ~~10,000~~

$\frac{40,000 \text{ ~~km~~ } 1000\times \cancel{1000}}{24\times\cancel{60}\times\cancel{60}\times36} = \frac{10,000, 10^3}{24\times9}$

50,000 cm

$M v R = 4.10^{27}\times5\,10^4\times\;6\times10^8 =$

~~4 × 5 × 6~~

~~10~~

$\underline{10^{41}}$

41
26
15

$\frac{e}{2mc}$

$\boxed{10^{-15}}$

4.10^{-10}

$\frac{e}{2mc}$ | $\frac{5\,10^{-10}}{2\times1.6\,10^{-24}\,3\,10^{10}}$

$\frac{5\,10^{-20}}{2\times1.6\times3\times10^{24}} = \frac{1}{2}10^4$

$$H \frac{eh}{2me} = \frac{5\,10^{-10}\ 10^{-27}}{3\ 2 \times 1.6 \times 10^{-24}\ 10^{10}} =$$

10^{-14} ergs

$$\frac{5\ 10^{-37}}{3 \times 2 \times 1.6 \times 10^{-14}}$$

$$\frac{5}{6}\,\frac{1}{1.6}\,10^{-23} = \frac{1}{2}\,10^{-23}$$

$$\begin{array}{r} 37 \\ 14 \\ \hline 23 \end{array}$$

10^{-31} ergs

MvR , $E = \frac{Mv^2}{2}$

$$\frac{dE}{dv} = Mv\,dv = \frac{v\,dp}{M}$$

$p = Mv$

$dp = \underline{M\,mvR}$

$dE = \underline{v\,dp}$

$$dE = \frac{5.10^4}{R}\,dp$$

$$\frac{5.10^4}{6.10^8}$$

-17

$10^{2.3}$ "

~~$5.10^{3}\ 10^{3}$~~

$6\,10^8$

10^{-27}

10^{-31} erg

$(31-14)$

-17

Magnetic

Momentum of all protons ordered

$$5 \frac{4\pi}{3}(6\,10^{8})^3 \frac{1}{1.6\,10^{-24}} \frac{1}{2} 10^{-23}$$

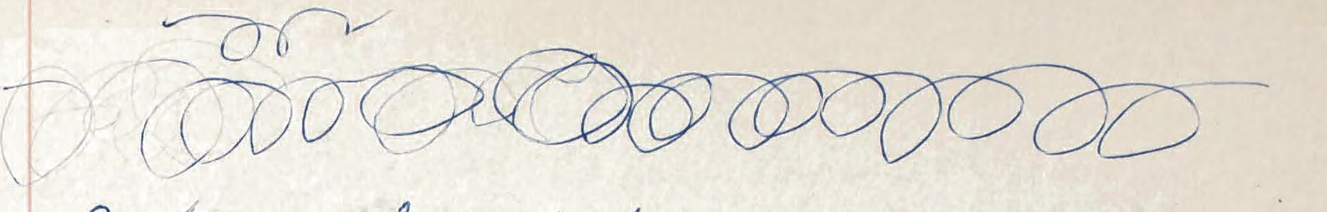
$$15 \times 4 \times \underbrace{(6 \times 36 \times 10^{24})}_{R^3} =$$

Mass 4×10^{27}

$$\frac{e}{m} = \frac{5\,10^{-10}\;2000}{1.6\,10^{-24}\;3\,10^{10}}$$

$$= \frac{10}{5}\;\cancel{10}\;10^{7}$$

Ratio for proton 10^4

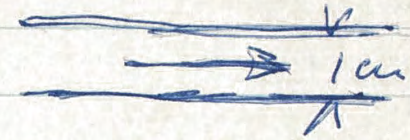


Critical lenght for $r = 1cm$ 75 cm

$r = 2 \frac{\pi r^2}{2\pi r} = \frac{2R}{F}$

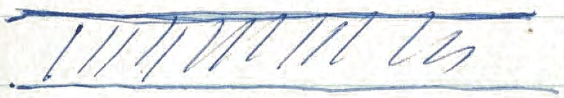
for slit of 1cm diameter

$[r] = \frac{2}{2} = 1$



Energy is lost in time $\tau = \frac{75}{v}$ sec

for $v =$ 1.5 cm/sec $\frac{1}{2}$ sec



if wall moves 1.5 m/sec and changes by 10% energy of relative motion of $\Delta v = 1.5$ meter would be lost in ~~[illegible]~~

$\frac{1}{2}(1+1/10)^2$; $\frac{1}{2}(1/10)^2$ longer time

$1+\frac{2}{10}+\frac{1}{100}$; $\frac{1}{100}$ longer by factor of 21

or say 20 or 10 second

ground mfg ~~[illegible]~~ 1/3 cm wall

Energy input every 10 secs

2/10 of kinetic energy in liquid (at lower rot. rate)

+ $\frac{6}{10}$ kinetic energy (in wall)

or every 10 sec $\frac{8}{10}$ of kin energy in liquid

or 8/100 of kin energy in liquid goes in per second of which 6/8 is recoverable

Amount processed 5 cm long sections
in 30 sec. 1 cm sheet 500 cc and
in ten layers 5 liters per 1/2 minute

Assuming drum 30 cm diameter, layer 10 cm liquid

1 meter long drum = 100 kg weight

$\frac{1}{2}\, 10^5$ gm $(1500)^2$ erg $= \frac{225}{2}\, 10^9 \approx 100\ 10^9 = 10^{11}$ erg

$\sim 10^{10}$ erg/sec = 1000 Joule **1 KWatt**

Heat cond of water $\frac{0.0013}{0.0003}$
ether

Water for $v = \frac{65}{30}$ m/sec ≈ 2 m/sec

for 25 degree diff. $\frac{116}{15}$ cal/cm² sec

or for 1 degree diff. $\frac{1}{[illegible]}\ \frac{4.65}{15}$ cal $\sim \frac{1}{3}$ cal

check: $\frac{4800 \text{ kW/m}^2}{25} = \frac{250}{25}\ \frac{4800}{10^4} = 4.8$ cal/cm² degree

say 20 sections in a meter length

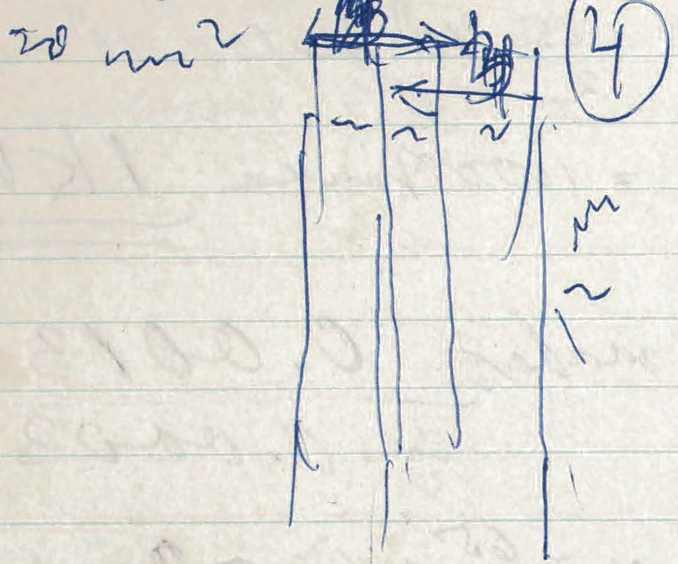
5 cm

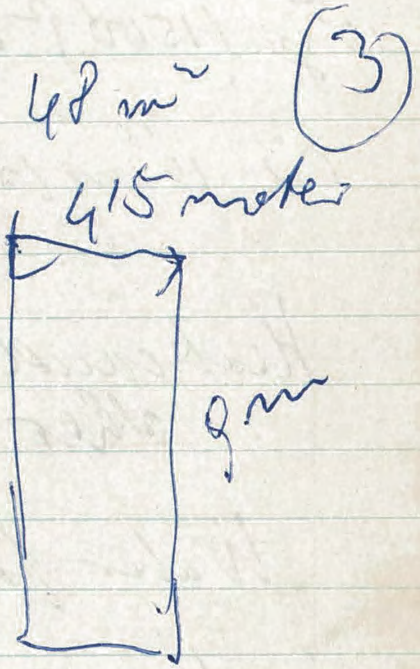
$k = 14 \times 10^{-4}$ for heat

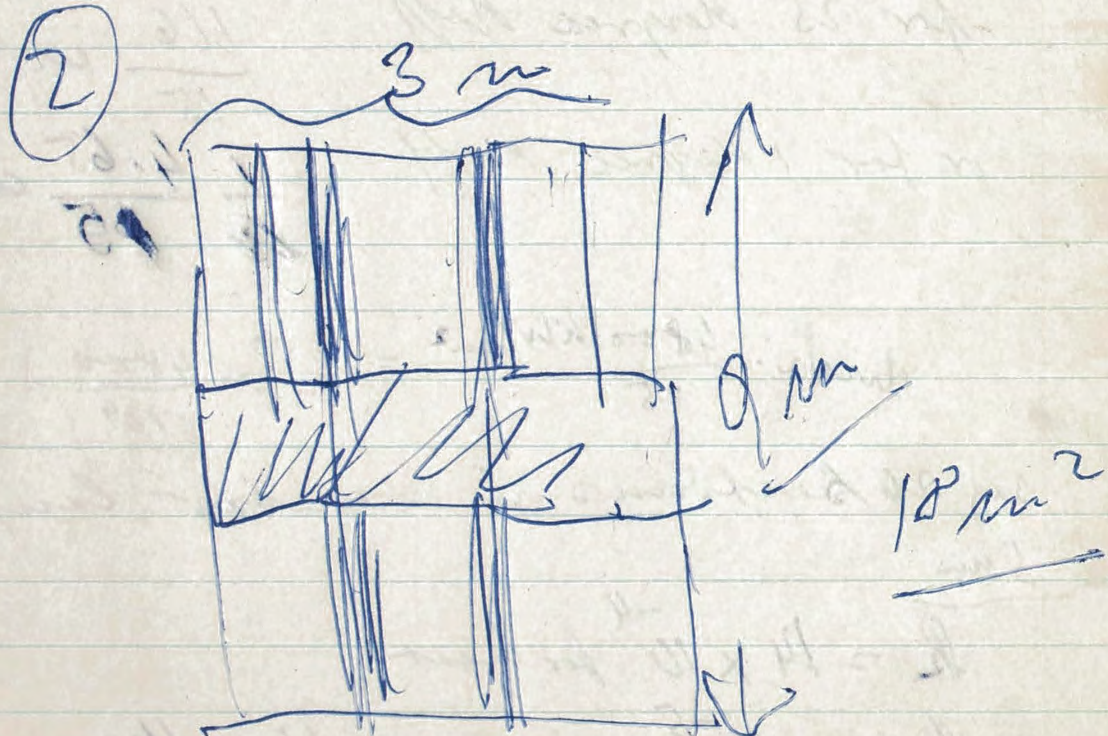
$d = 10^{-5}$ ratio 140 say

$\sqrt[2]{140} = 12\ 12$

say it takes 30 sec — for leveling up the difference for 2.0 m velocity Cross section

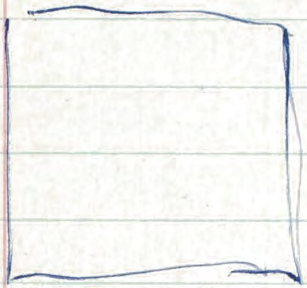






April 6th/43 80 m² for 13 000 kg

H



1 m²

10 meter/sec

$v = 10^3$

$10^4 \times 10^3$ cc

10^4 liter

$10^4 \cdot 1.3$ gm

~~Ppt~~ momentum/sec.

10^7 1.3 gmcm/sec

$m = v\,Q\ 1.3$

$mv = v^2\,Q\,.1.3$ will support 13 kg

~~work in kgmeter~~

$\frac{v^2}{2} v\,Q\ 1.3 = \frac{10^6\ 10^4\ 1.3}{2} =$

$= 10^{13} \times 0.6$ erg/sec or ~~joule~~

$10^6 \times 0.6$ joule

~~1000 kWatt~~

500 kWatt

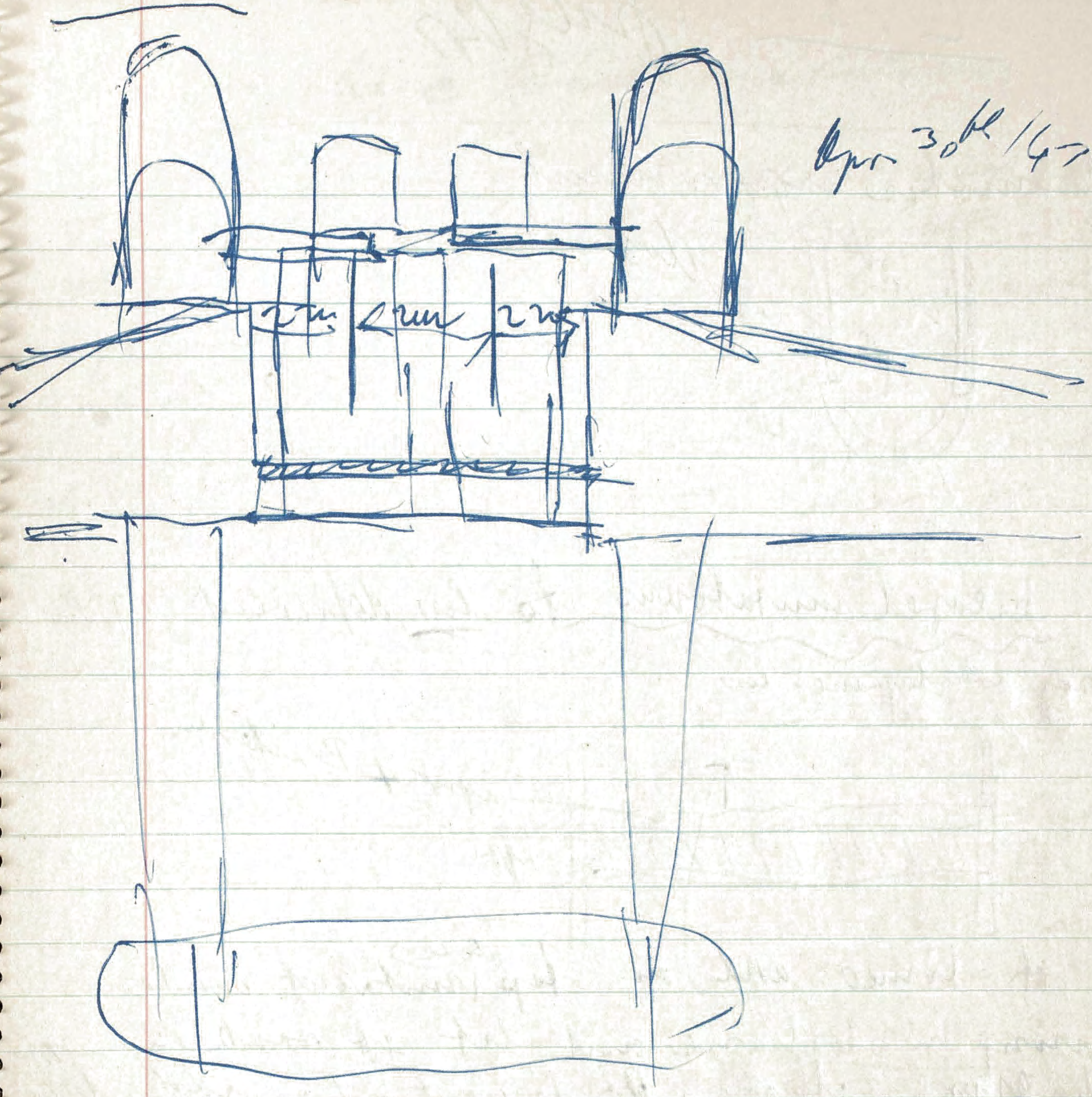
Weight 13 kg = 13 000 gm $\frac{10^6}{2}$ = ~~6 10~~

$6\ 10^9$

0.6×10^{10}

600 Watt 600 Joule

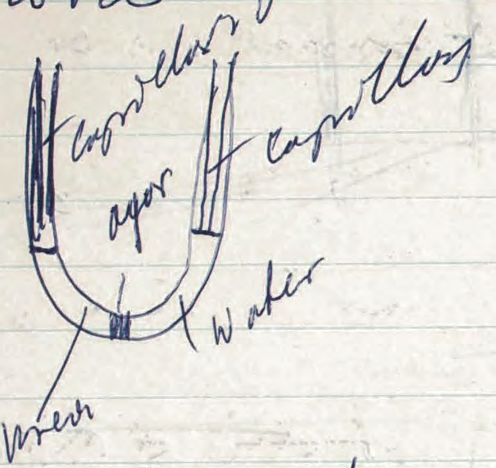
0.6 KW ≈ 1 HP



Apr 30th /47

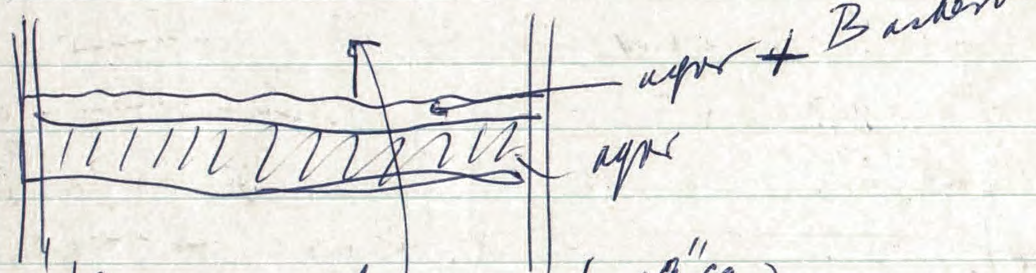
① L.S. July/48

Osmotic experiment



Delayed mutations to less deficient type

say tryptophane-less



At time 0 add on top "a cc" mutadent containing tryptophane and let it soak in by ~~agar~~ (osmotic) methode. At time t = t0 add "b cc" minimal medium and let ~~the~~ it soak in by osmatic method. — ~~[illegible]~~ allow new colonies to grow in minimal medium and see how many appear.

② Are there back mutations?

Take K12 strain showing segregation
Take wild type ~~[illegible]~~ W1,
~~[illegible]~~ allow it to mutate for growth
deficiency B, allow this to ~~[illegible]~~
revert back(?) to a B independent strain W2
Now allow W1 to mutant into a growth
~~[illegible]~~ ~~[illegible]~~ deficiency A, allow W2
to ~~[illegible]~~ mutate into growth of deficiency
C.
Now take strains W/1 ~~[illegible]~~ A and W/2 C
and make them on plate containing
minimal medium + B, there
might appear ~~[illegible]~~ colonies. Are
these colonies deficient in B?
If so we did not have a true back
mutation. — B^+ ...... A^-C^+ }
~~[illegible]~~, B^- ... L^* ~~[illegible]~~ A^+C^- }

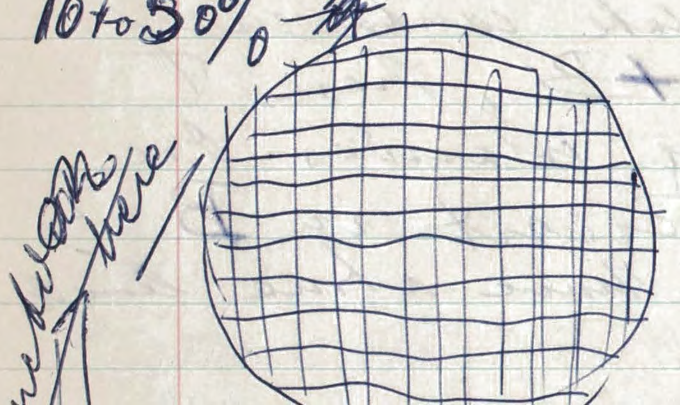
Among colonies which appear some
will be only mutations of W/1 A
or W/2 C which became independent
of A or C respectively. — Double
markers i.e. strains W/1 A A' and
W/2 C C' would get rid of this diffi-
culty but would also reduce chances
of finding B dependent strain unless

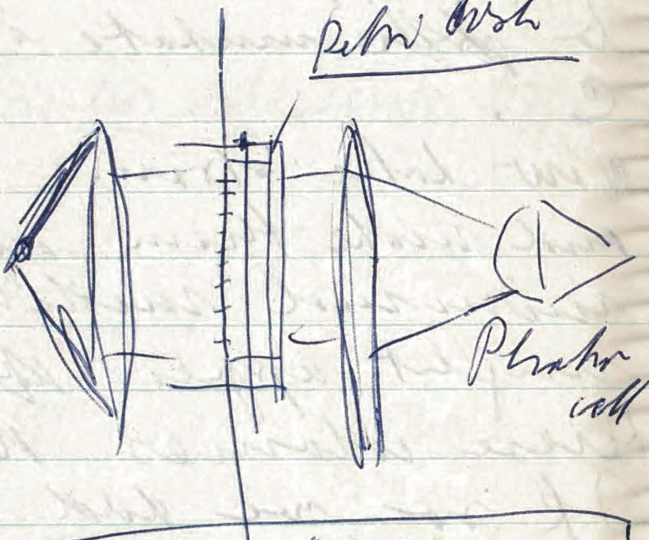
chromosome map is known and markers are accordingly picked. —

Viable count

holes ~~in~~ pins in plate,
in a lattice 3 mm apart, fussy!

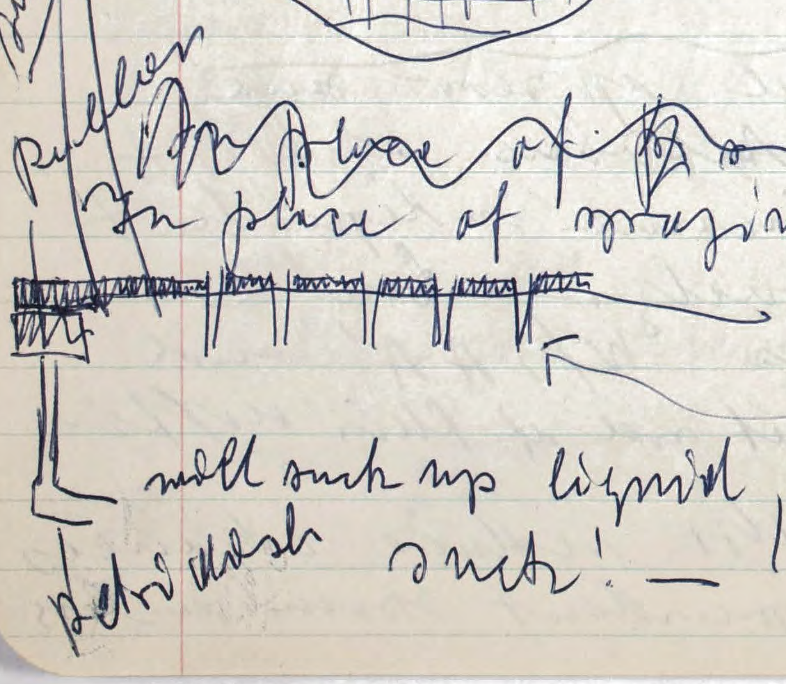
~~[illegible]~~
in 100 cm²
1000 holes
10 to 50% ~~4~~





3 plates. 1 copper
2.) empty
3. 100% background

~~In place of [illegible]~~
In place of spraying: dip into bacterial culture capillary action



will suck up liquid, place on petri dish, quick! —

Make radiation resistant strain of K12 !

To Monod

If we give (continuous addition) just so much glucose that in an ~~[illegible]~~ "adapted" situation $1/2$ of glucose and $1/2$ of galactose are consumed does that mean perchance that $1/2$ of the bacteria use full amount of glucose and the other half full amount of galactose ?

Can we allow bacteria to metabolise preventing division and avoiding death? — do mutations accumulate in such a situation? (ask Witkin) what about B/r in this connection?

Select mutations deficient for a growth factor by growing in presence of excess of that growth factor under starvation conditions. — (old idea)

To Cohen: Have the storage form of very little ~~[illegible]~~ P present in nutrient?

To Monod second remark

This experiment becomes easy if constant amounts of glucose and say ~~[illegible]~~ lactose can be added per unit time. An apparatus (Bactogen) which maintains a culture under constant ~~[illegible]~~ condition in the logarithmic growth phase is therefore proposed ~~If generation time is 30 minute and only [illegible] 1/20 [illegible]~~

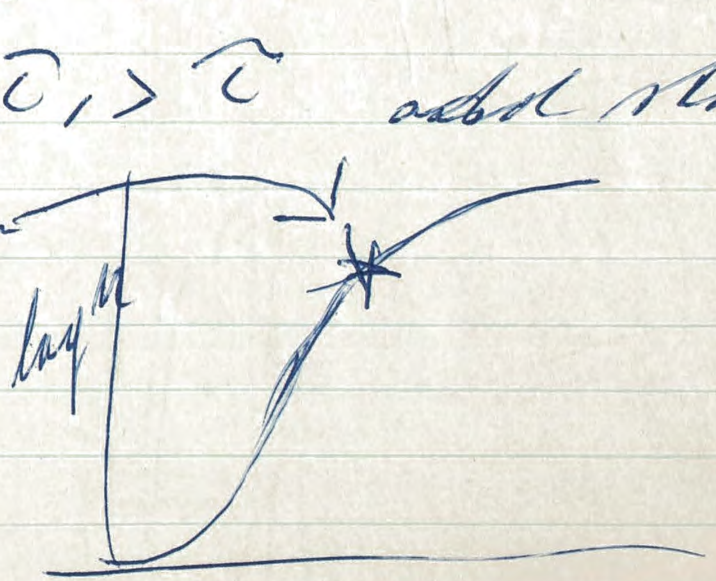
This can be done in either of two ways. Either nutrient is added at constant time intervals (interval slightly ~~[illegible]~~ longer than would correspond to the steepest portion of logarithmic growth curve. Or nutrient is added whenever turbidity exceed a certain value.

In former case: τ is measured time in which concentration rises $\left(n = e^{\frac{t}{\tau}}\right)$ from 1 to e

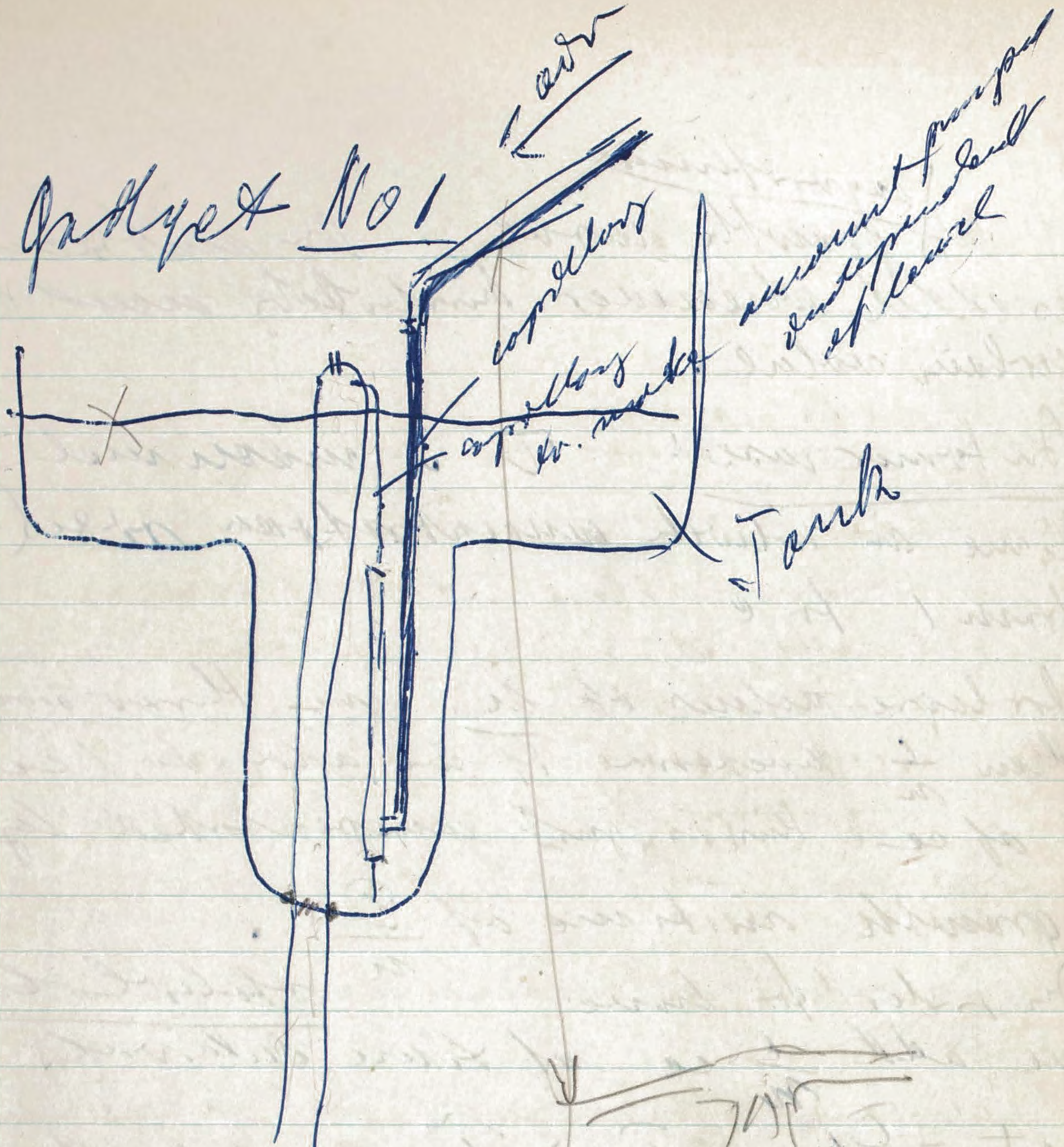
for large values of n we throw away then $\frac{1}{n}$ bacteria If we add to 1 cc $\frac{1}{n}$ of cc this is just compensated by growth in time of $\frac{\tau}{n}$.

In order to have stability we add $\frac{1}{n}$ cc at time intervals

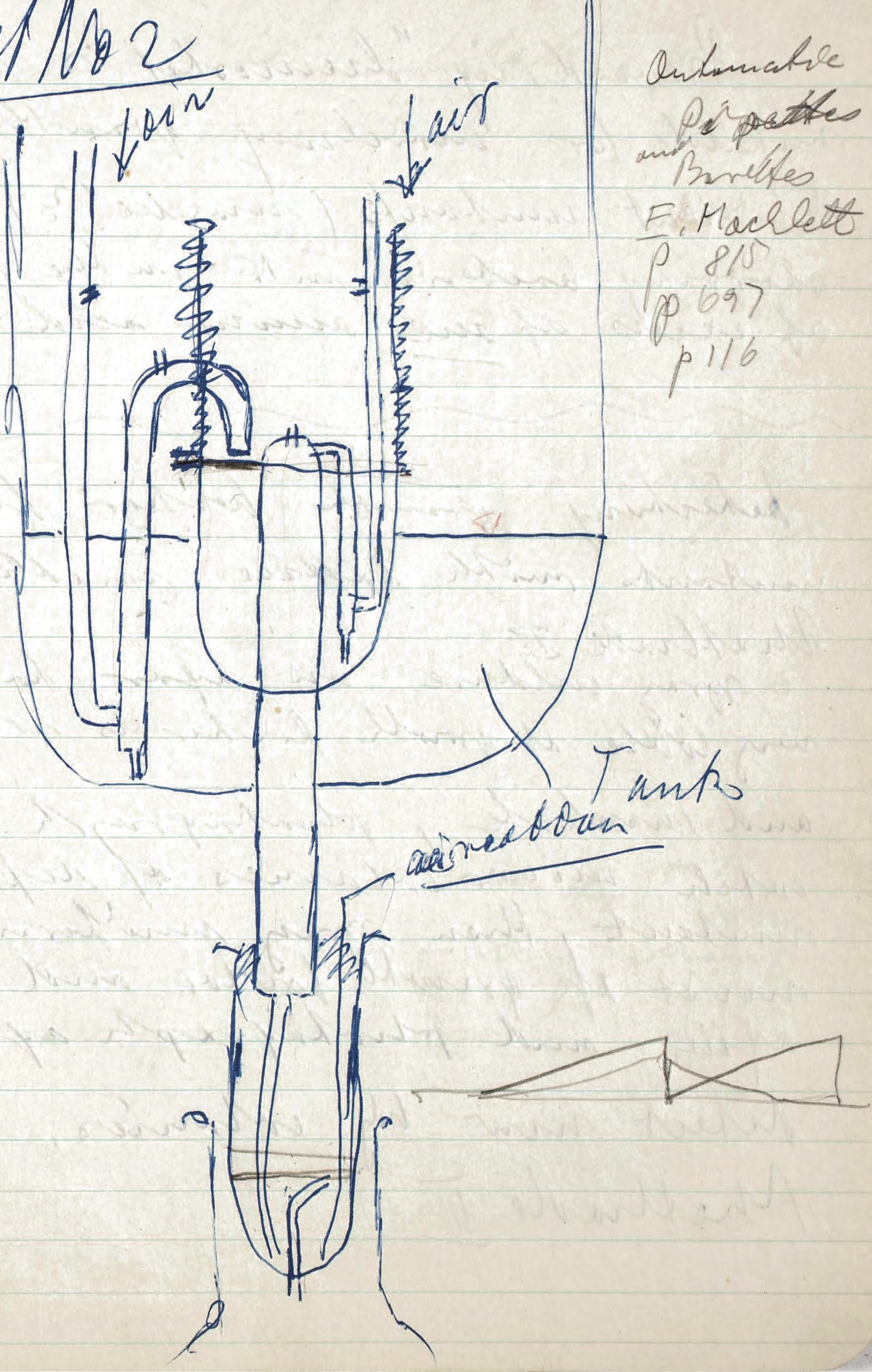
$\Delta t = \frac{\tau_1}{n}$ $\tau_1 > \tau$ add solution concentration



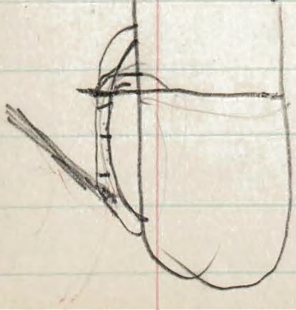
Gadget No 1


air
capillary
capillary to mark
amount pumped independent of level
Tank

Gadget No 2



Automatic
~~Pipettes~~
and Burettes
F. Machlett
p 815
pp 697
p 116



Preceding "chemostat" is very suitable for enriching growthfactor dependent mutants (may be!?) by starving bacteria in N in the presence of excess of one amino acid.

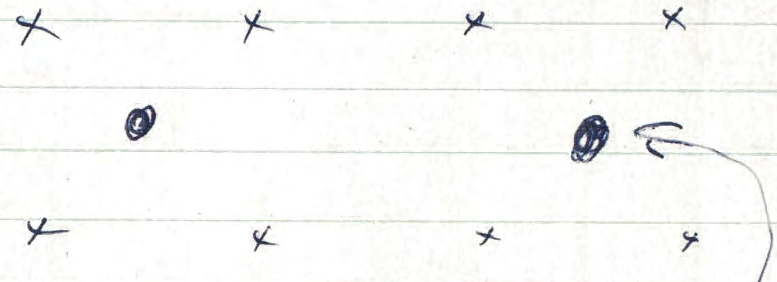
Detecting growth factor dependent mutants with lattice methode

Methode I

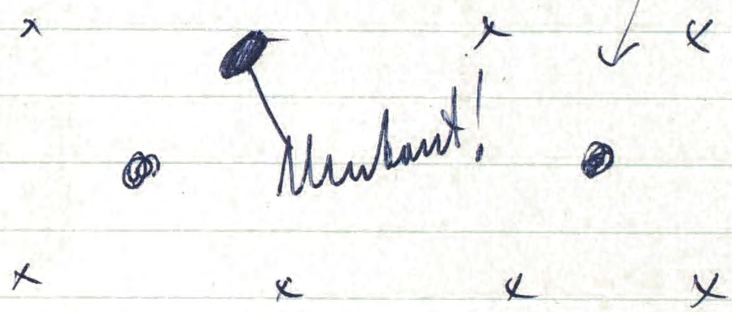
Spray culture on agar to which very little of growth factor is added and incubate, photograph to catch micro colonies of dependent mutant, then spray uniformly mist of growth factor and incubate again and photograph again to detect new big colonies.

Methode II

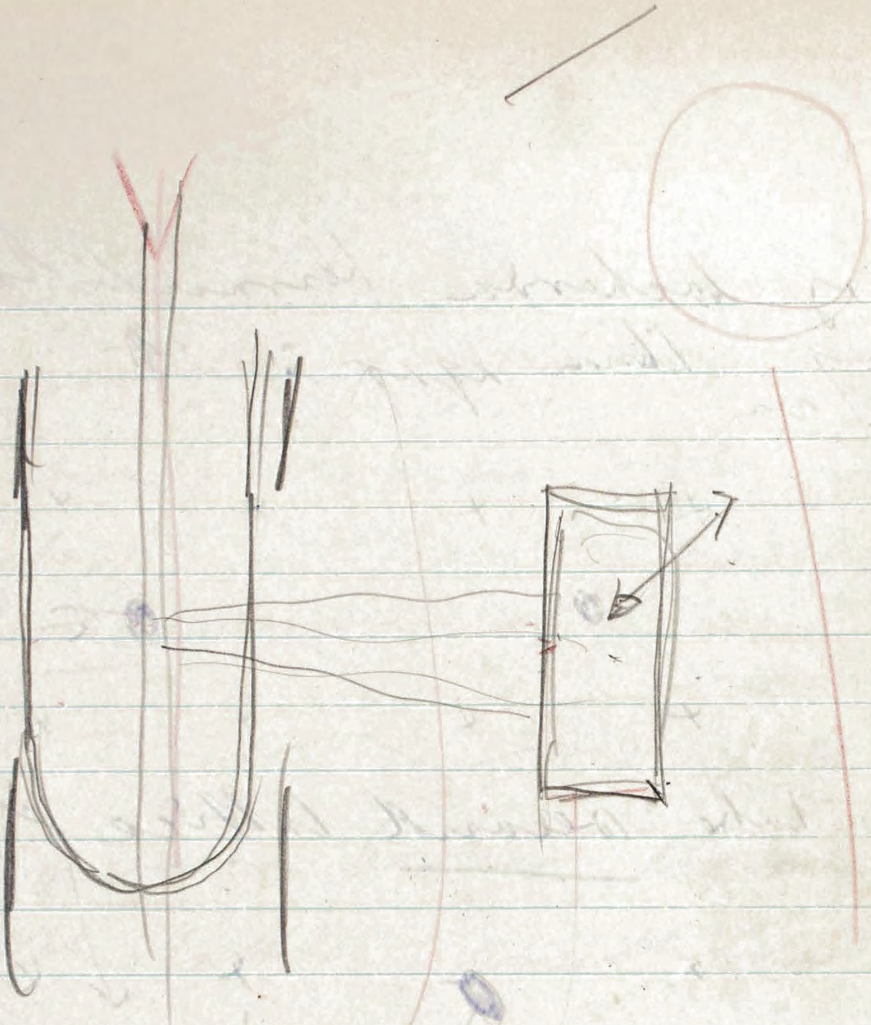
Spray bacteria through lattice on 1/2 mm/mm thin agar : A



Now take second lattice for growth factor



Original lattice could be 1/2 mm/mm holes 1,3 mm/mm apart giving about 1000 colonies per 100 cm²



6 cf. incub
6 cf ice box
1 centrifuge
6 Timer ~~and tubes~~ signals
Petri dishes
Test tubes
sprayers
box for sprayers

Total host vol ~~[illegible]~~ 10^{-12} cc of 10^{8}/cc 10^{-4} cc
10^{-5} gm 10^{-6} gm/$\frac{N}{cc}$ ~

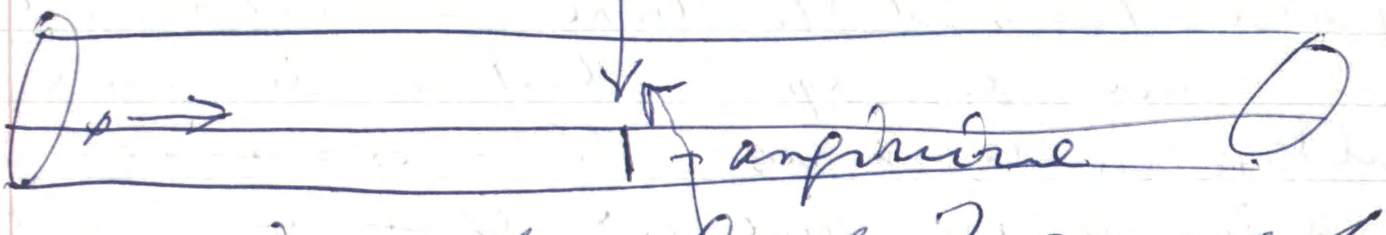
Monod chemostat experiment

analyse for glucose by using strain which can not adapt to the other sugar and measure turbidity of fully grown (glucose limited) culture. — Question is it true (as I expect) that if we have culture in chemostat which ~~adapts~~ uses glucose in amount of $\frac{1}{n}$ of total sugar consumption that $1-\frac{1}{n}$ is adapted and ~~on transfer to glucose free medium would be~~ if phaged ~~which~~ on plating on glucose free agar would form plaques while $\frac{1}{n}$ would form no plaques. —

Experiments of this sort should be extended to various nitrogen sources. —

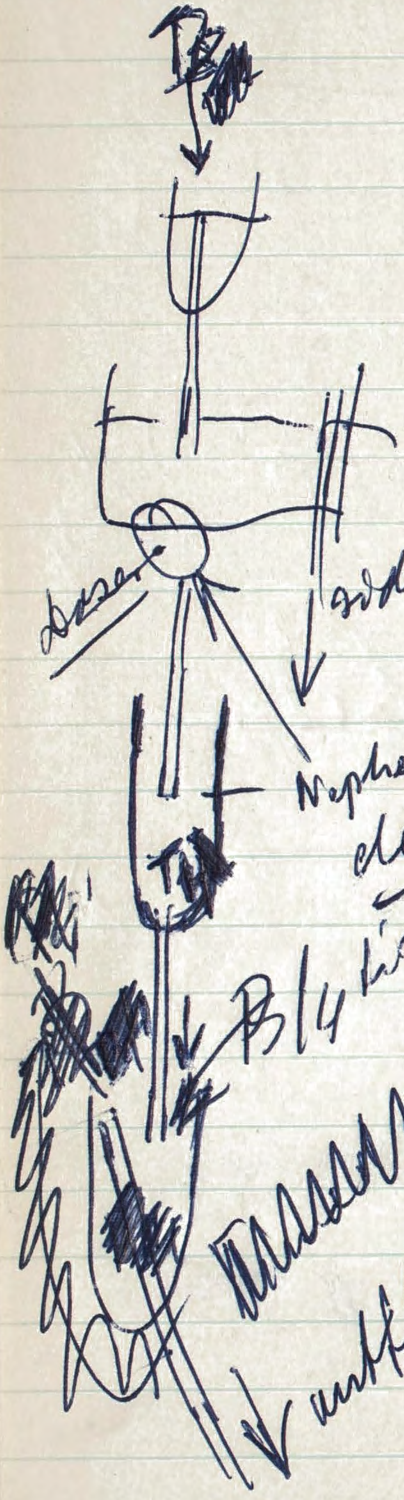
Novick suggest using specific absorption in 3600 line to assay phage culture containing debris of bacteria! —

~~Do~~ Do mutants in general lack corresponding enzyme? For instance Proteus from which urease can be extracted if it mutates so that it no longer can live on urea but must be fed ammonium salt does it show less extractable urease?

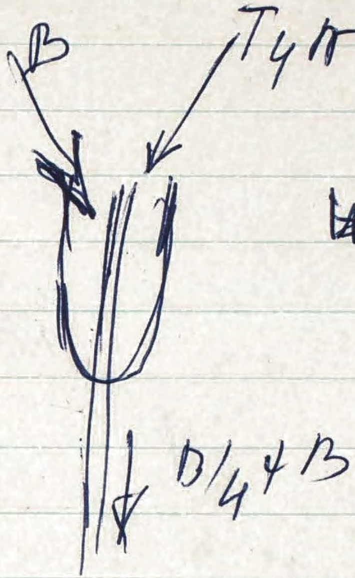


To experiment worked I suggested to Beadle. Does heterocaryon coming from left stop here

Selection of various mutants in the chemostat.—



Selection of resistent B



Timing:

[illegible] = [illegible], doubling rate of B/4 = 30 min we admit about 1/2 cc B at 10^8 ~~[illegible]~~ per 30 min [illegible] or 50x in a day a "normal" chance for the begin of B/4 growth of one in 10^8 B ~~is~~ B/4 ~~[illegible]~~

All this if Vol = 1 cc

Chemical Kinetics of the bacterial cell
Hinshelwood
Oxford Univ Press

Prof L. H. c/o Mrs Crane
Brit Commonwealth Sc. Off.
Room 2002
43 Exch. Pl.
N.Y.C.

Sargent
Central Scientific Co
1700 W Irving Pk

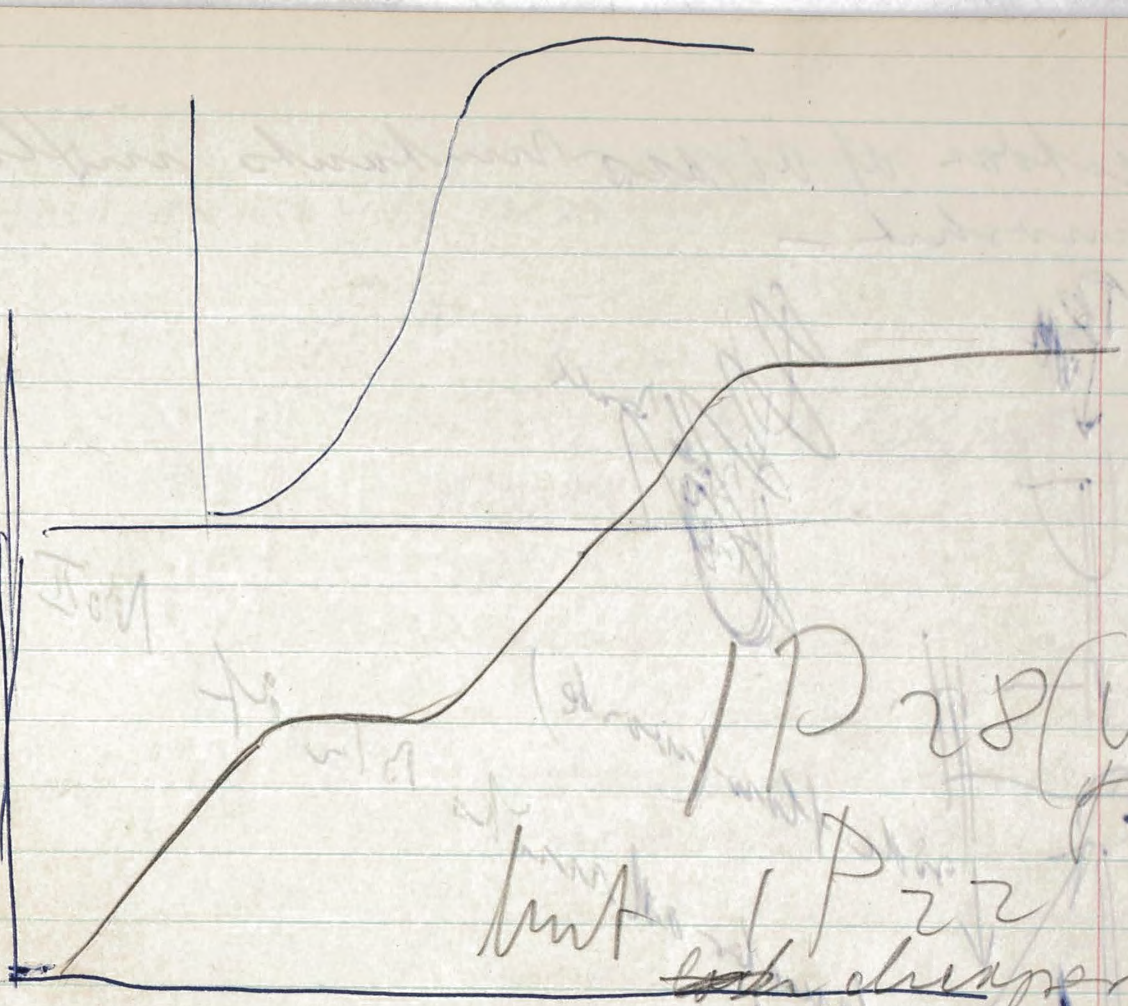
not carried here

needed for present since
4 on order

[illegible]

Wilson Stone Proc. Nat. Ac.
March .47

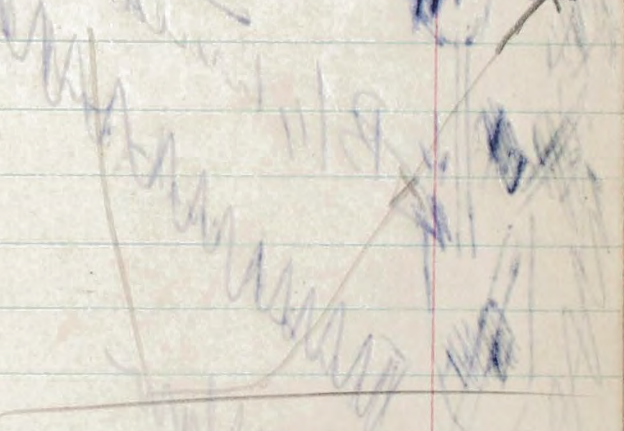
Eimer & Amend
Fisher Scientific Co
711-723 Forbes St. Pittsburgh
633-635 Greenwich St. N.Y.

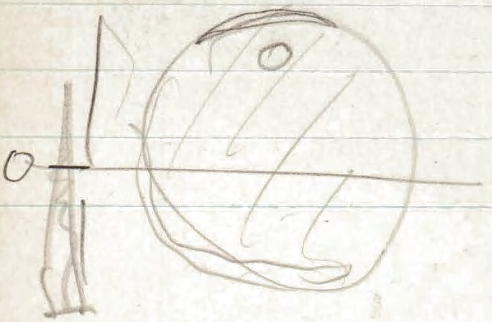


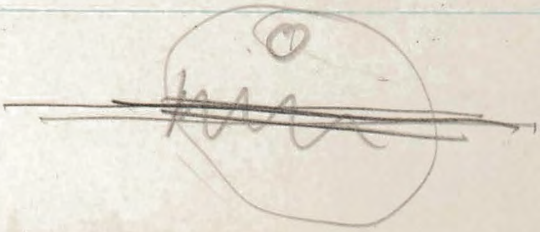
IP 28 (UV / flex)

but IP 22 ~~[illegible]~~ cheaper

2N







atomic energy is a too serious ~~subject~~ issue to be seriously discussed all the time. May I therefore respectfully suggest that you appoint Senator Taft as Chairman of the Atomic Energy Commission. The Senate should refuse to confirm Mr. Lilienthal. — While Taft may not be temperamentally fit to be President no one doubts that his ~~[illegible]~~ greater intelligence and competence ~~[illegible]~~ — If subsequent to his appointment he were to devote his undivided attention to the problems ~~now~~ facing the Atomic Energy Commission we could hope that by the spring of 1948 this commission could begin to operate in a satisfactory manner. — In the meantime the scientists now ~~employed~~ working for the commission could be ~~retained~~ kept at their work by a suitable law speedily enacted by congress. ~~That a law might be~~ Even though such a law might be slightly unconstitutional and even though it might not be certain that ~~[illegible]~~ it would inspire the scientists to solve the difficult scientific and technical problems ~~[illegible]~~ involved in their work at least it would ~~keep the scientists~~ prevent the scientists now working for the commission from obtaining employment elsewhere. ([illegible]