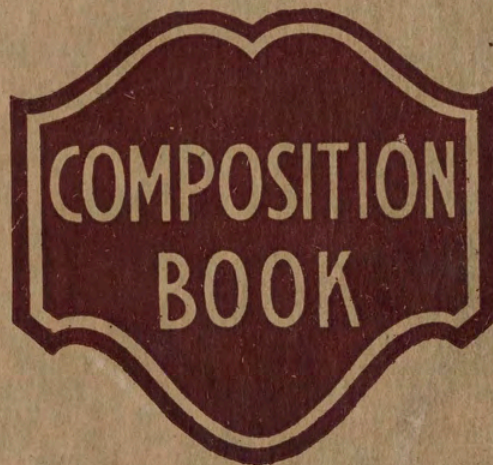


Numerical calculations

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The

SPIRAL



QUADRILLE RULED

No. 882-Q



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1516932-1942026-1985776—Other Patents Pending.

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11/12/40

Outside

$$\left| \begin{array}{l} e^{-.264z} \\ A e^{-.1068z} - 2.503 e^{-.264z} \end{array} \right|$$

Inside

$$\left| \begin{array}{l} B \sinh .3707z + C \sin .335z \\ -1.302 B \sinh .3707z + .5444 C \sin .335z \end{array} \right|$$

connect at R (continuous function & first derivative)

R	$e^{-.264R}$	$\sinh .3707R$	$\cosh \dots$	$\sin .335R$	$\cos$
5	.2674	3.113	3.269	.9946	-.1039
6	.2054	4.569	4.677	.9051	-.4252
7	.1578	6.660	6.735	.7151	-.6990
8	.1212	9.678	9.729	.4454	-.8953

R	$e^{-.1068R}$
5	.5863
6	.5270
7	.4736
8	.4257

204060

2

~~8~~ $R=5$

$$3.113 B + .9946 C = .2674$$

$$1.212 B - .0348 C = -.0706$$

$$3.130 B + C = .2689$$

$$34.828 B - C = -2.0287$$

$$37.958 B = -1.7598$$

$$B = -.0464$$

$$C = .4140$$

$$A = \cancel{5.2857} 1.8448$$

$$E = \cancel{3787} 1657 .0042$$

 $R=6$

$$4.569 B + .9051 C = .2054$$

$$1.734 B - .1424 C = -.0542$$

$$B = -.00892$$

$$C = .2719$$

$$A = 1.3304$$

$$E = -.0618$$

 $R=5.1$

$$\cancel{6.660 B + .7151 C = .1578}$$

$$\cancel{2.497 B - .2342 C = -.0417}$$

$$e^{-.264 \times 5.1} = .2604$$

$$e^{-.1068 \times 5.1} = .5764$$

$$\left. \begin{array}{l} \sin \\ \cos \end{array} \right\} = \begin{cases} .9905 \\ -.1372 \end{cases}$$

$$\left. \begin{array}{l} \sinh \\ \cosh \end{array} \right\} = \begin{cases} 3.2362 \\ 3.3872 \end{cases}$$

$$\left. \begin{array}{l} B \\ C \\ A \\ E \end{array} \right\}$$

$$B \sinh .3707 R + C \sin .335 R = e^{-.264 R}$$

$$.3707 B \cosh .3707 R + .335 C \cos .335 R = -.264 e^{-.264 R}$$

(B, C)

(A)

$$A e^{-.1068 R} = 2.503 e^{-.264 R} - 1.302 B \sinh .3707 R + 1.5444 C \sin .335 R$$

$$+ .1068 A e^{-.1068 R} = .6608 e^{-.264 R} + .4827 B \cosh .3707 R + .1824 C \cos .335 R$$

(R=8)

$$9.678 B + .4454 C = 12.12$$

$$3.8065 B - .2999 C = -.0320$$

(R=5.1)

$$3.2362 B + .9905 C = .2604$$

$$1.2556 B - .0460 C = -.0687$$

$$B = -.0403$$

$$C = .3944$$

$$A = 1.7944$$

$$E = -.0056$$

$$R = 5.043$$

$$B = -.0438$$

$$C = .4056$$

$$A = 1.8231$$

4

Inside

$$\begin{vmatrix} .4056 \sin .335 r & -.0438 \sinh .3707 r \\ .2208 \sin .335 r & +.0570 \sinh .3707 r \end{vmatrix}$$

$$R = 5.04$$

Outside

$$\begin{vmatrix} e^{-.264 r} \\ -2.503 e^{-.264 r} + 1.8231 e^{-.1068 R} \end{vmatrix}$$

r	P_1	$P_1 r$	P_2	$P_2 r$
0	0	0	.0000	0
1	.1168	.117	.0942	.094
2	.2164	.433	.1833	.367
3	.2831	.849	.2636	.791
4	.3034	1.214	.3340	1.336
5	.2671	1.335	.3970	1.985
6	.2052	1.231	.4470	2.682
7	.1576	1.103	.4688	3.282
8	.1210	.969	.4730	3.784
9	.0929	.836	.4648	4.183
10	.714	714	.4480	4.480
11	.548	603	.4260	4.686
12	.421	505	.4008	4.810
13	.323	420	.3741	4.863
14	.248	347	.3467	4.854
15	.191	286	.3196	4.794
16	.146	234	.2937	4.699
17	.113	192	.2685	4.564
18	.86	155	.2453	4.415
19	.66	125	.2233	4.243
20	.51	102	.2027	4.054
21	.39	.082	.1839	3.862
22	.30	.66	.1665	3.663
23	.23	.53	.1506	3.464
24	.18	.43	.1361	3.266
25	.14	.35	.1228	3.070
26	.10	.26	.1110	2.886
27	.8	.22	.1000	2.700
28	.6	.17	.902	2.526
29	.5	.15	.811	2.352
30	.4	.12	.731	2.193

$$14 \int_0^{5.04} (p_1 + p_2) r dr = \text{loss} = .9674$$

$$\int_0^{5.04} p_1 r dr = 3.32$$

$$\int_0^{5.04} p_2 r dr = 3.59$$

$$\int_{5.04}^{\infty} (.003 p_1 + .010 p_2) r dr = \text{gain}$$

$$\int_{5.04}^{\infty} p_1 r dr = 8.84$$

$$\int_{5.04}^{\infty} p_2 r dr = 121.2$$

$$\text{loss} = \left[.0877 \int_0^{5.04} \sin .335 r \times r dr + .00185 \int_0^{5.04} \sinh .3707 r \times r dr \right]$$

$$\text{gain} = .0182 \int_{5.04}^{\infty} e^{-.1068 r} r dr - .0220 \int_{5.04}^{\infty} e^{-.264 r} r dr$$

$$\int_0^{5.04} \sin .335 r \times r dr = -\frac{5.04}{.335} \cos 1.688 + \frac{1}{.335^2} \sin 1.688 = \frac{10.56}{.335^2} = 7.04$$

$$\int_0^{5.04} \sinh .3707 r \times r dr = \frac{5.04}{.3707} \cosh 1.868 - \frac{1}{.3707^2} \sinh 1.868 = 22.07$$

$$\int_{5.04}^{\infty} e^{-.1068 r} r dr = \frac{5.04}{.1068} e^{-.5382} + \frac{1}{.1068^2} e^{-.5382} = 78.62$$

$$\int_{5.04}^{\infty} e^{-.264 r} r dr = \left(\frac{5.04}{.264} + \frac{1}{.264^2} \right) e^{-1.3306} = 8.835$$

$$\text{loss} = .967$$

$$\frac{\text{gain}}{\text{loss}} = 1.278$$

$$\text{gain} = 1.236$$

11/13/43

Metal lattice

 $k = 1.10$ reduced by coolant
to 1.04

Fast fissions

Slow fissions

 $= 10$ ~~$k = 1.85$~~ One fast neutron ~~is~~ ^{was} produced(1-a) ~~it~~ may be slowed down(a) ~~it~~ may produce fast fission
~~thereby generating altogether~~One thermal fission is immediately followed
by $= \frac{va}{1 - va}$ fast fissions $\frac{v(1-a)}{1 - va}$ neutrons beginning
slowing downof these $\frac{v(1-a)}{1 - va}$ neutrons

One neutron begins being slowed down

~~Q~~ L, leak out before resonance

(1-L)(1-p) are captured at resonance

(1-L)p become thermal

One neutron becomes thermal

L_2 leak out

$(1 - \frac{L_2}{2}) f \varphi$ produce thermal fissions

$(1 - \frac{L_2}{2}) f (1 - \varphi)$ are captured at resonance

$(1 - \frac{L_2}{2}) (1 - f)$ are captured by moderator and coolants

Critical condition

$$\eta = \nu \varphi$$

$$1 = \frac{\nu(1-a)}{1-\nu a} (1-L) p (1-l) f \varphi$$

$$K = \frac{\nu(1-a)}{1-\nu a} p f \varphi$$

$$(1-L_1)(1-L_2)f$$

$$1 - \text{loss} = 1 - L_1 - L_2 + L_1 L_2$$

$$\varphi = \frac{\text{Fast fissions}}{\text{Slow fissions}} = \frac{\nu a}{1 - \nu a}$$

$$\begin{aligned} \text{loss} &= L_1 + (1-L_1)L_2 + \\ &+ (1-L_1)(1-L_2)(1-f) \\ &= 1 - (1-L_1)(1-L_2)f \end{aligned}$$

~~Loss of~~

$$\frac{\text{Formation of "q"}}{\text{Loss of "q or s"}} = \frac{\frac{\nu(1-a)}{1-\nu a} (1-L)(1-p) + \frac{\nu(1-a)}{1-\nu a} (1-L)p(1-l)f(1-\varphi)}{\frac{\nu(1-a)}{1-\nu a} (1-L)p(1-l)f\varphi}$$

$$\frac{\text{Formation of "q"}}{\text{Loss of "q or s"}} = \frac{\frac{\nu(1-a)}{1-\nu a} (1-L)(1-p) + \frac{\nu(1-a)}{1-\nu a} (1-L)p(1-l)f(1-\varphi)}{\frac{\nu(1-a)}{1-\nu a} (1-L)p(1-l)f\varphi}$$

$$= \frac{1-\varphi}{\varphi} + \frac{1-p}{1-l} \frac{1}{p f \varphi} = \frac{\nu-\eta}{\eta} + \frac{\nu(1-a)}{1-\nu a} (1-L)(1-p)$$

$$\left[(1-L_1)(1-L_2)f \nu \left(1 + \frac{\nu a}{1-\nu a} \right) \right] = \left(1 + \frac{\nu a}{1-\nu a} \right)$$

Numerical example (1)

$$v = 2$$

$$\eta = 1.3$$

$$\phi = \frac{1.3}{2} = .65$$

Fast fissions

$$\frac{\text{Fast fissions}}{\text{Slow fissions}} = .15$$

Slow fissions

$$L = l = .02$$

$$\frac{va}{1 - va} = .15$$

$$va = .1304$$

$$a = .0652$$

From crit condition

$$1 = \frac{2 - .1304}{1 - .1304} \times .98^2 \times .65 \times pf$$

$$pf = .7451$$

$$.89 \times .8372 \times .819 \times .79 \times$$

$$\frac{\text{Formation}}{\text{Loss}} = .5385 + \frac{2 - .1304}{1 - .1304} \times .98 \times .1628 = .8815$$

$$2.1500$$

$$.3430$$

Same conditions with $v = 2.2$

$$\phi = \frac{1.3}{2.2} = .591$$

$$va = .1304$$

~~2.2~~
Formation

$$\frac{\text{Formation}}{\text{Loss}} = \frac{2.2 - 1.3}{1.3} + \frac{2.2 - .1304}{1 - .1304} \times .98 \times (1 - p) = .692 + 2.332(1 - p)$$

$$= 1.07$$

$$f = \frac{p}{1+p}$$

(CF 338)

$$p = \frac{1}{1+\alpha p}$$

$$\alpha = .015$$

best pf .794

$$.7451 = \frac{p}{(1+\alpha p)(1+p)}$$

P-9 pile may have a chance especially if cooled by P9

With notations of CP-644 (lattice cell)

$$a = \frac{p \frac{\sigma_f}{\sigma_{tot}}}{1 - p \frac{\sigma_{elastic}}{\sigma_{total}}}$$

$$1.25$$

$$1.07$$

$$.80$$

$$.97$$

Example Metal rods $r = 4 \text{ cm}$

$$p = 0.54$$

$$\frac{\sigma_f}{\sigma} = \frac{.35}{4.5}$$

$$a = \frac{0.54 \times .0778}{1 - 0.54 \times .0778} = .044$$

$$E = \frac{1 - .044}{1 - .088} = 1.048$$

$$\frac{2 - .088}{1 - .088}$$

$$v = 2$$

$$\text{Formation} = .538 + 2.096(1-L)(1-p)$$

Loss

for $\frac{P9}{v}$ volume ratio ~ 8

$$p = .8 \quad f = .97$$

$$M^2 = 120 + 4900(1 - .97) = 267$$

$$E = 1.048$$

$$k = 1.0572$$

$$(1-L)(1-l) = .975 \times .970$$

$$\frac{M^2}{k-1} = 4667$$

10 MeV

 $1/\sigma^2 E$ 310/6599

.8	.157	.196	49
1.0	.186	.186	58
1.2	.216	.180	67
1.4		.174	76
1.6		.178	82
1.8		.176	98
2.0		.184	114
2.2		.178	121
2.4		.168	125
2.6		.158	127
2.8		.144	125
3.0		.130	121
3.2		.103	102
3.4		.070	74
3.6		.047	52
3.8		.048	57
4.0		.070	87
4.2		.055	72
4.4		.053	72
4.6		.075	107
4.8		.101	150
5.0		.130	201
5.2		.146	235
5.4		.153	256
5.6		.160	278
5.8		.162	291
6.0		.162	301

1.44

$$90.52 \log 1.44 = 33$$

$$-33 + 13$$

1	1580		
1.2	1665		
1.4	1748		
1.6	1827	1858	1.63
1.8	1917		

$$\pi(E) dE = e^{-2E} (e^{4\sqrt{E}} - e^{-4\sqrt{E}}) dE$$

$$\bar{E} = \frac{\int E \pi(E) dE}{\int \pi(E) dE} = \frac{33995}{18.45} = 1843$$

MeV	$\pi(E)$	MeV	$\pi(E)$	$\bar{E}(E)$	
0		0	0	0	
0.5		0.5	5.8	1346	7807
1		1	7.38	1580	11640
1.5		1.5	6.7	1787	11973
2		2	5.2	2008	10442
2.5					
3		2	5.2	2008	10442
3.5		3	2.5	2350	5875
4		4	1.0	2469	2469
4.5		5	.35	2743	960
5		6	.10	3162	316
5.5		7	.04	(3547)	142
6		8	.01	(3932)	40
6.5					
7		0	0	—	0
7.5		.1	2.66	1061	2822
8		.2	3.90	1157	4512
		.4	5.61	1290	7237
		.6	6.69	1398	9353
		.8	7.24	1491	10795
		1.0	7.38	1580	11660

6.57 { 11641

6.33 { 14693

.48 { 527

5.07 { 7134

12	T	$\frac{dT}{dt}$	T/τ	θ
54	1.10	.85	.07	.92
55	1.91	.80	.13	.93
56	2.71	.76	.18	.94
57	3.44	.70	.23	.93
58	4.10	.64	.27	.91
59	4.72	.60	.31	.91
60	5.30	.57	.35	.92
61	5.86	.54	.39	.93
62	6.38	.50	.42	.92
63	6.87	.47	.46	.93
64	7.32	.44	.48	.92
65	7.74	.42	.51	.93
66	8.16	.39	.54	.93

$$1.3 = \frac{F}{F+C} \cdot 2$$

2

$$1.3 \cdot \frac{2}{1.3} - 1 = \frac{C}{F}$$

.538

$$.85 + \frac{1}{\tau} 1.10 = \theta$$

$$\theta - \frac{1}{\tau} T = \frac{dT}{dt}$$

$$\frac{.925}{29.7} 60 = 1.87$$

$$13 \theta - \frac{1}{\tau} 65.61 = 7.68$$

$$65.61 \theta - 393.53 \frac{1}{\tau} = 34.64$$

$$\theta - 5.047 \frac{1}{\tau} = .5908$$

$$\frac{F}{C} \approx 93.1 \quad 1.86$$

$$\theta - 5.998 \frac{1}{\tau} = .5280$$

$$5.94$$

$$.951 \frac{1}{\tau} = .0628$$

$$\begin{cases} \tau = 15.1 \\ \theta = .925 \end{cases}$$

$$\frac{v_f}{f} = 1.3$$

$$\frac{\sigma_i - .15}{.65} = 1.6$$

$$\sigma_i = 1.2$$

$$\frac{1.04}{1.5} = 1.2$$

$$\frac{1}{140} \left(\frac{\sigma_s}{\sigma_c} \right) \frac{1.7}{1.04} = .12$$

$$\left(\frac{\sigma_s}{\sigma_c} \right) = 10$$

66		$-\frac{dT}{dT}$	
66	8.16		
67	7.80		
68	7.33	47	.46
69	6.84	45	.43
70	6.47	41	.40
71	6.08	39	.38
72	5.70	38	.35
73	5.39	31	.31
74	5.08	31	.28
75	4.82	26	.26
76	4.55	27	.26
77	4.30	25	.23
78	4.10	20	.22
79	3.87	23	.21
80	3.67	20	

14

11/23/43

1 sec

$$.57 e^{-1.38t} + .40 e^{-.154t} + .024 e^{-.030t} + .002 e^{-.014t}$$

CP 1014

Reduce to ~~very~~ short irradiation

$$A e^{-1.38t} + B e^{-.154t} + C e^{-.030t} + D e^{-.014t}$$

1 sec

$$\int_0^1 e^{-\alpha t} dt = \frac{1}{\alpha} (1 - e^{-\alpha})$$

 ∞

$$\int_0^{\infty} e^{-\alpha t} dt = \frac{1}{\alpha}$$

$$1 - \frac{\alpha}{2} + \frac{\alpha^2}{2} - \frac{\alpha^3}{6} + \frac{\alpha^4}{24} - \frac{\alpha^5}{120} + \dots$$

α	$1/\alpha$	$\frac{1}{\alpha}(1 - e^{-\alpha})$	A, B, C, D	$\frac{A}{\alpha}, \dots$		
1.38	.725	.543	1.050	.761	1.2	3
.154	6.49	.927	.431	2.797	1.2	10.1
.030	33.3	.985	.0244	.813	1.0	24.5
.012	83.3	.993	.0020	.110		
.014	71.4	.993	.0020	.143	.135	8.0

	from C81
72	272
168	46.0
264	9.06
360	3.10
432	1.12

11.000

 6.5×10^4

8.69	2.74
154	10.5
2750	40.2
49000	154
424000	424

2797

813

443

1.867

93.5	52.2	272
5.3	13.6	35.3
.30	3.56	7.21
.017	.929	1.77
.002	.337	.633

(470)

172
44.8
11.7
3.05
1.1

$$\frac{1}{39.1} = .02558$$

1.867

$$[v_9 + (v_8 - 1)\varphi](1 - l) - 1 = \rho$$

~~$$(2 + \varphi)(1 - l) - 1$$~~

~~$$1 + \varphi - 2l - l\varphi > 1$$~~

~~$$\varphi > 2l + l\varphi$$~~

~~$$\varphi > (2 + \varphi)l$$~~

$$[v + (v - 1)\varphi][1 - l] - 1 = \rho$$

$$l = .18$$

$$(2 + \varphi)0.82 - 1 = 0.64 + .82\varphi = \rho$$

$$\boxed{.72}$$

$$v(1 + \varepsilon)(1 - l) - 1$$

$$2 \times 1.04 \frac{f}{K}$$

~~$$2 \times 1.04 \frac{f}{K}$$~~

~~$$2.08 \times 1.04 \frac{.9}{1.0}$$~~

$$2.08 \times 1.04 \frac{.85}{1.03} - 1 = \underline{.79}$$

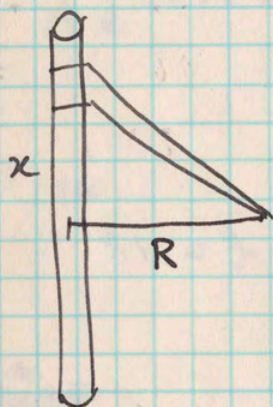
~~76.7~~
189 77

11/24/43

 $4\pi\lambda$

$$\frac{\delta m_i}{n} = \frac{RD}{4\pi\lambda} \int \frac{D dx e^{-\frac{r}{\lambda}}}{r^3}$$

$$\int_r^\infty e^{-\frac{r}{\lambda}} dr = \lambda e^{-\frac{r}{\lambda}}$$

 $D dx$

$$x^2 = r^2 - R^2$$

$$x dx = r dr$$

$$\frac{2RD}{4\pi\lambda R} \int_R^\infty \frac{R^2 e^{-\frac{r}{\lambda}} dr}{r^2 \sqrt{r^2 - R^2}} =$$

$$= \frac{RD}{2\pi\lambda R} \int_1^\infty \frac{e^{-\frac{R}{\lambda} u} du}{u^2 \sqrt{u^2 - 1}}$$

$$1 - \frac{R}{\lambda} u$$

$$\int \frac{du}{u \sqrt{u^2 - 1}} = \arccos \frac{1}{u}$$

$$\int \frac{du}{u^2 \sqrt{u^2 - 1}} = -\frac{1}{u} \frac{1}{\sqrt{u^2 - 1}} = \int \frac{2}{(u^2 - 1)^{3/2}} du$$

$$\begin{aligned} &1.0 e^{-.029t} + .135 e^{-.012t} \quad \text{for } \infty \\ &.029 e^{-.029t} + .00162 e^{-.012t} \quad \text{for } \epsilon \end{aligned}$$

~~1.38~~
1.154
0.029
0.012

		$.40 e^{-.15ft}$	Diff	$e^{-.029t} + .05586x$
10	.109	.086	(.023)	.7970
20	.0326	.0183	(.0143)	6023
30	.0137	.0039	.0098	4559
40	.0090	.0008	.0082	3456
50	.0066	.0002	.0064	2625
60	.00485	.00004	.0048	1998

α	τ $1/\alpha$	$\frac{1}{\alpha}(1-e^{-\alpha})$	Short $A, \dots$	∞ $\frac{A}{\alpha}$		$\times 100$
1.38	.725	.542	1.050	.761	.55	.1275
.154	6.49	.926	.431	2.797	18.15	.4687
.029	34.5	.985	.0244	.842	29.05	.1411
.012	83	.994	.00135	.112	9.30	.0188
					57.05	

$$57.05x + 1.25 \times 10^{-2} = .0968$$

$$\frac{.0968}{.0956}$$

$$x = .0016757$$

$$\frac{2600}{9.6171} \left[\frac{.1250}{\tau} + \frac{.0924}{\tau + .725} + \frac{3.0419}{\tau + 6.5} + \frac{4.7974}{\tau + 34} + \frac{1.5604}{\tau + 83} \right]$$

$$9.6171$$

$$\left[\frac{47}{\tau} + \frac{35}{\tau + .7} + \frac{1139}{\tau + 6.5} + \frac{1795}{\tau + 34} + \frac{584}{\tau + 83} \right]$$

$$ih = \frac{47}{\tau} + \frac{35}{\tau+7} + \frac{1139}{\tau+6.5} + \frac{1795}{\tau+34} + \frac{584}{\tau+83}$$

τ						ih
124	.379	.281	8.728	11.361	2.821	23.57
58.3	.806	.593	17.577	19.447	4.133	42.56
34.4	1.366	.997	27.848	26.243	4.974	61.43
22.3	2.108	1.522	39.549	31.883	5.546	80.61
16.5	2.848	2.035	49.522	35.545	5.869	95.82
11.7	4.017	2.822	62.582	39.278	6.167	114.87

(N)	ih_{740}	$\Delta \times 10^6$	
369	22.91	99.396	99404 +8
372	41.93	98.700	98706 +6
377	60.88	98.020	98012 -8
381	80.20	97.348	97303 -45
385	95.66	96.691	96736 +45
389	114.76	96.040	96036 -4

$$A - 2291 B = 99396$$

$$A - 4193 B = 98700$$

$$A - 6088 B = 98020$$

$$A - 8020 B = 97348$$

$$A - 9566 B = 96691$$

$$A - 11476 B = 96040$$

$$6A - 41,634B = 586,195$$

$$41,634A - 347,421,006B = 4,046,143,202$$

$$A - 6939B = 97,699.2$$

$$A - 8345B = 97,183.6$$

$$1406B = 515.6$$

$$B = .3667$$

$$A = 100,244$$

$$\Delta \times 10^6 = 100,244 - .03667 \times ih$$

$$27.27$$

$$M^2 = 635$$

$$ih = 2.33 \times 10^{-5}$$

$$\frac{.4 \times 1.6 \times 10^{-6}}{t} dt = \frac{6.4 dt}{t} \times 10^{-7}$$

$$w_0 = 6.4 \times 10^{-7} \text{ ergs}$$

$$\frac{w_0}{t} dt$$

~~dt~~

$$c \frac{dT}{dt} -$$

$$\frac{dT}{dt} = -\frac{T}{\tau} + \frac{1}{c} (q_f + q_r)$$

$$q_r = \int_{-\infty}^t q_f D(t-x) dx$$

$$\frac{dT}{dt} + \frac{T}{\tau} = q_f + \int_{-\infty}^t q_f(x) D(t-x) dx$$

$$\frac{dT}{dt} + \frac{T}{\tau} = \Theta D(t) = \frac{\gamma \Theta}{t}$$

$$\frac{1}{10}$$

$$\frac{dT}{dt} + \frac{T}{\tau} = \frac{\gamma \Theta}{t}$$

$$\gamma \approx \frac{1}{10} \text{ fraction}$$

$$T = f(t) e^{-\frac{t}{\tau}}$$

$$f = \int \frac{\gamma \Theta}{t} e^{\frac{t}{\tau}} dt$$

$$f = r \int \frac{1}{t} e^{t/\tau} dt$$

$$\frac{\log 60}{60}$$

$$\frac{1}{100}$$

$$T = \frac{\ominus}{100} \frac{\tau}{t}$$

$$\frac{1}{t} = \frac{\int_{T_1}^{T_2} \frac{dt}{t}}{T_2 - T_1} = \frac{\log \frac{T_2}{T_1}}{T_2 - T_1}$$

$$\frac{1}{100}$$

$$\frac{25}{100} \quad \frac{14}{60 \times 1440} \quad 100$$

$$\frac{1}{60}$$

$$.01 \frac{\ominus \tau}{t}$$

$$\frac{1}{100} \frac{\ominus \tau}{t}$$

$$11.5$$

$$\frac{t}{T} \left(\frac{1}{\tau_0} - \frac{1}{\tau} \right) = A$$

$$t \frac{dT}{dt} + \frac{Tt}{\tau} = \frac{A}{\tau}$$

$$\frac{dT}{dt} = -\frac{T}{\tau} \frac{1}{t}$$

$$\frac{dT}{dt} + \frac{T}{\tau_0} = \frac{A}{t}$$

$$\frac{T}{\tau_0} - \frac{T}{\tau} = \frac{A}{t}$$

$$\left(\frac{1}{\tau_0} - \frac{1}{\tau} \right) = \frac{A}{t} \frac{T}{T}$$

11/27/1940

$$1 \text{ ih} = 2.33 \times 10^{-5}$$

$$\text{av. gener. time} = 2.33 \times 10^{-5} \times 3600 = .08388 \text{ sec}$$

~~$$8K \times 100 = \frac{.00125}{\tau} + \frac{.0924}{\tau+.7} + \frac{3.0419}{\tau+6.5} + \frac{4.7974}{\tau+34} + \frac{1.5604}{\tau+83}$$~~

τ	fraction/x	$f \times \tau / x$	fraction = f	$f \tau$
.7	.761	.533	.001110	.000777
6.5	2.797	18.180	.004080	.026520
34	.842	28.628	.001228	.041752
83	.112	9.296	.000163	.013529
		<u>56.637</u>		<u>.001250</u>

$$.08388 = .00125 + x \times 56.637$$

$$x = .0014589$$

$$ih = \frac{54}{\tau} + \frac{33}{\tau+.7} + \frac{1139}{\tau+6.5} + \frac{1793}{\tau+34} + \frac{581}{\tau+83}$$

τ	$\frac{54}{\tau}$	$\frac{33}{\tau+7}$	$\frac{1139}{\tau+6.5}$	$\frac{1793}{\tau+34}$	$\frac{581}{\tau+83}$	i_h
124	.435	.265	8.728	11.348	2.807	23.58
58.3	.927	.560	17.577	19.426	4.112	42.60
34.4	1.57	.94	27.85	26.21	4.95	61.52
22.3	2.42	1.43	39.55	31.85	5.52	80.77
16.5	3.27	1.92	49.52	35.50	5.84	96.05
11.7	4.61	2.66	62.58	39.23	6.14	115.22

$$i_h_{740} \quad 10^6 \Delta \quad 1002.408 - .036543 i_h_{740}$$

22.92	99.396	99.402	+6
41.97	98.700	98.706	+6
60.97	98.020	98.012	-8
80.36	97.348	97.303	-45
95.89	96.691	96.736	+45
115.11	96.040	96.034	-6

$$6A - 417.22B = 46.195$$

$$417.22A - 34907.0820B = 2996.82439$$

$$A - 69.536667B = 7.6991667$$

$$B = .036543$$

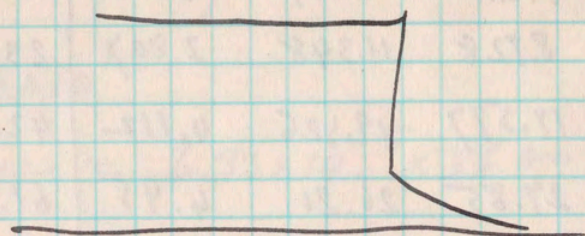
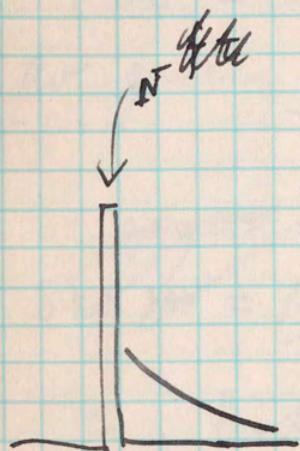
$$A - 83.665889B = 7.1828397$$

$$14.12922B = .516327$$

$$i_h = 2.32 \times 10^{-5}$$

1 d

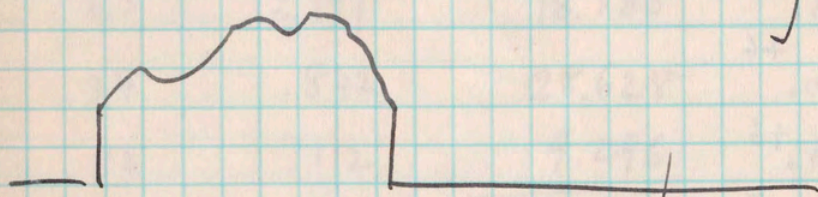
$$f e^{-t/\tau}$$



$$fN = \int A e^{-\frac{t}{\tau}} = \tau A$$

$$\frac{fN}{\tau} e^{-\frac{t}{\tau}}$$

$$\int \frac{f}{\tau} n d\theta e^{-\frac{t-\theta}{\tau}}$$



$$\frac{f}{\tau} \left[\int n(\theta) e^{\frac{\theta}{\tau}} \right] e^{-\frac{t}{\tau}}$$

$$n(\theta) = \frac{N}{T} e^{\frac{\theta}{T}}$$

$$\frac{f}{\tau} \int_{-\infty}^0 n(\theta) e^{\frac{\theta}{\tau}} d\theta$$

$$\frac{T\tau}{T+\tau}$$

$$\frac{fN}{T} \int_0^{\infty} e^{-\frac{\theta}{T}} e^{-\frac{\theta}{\tau}} d\theta = \frac{fN}{T+\tau}$$

7.	84.5
8	18.2
9	

$$T = 60 \text{ sec}$$

$$\frac{.001110}{60.7} e^{-\frac{t}{.7}} + \frac{.004080}{66.5} e^{-\frac{t}{6.5}} + \frac{.001228}{94} e^{-\frac{t}{-54}} + \frac{.000163}{143} e^{-\frac{t}{83}}$$

$\times .7$
 $\times 6.5$
 $\times 34$
 $\times 83$

No of neutrons left $\times 10^{10}$

$$\frac{1.11 \times .7}{60.7} \times 10^7 \quad \frac{4 \times 10^7}{66.5} \times 6.5$$

$$128000 e^{-t/.7} + 3.99 \times 10^6 e^{-t/6.5} + 4.44 \times 10^6 e^{-\frac{t}{34}} + 946000 e^{-\frac{t}{83}}$$

0	128000	3990000	4440000	946000
1	30000	3421000	4329000	
2	7400	2933000	4221000	
3	1770	2515000	4115000	
4	425	2157000	4012000	
5	102	1850000	3912000	
6	24	1586000	3814000	
7	6	1360000	3719000	
8	1	1166000	3626000	
9	-	999800	3535000	
10		857300	3447000	
15		397400	2976000	
20		184200	2569000	
25		85390	2218000	
30		39580	1915000	659000
40		8506	1427000	
50		1828	1063000	
60		393	792000	459000
90		4	327500	
120		-	135400	222700
180			23150	108100
240			3959	52450
300			677	25450
360			116	12350
420			20	5992
480			3	2907
540			1	1410

November 28 1943

n's emitted from source (instantaneous irradiation)
 $= 3.84 \times 10^6$ Cd In Cd at 12" from
 Initial Source

1 KWH

wt period	(.7)	(6.5)	(34)	(83)	Total
0 min	120	3741	4163	887	8911
1 min	—	—	742	430	1172
2 min	—	—	127	209	336
3 min	—	—	21.7	101.3	123
4 min	—	—	3.7	49.2	52.9
5 min	—	—	.6	23.9	24.5
6 min	—	—	.1	11.6	11.7
1/2 min		37	1795	618	2450

$$\Delta \psi + \frac{k-1}{M^2} \psi = 0$$

$$\Delta \psi_n + \left(\frac{k-1}{M^2} + g_n \right) \psi_n = 0$$

$$g_1 \quad g_2 \quad \dots \quad g_n \quad \dots$$

$$\varphi_1 \quad \varphi_2 \quad \dots \quad \varphi_n \quad \dots$$

$$\Delta \psi + (g - u) \psi = 0$$

$$\Delta \varphi_n + (g_n - [u]) \varphi_n = 0$$

$$u = [u] + \lambda \Delta u$$

$$\psi = \varphi_1 + \sum_2^\infty \lambda \varphi_n a_n + \sum_2^\infty \lambda^2 b_n \varphi_n$$

$$g = g_1 + \lambda \gamma + \lambda^2 \chi$$

$$\begin{aligned} \cancel{u_0 = g_1} \quad & (U - g_1) \varphi_1 + \lambda \sum' a_n (U - g_n) \varphi_n + \\ & + \lambda^2 \sum' b_n (U - g_n) \varphi_n = \end{aligned}$$

$$= (U + \lambda V - g_1 - \lambda \gamma - \lambda^2 \chi) (\varphi_1 + \lambda \sum' a_n \varphi_n + \lambda^2 \sum' b_n \varphi_n)$$

$$\begin{aligned} \cancel{(U - g_1) \varphi_1} \quad & \sum' a_n \cancel{(U - g_n) \varphi_n} = (g_n - g_1) \sum' a_n \varphi_n + \\ & + (V - \gamma) \varphi_1 \end{aligned}$$

$$\begin{aligned} \sum' b_n \cancel{(U - g_n) \varphi_n} &= (g_n - g_1) \sum' b_n \varphi_n + \\ & + (V - \gamma) \sum' a_n \varphi_n - \chi \varphi_1 \end{aligned}$$

$$\sum' a_n V_{1n} \quad \gamma = V_{11} \quad a_n = \frac{V_{1n}}{g_1 - g_n} \quad n \neq 1$$

$$\sum' a_n V_{1n} = \chi$$

$$g = g_1 + \cancel{\frac{1}{2} V_{11}} \sum' \frac{|V_{1n}|^2}{g_n - g_1}$$

$$V_{1n} = A\varphi_1 \varphi_n$$

$$g = g_1 + A\varphi_1^2 - A^2\varphi_1^2 \sum' \frac{\varphi_n^2}{g_n - g_1} = g_1 + A'\varphi_1^2$$

$$A' = A - A^2 \sum' \frac{\varphi_n^2}{g_n - g_1}$$

Example center of spherical pile

~~$$\sin \frac{n\pi z}{R}$$~~

$$\varphi_n = \frac{\sin \frac{n\pi z}{R}}{\sqrt{2\pi R}}$$

$$g_n = \frac{\pi^2 n^2}{R^2}$$

~~$$2\pi R \sum' \frac{\varphi_n^2}{g_n - g_1} = \sum' \frac{n^2}{2\pi R (n^2 - 1)}$$~~

$$\sum' \frac{\varphi_n^2}{g_n - g_1} = \sum_2^\infty \frac{n^2}{2\pi R (n^2 - 1)}$$

$$2 \int_0^R \frac{\sin \frac{\pi z}{R} \sin \frac{n\pi z}{R}}{2\pi R} dz = \frac{2}{\pi} \int_0^\alpha \sin \alpha \sin n\alpha d\alpha$$

$$\sin n\alpha \sin \alpha = \frac{1}{2} [\cos (n+1)\alpha + \cos (n-1)\alpha]$$

$$\frac{1}{\pi} \left\{ \frac{\sin (n-1)\alpha}{n-1} - \frac{\sin (n+1)\alpha}{n+1} \right\}$$

8/4

$$V_{1n} = \frac{G}{\pi} \left(\frac{\sin(n-1)\alpha}{n-1} - \frac{\sin(n+1)\alpha}{n+1} \right)$$

$$\frac{G}{\pi} (\alpha - \sin \alpha \cos \alpha) - \frac{G^2 R^2}{\pi^4} \sum_{n=2}^{\infty} \frac{\left[\frac{\sin(n-1)\alpha}{n-1} - \frac{\sin(n+1)\alpha}{n+1} \right]^2}{(n^2-1)}$$

$$\frac{G}{2} - \frac{G^2 R^2}{2\pi^4}$$

$$.0976 = .117 \left(\frac{R-1}{R} \right)$$

$$\begin{array}{r} .985 \\ .987 \\ .976 \\ .977 \\ .975 \end{array}$$

$$\frac{\sin m\alpha}{m} = \alpha - \frac{m^2 \alpha^3}{6}$$

$$(n-1)^2 - (n+1)^2$$

$$1 - \frac{1}{R} = .834$$

$$\frac{\frac{1}{1} + \frac{1}{3}}{2^2-1}$$

$$\frac{\frac{1}{3} + \frac{1}{5}}{4^2-1}$$

$$\frac{\frac{1}{5} + \frac{1}{7}}{6^2-1}$$

$$\frac{1}{R} = .166$$

$$R = 6$$

$$\frac{4}{3 \times 3} + \frac{8}{15 \times 15} + \frac{12}{35 \times 35} + \frac{16}{63 \times 63} + \frac{20}{99 \times 99}$$

$$\begin{array}{r} .4444 \\ 356 \end{array}$$

$$.499$$

$$.117$$

$$.54172$$

$$n\alpha = .117 A \left(1 - \frac{1}{R} \right) \frac{5}{6}$$

$$.18$$

$$.0914 \quad .0256$$

$$f = .886 = 1 - \frac{.0256}{3 \times 2.56} \quad (\text{Col Ratio} - 1.1)$$

$$= 1.028 - .0256 \quad (\text{CLR})$$

$$\frac{\lambda n\alpha}{9} = 192 \quad (\text{Col Ratio} - 1.15)$$

$$\begin{array}{r} 98 \\ 40 \\ 20 \\ 12 \\ 7 \\ 4 \\ 2 \\ 2 \end{array}$$

30 731.5

$$718 = H$$

$$\frac{676}{42} = H_1$$

$$42$$

$$q \frac{1.53}{R\sqrt{H}} \iint J_0 \left(2.405 \frac{r}{R} \right) \cos \frac{\pi x}{H} dx 2\pi r dr$$

$$5.784$$

$$\frac{\pi}{2.405^2} \frac{1.53^2}{R^2} \iint J_0^2 \left(\frac{2.405}{R} r \right) r dr dx \left(\frac{2.405}{R} \right)^2$$

$$\frac{\pi x^2}{2.405^2} \times 7808 = 1$$

$$\sqrt{\frac{2.405^2}{\pi \times 7808}} = \sqrt{2.358} = 1.535$$

$$\varphi_1 = \frac{1.5356}{R\sqrt{H}} J_0 \left(2.405 \frac{r}{R} \right) \sin \frac{\pi x}{H} - \frac{H}{\pi} \cos \frac{\pi x}{H}$$

$$Q_1 = q \frac{1.5356}{R\sqrt{H}} 2\pi \int_0^{R_1} J_0 \left(2.405 \frac{r}{R} \right) r dr \int_0^{H_1} \frac{\pi x}{H} dx$$

$$= \frac{2\pi \times 1.5356}{R\sqrt{H}} q \left(\frac{R^2}{2.405^2} \frac{H}{\pi} \right) \int_0^{2.405 \frac{R_1}{R}} J_0(x) x dx \times \left(1 - \cos \frac{\pi H_1}{H} \right)$$

$$Q_1 = 1.53 \times q R\sqrt{H} \left(1 - \cos \frac{\pi H_1}{H} \right) \int_0^{2.405 \frac{R_1}{R}} J_0(x) x dx$$

$$\frac{\pi H_1}{H} = 169.5^\circ$$

$$1 - \cos 169.5^\circ = 1.982$$

$$1.249$$

$$1.0524$$

$$\frac{766}{876}$$

N

~~120~~
238
300
332
~~583~~

~~R₁~~

$$\sqrt{\frac{412.9 N}{\pi}} = R_1$$

$$\sqrt{131.41} \sqrt{N} = 11.463 \sqrt{N}$$

N	R ₁	R = R ₁ + 47.6	2.405 $\frac{R_1}{R}$	$\int_0^{2.405 \frac{R_1}{R}} J_0(x) x dx$
177	152.50	200.10	1.833	1.0665
235	175.72	223.32	1.892	1.0998
297	197.55	245.15	1.938	1.1239
329	207.92	255.52	1.957	1.1333
341	211.68	259.28	1.963	1.1362

J₀(x) x $\int_0^x$

0	0
1	.0998 -
2	.1980
3	.2933 -
4	.3842
5	.4693 -
6	.5472
7	.6168 -
8	.6770
9	.7267 -
1.0	.7652
1.1	.7916 -
1.2	.8053
1.3	.8061 -
1.4	.7937
1.5	.7677 -
1.6	.7286
1.7	.6766 -
1.8	.6120 • 1.0467 31.4020
1.9	.5354
2.0	.4478 • 1.1533 34.5994
2.1	.3499 -
2.2	.2429
2.3	.1277
2.4	.0060

~~6.120~~
18 - .711
18.5 - .766
19 - .821 - 1.10
19.5 - .876
20

$$.6120 - .711x - .55x^2$$

5354

$$.6120x - .711 \frac{x^2}{2} - .55 \frac{x^3}{3}$$

$$1.0467 + .612x - .3555x^2 - .1833x^3$$

11/29/43

$$\psi(r) \frac{\psi_0}{\psi_r}$$

$$\frac{\frac{\psi_0}{\psi_r} \psi_r^2}{\psi_0^2} = \frac{\psi_r}{\psi_0}$$

$$\psi_r = \psi_0 + \kappa \frac{\partial \psi_0}{\partial x} + \dots + \frac{1}{2} \kappa^2 \frac{\partial^2 \psi_0}{\partial x^2} + \dots$$

$$\frac{\psi_r}{\psi_0} = 1 + \frac{1}{6} \kappa^2 \Delta \psi_0 = 1 \pm \frac{\kappa-1}{M^2} \approx 1 \pm \frac{\kappa-1}{2} \sim \boxed{.97}$$

$$1 - 350 \times 10^5 \times 10^{-6} = .965$$

$$\boxed{.838}$$

$$\Delta n v - \frac{3}{\lambda \Lambda} n v + \frac{3}{\lambda} q = 0$$

$$\Delta q = \frac{\partial q}{\partial t} \quad q = q_0 e^{t\Delta}$$

$$q(0) = p(1+\varepsilon) Q + \kappa \frac{k}{\Lambda} n v$$

 $\Delta(nv)$

$$0 = n v \left[\Delta - \frac{3}{\lambda \Lambda} + \frac{3}{\lambda \Lambda} e^{t\Delta} \frac{k}{\Lambda} \right] + \frac{3}{\lambda} e^{t\Delta} p(1+\varepsilon) Q$$

$$n v = \frac{\Lambda p(1+\varepsilon) Q}{e^{-t\Delta} \left(1 - \frac{\lambda \Lambda}{3} \Delta \right) - k}$$

$$Q = Q_1 \varphi_1$$

$$n\nu = \frac{\Lambda p (1+\varepsilon) Q_1}{e^{-t\Delta} \left(1 - \frac{\lambda\Lambda}{3} \Delta\right) - \kappa} \varphi_1$$

(no) center

$$Q_1 = .531 \, q \, R \sqrt{H} \times 1.982 \int$$

$$\varphi_1(0) = \frac{1.536}{\sqrt{H} R}$$

$$-\Delta = \frac{\pi^2}{H^2} + \frac{5.784}{R^2}$$

$$Q_1 \varphi_1(0) = q \times \int \times .531 \times 1.982 \times 1.536 = 1.6165 \, q \times \int$$

$$\frac{n\nu}{\Lambda p (1+\varepsilon) q} = \frac{1.6165 \times \int}{e^{-t\Delta} \left(1 - \frac{\lambda\Lambda}{3} \Delta\right) - \kappa}$$

$$t = 350$$

$$\frac{\Lambda\lambda}{3} = 285$$

N	1.6165 ∫	$-\Delta \times 10^6$	$1 - \frac{\lambda\Lambda}{3} \Delta$	$e^{-t\Delta}$	④ × ⑤	②/⑥ - κ
177	1.724	163.60	1.0466	1.0588	1.1081 .0428	40.3
235	1.778	136.93	1.0390	1.0489	1.0898 .0245	72.6
297	1.817	115.39	1.0329	1.0411	1.0754 .0101	179.9
329	1.832	107.73	1.0307 ₀	1.0383 ₅	1.0702 ₃ .0049₂	372.4
341	1.837	105.18	1.0299 ₈	1.0374 ₃	1.0685 ₃ .00322	570.5
crit		100.39	1.0286 ₁	1.0356 ₈	1.0653 ₁	

34

N	nv	nv/1.6165		
177	46	26.7	1.1081 ₄₂₁₅	1.125
235	88	49.5	1.0898 ₂₃₈₅	1.181
297	219	120.5	1.0754 ₉₄₅	1.139
329	475	259.3	1.07023 ₄₂₈	1.110
341	790	430.0	1.06853 ₂₅₈	1.110
			1.06595	

$$\Lambda p (1+\epsilon) q = 1.12$$

$$q = \frac{1.12}{313 \times 886 \times 1.03} = .00389$$

285.6

$$14.3 \text{ n/sec Kg}$$

7.1

6.5

12/1/1943

Breit Wigner formula for fission

$$\sigma_f = \frac{2.6 \times 10^{-18}}{\sqrt{R_{\text{volts}} (KT)_{\text{volts}}}} \frac{\Gamma_n \Gamma_f}{R^2}$$

assume

$$\dot{\sigma}_f = 650 \text{ B} \quad R = 1$$

$$\Gamma_n \Gamma_f = 4 \times 10^{-5}$$

$$\frac{650 \times 10^{-24}}{2.6 \times 10^{-18}} \frac{1}{\sqrt{40}}$$

$$\frac{650 \times 10^{-24}}{2.6 \times 10^{-18}} \sqrt{1 \times \frac{1}{40}} \quad 1^2 = \Gamma_n \Gamma_c = 4 \times 10^{-5} \quad 35$$

$$\frac{3}{3000} = 10^{-4} \text{ sec}$$

$$\boxed{1000} \quad 1 \text{ cm}$$

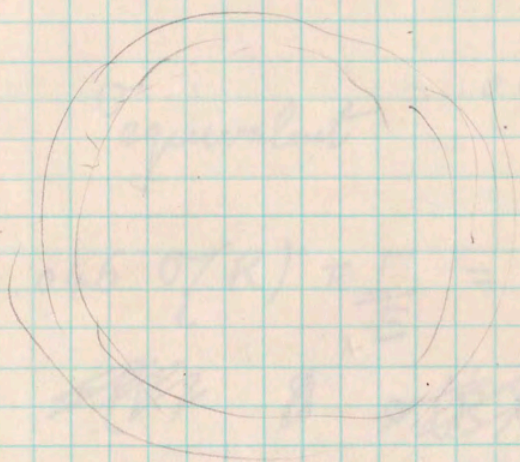
$$2 \times 10^{\frac{15}{4}} = \cancel{2} \times 10^{\cancel{24}} \text{ v}^2$$

$$10^{-8} \times 3 \times 10^5 = 3 \times 10^{-3}$$

$$10^{-7} \quad 10^{-5} \quad \frac{3}{100}$$

$$3 \times 10^5 = \text{v}$$

$$3 \times 10^{+5} \quad 3 \times 10^{-8} = 10^{-2} \text{ cm/gen}$$



$$\frac{6.70 \text{ f kg sec}}{\sqrt{960}} \quad (28)$$

Pa	3B	400 KW
img		

$$\frac{1}{4}$$

$$1 + \frac{va}{1-va} = \frac{1 - \cancel{va} - a}{1-va}$$

$$(1-l) = (1-L_1)(1-L_2)f$$

$$\alpha = \left[(1-L_1)(1-L_2)f \frac{v}{-1} \right] \left(1 + \frac{va}{1-va} \right)$$

$$\left[(1-L_1)(1-L_2)f v - 1 \right] \frac{1}{1-va} = \alpha$$

$$v f (1-L_2) = \frac{1-va}{1-a} \frac{1}{\varphi p}$$

$$\left\{ \frac{1-va}{1-a} \frac{1-L_1}{\varphi p} - 1 \right\} \frac{1}{1-va}$$

$$\frac{1-\varphi}{\varphi} + \frac{v(1-a)}{1-va} (1-L_1)(1-p)$$

$$\frac{(1-\varphi)(1-va) + \varphi v(1-a)(1-L_1)(1-p)}{\varphi(1-va)}$$

12/17/43

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Resonance captures between 2 Cd foils

Neutrons captured

$$\frac{\lambda}{.158} q \int \sigma \frac{dE}{E} = n v \sigma_{\text{equivalent}}$$

$$\frac{\lambda q \Lambda}{.158 n v \Lambda}$$

$$q = \frac{n v}{\Lambda}$$

$$\sigma_{\text{equivalent}} = \frac{\lambda}{.158 \Lambda} \int \sigma \frac{dE}{E}$$

$$\lambda = 2.6$$

$$\Lambda = 357$$

$$\sigma_{\text{equivalent}} = .046 \int \sigma \frac{dE}{E}$$

56.4

$$.046 \sigma(R) \pi \frac{\Gamma}{E} = .1445 \frac{\Gamma \sigma(R)}{R}$$

$$\boxed{\frac{1}{1000} S}$$

$$\cancel{\sigma(R)} \quad \cancel{\sigma(R)} \quad \frac{1}{48}$$

$$.04 S \frac{\Gamma}{R}$$

$$\frac{.1}{10}$$

$$\cancel{.04 S} \quad \boxed{\frac{1}{1000} S}$$

$$\pi \times 2100 \frac{\Gamma}{35}$$

$$\frac{\pi 2.6 \times 10^{-18}}{R} \frac{\Gamma_m}{\cancel{E}}$$

- .17
- .035
- .045
- .019
- .015
- .1075

$$\frac{1}{1000} S$$

$$S = 8 \times 125 = \underline{1000}$$

~~Chapman & Seaton 1970~~ ~~Method~~ ~~of~~ ~~determination~~

$$0.046 \sigma(R) \frac{\Gamma}{R} \pi n S$$

$$1.66 \times 10^{-24}$$

$$n \sigma(R) \ll 1$$

$$\Sigma_{\text{eqn}} \ll 0.05 S \frac{\Gamma}{R} \sim \frac{1}{1000} S$$

$$n = 2 \times 10^{-3} \text{ gr/cm}^2 \text{ In}$$

$$\frac{.3}{20000} \times 1.66$$

$$2 \times 10^{-3} \text{ gr/cm}^2 \text{ I}$$

$$\frac{1}{50000} \quad \frac{.5}{20000}$$

$$1000 \times 2 \times 10^{-3} = 2 \times \text{~~1000~~}$$

$$\int \sigma \frac{dE}{E} \quad \int \frac{1 - e^{-\sigma n}}{n}$$

$$\int \frac{1 - e^{-\sigma n}}{n} \frac{dE}{E} \approx \frac{\Gamma}{R n} \int \left(1 - e^{-\frac{\sigma R n}{1 + \frac{E^2}{R^2}}} \right) d\frac{E}{R}$$

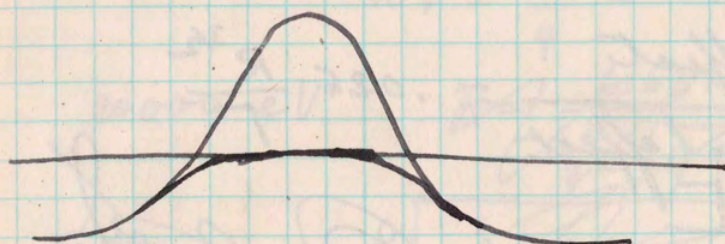
$$\sigma \approx \frac{\sigma(R)}{1 + \frac{E^2}{R^2}}$$

$$\sigma(R) n = \Sigma(R)$$

$$\frac{1}{n} \frac{\Gamma}{R} \int_{-\infty}^{\infty} \left(1 - e^{-\frac{\Sigma(R)}{1+x^2}} \right) dx$$

$\pi \Sigma \longleftrightarrow 2\sqrt{\pi \Sigma}$

148B



$$2y = \Sigma$$

$$\frac{1}{\pi} \int \frac{dx}{1+x^2} e^{-\frac{\Sigma}{1+x^2}} = \oint e^{-\frac{\Sigma}{2}} J_0\left(i \frac{\Sigma}{2}\right) = \begin{cases} 1 - \frac{\Sigma}{2} + \dots \\ \frac{1}{\sqrt{\pi \Sigma}} \end{cases}$$

$$\int \sqrt{\frac{\pi}{\Sigma}} d\Sigma = 2\sqrt{\pi \Sigma}$$

$$\frac{2}{n} \frac{\Gamma}{R} \sqrt{\pi \sigma(R) n}$$

$$\frac{2 \sqrt{\pi \sigma(R) n}}{\pi \sigma(R) n} = \frac{2}{\sqrt{\pi}} \frac{1}{\sqrt{\sigma(R) n}}$$

~~0.36~~ .36 ~~0.30~~ 30

$$\sigma_T + .046 \int \sigma \frac{dE}{E} \times \frac{2}{\sqrt{\pi} \sqrt{\sigma(R) n}}$$

$$\frac{\sqrt{\pi}}{20} \sqrt{\sigma(R) n} = \frac{2}{\sqrt{\pi}} F$$

$$\sigma(R) n = \frac{4}{\pi} F^2$$

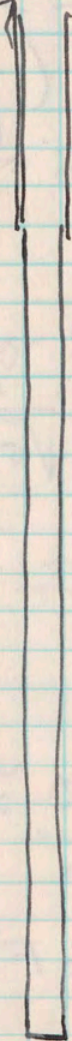
$$\frac{.046 \times 8.17 \times 10^{-18} \frac{\text{in}}{\text{R}}}{\frac{2.6 \times 10^{-18} \frac{\text{in}}{\text{R}}}{\sqrt{R (KT)}}}$$

$$.144 \frac{R}{\Gamma} \sqrt{R E_T}$$

$$\boxed{.026 \frac{R^{3/2}}{\Gamma}}$$

~~2.4 x 10^-2~~

(2)

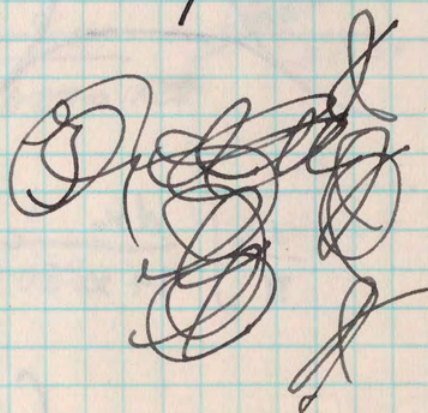
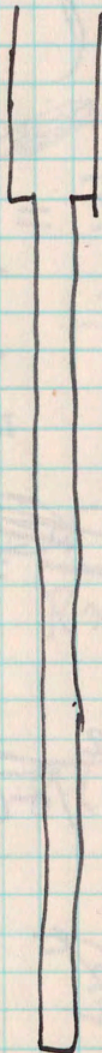
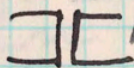


$$\boxed{2500 \text{ m/sec}}$$

$$\frac{1}{2} \frac{1.68 \times 10^{-24} \times 2.5^2 \times 10^{10}}{1.6 \times 10^{-12}}$$

$$\cancel{.0328 \times 10}, .0328$$

$$\frac{\text{Res effect}}{\text{thermal effect}} = .026 \frac{R^{3/2}}{\Gamma}$$



12/23/43

41

X-ray identification of fission products
Assume emission of one quantum K line
per disintegration

$$h\nu = \frac{3}{4} (Z-1)^2 \times 13.5 \text{ eV} = 10.1 \times (Z-1)^2$$

20000 eV

$$\lambda = \frac{6.62 \times 10^{-27} \times 10^{-7}}{\sqrt{2 \times 9.8 \times 10^{-28} \times 20000 \times 1.6 \times 10^{-12}}}$$

$$\lambda = 8.69 \times 10^{-10}$$

$$\nu = \frac{20000 \times 1.6 \times 10^{-12}}{h}$$

$$\lambda_{20000} = \frac{6.62 \times 10^{-27} \times 3 \times 10^{10}}{20000 \times 1.6 \times 10^{-12} \times 10^8 \text{ A}}$$

$\lambda = 2d \sin \theta$
 $\frac{.0869}{6}$
 $\frac{.6}{6}$

45 1936 641 XU = .623 Å
 46 20250 613
 147

1241

.0046 D = .1

$D = \frac{.0180}{5} = 20$

20 cm

573 144
 600 613
 .1068
 .1022
 .0046
 .01

~~CaCO₃~~ ~~6.361~~ ~~$\alpha = 46.6$~~

Calcite λ 3.03 Å

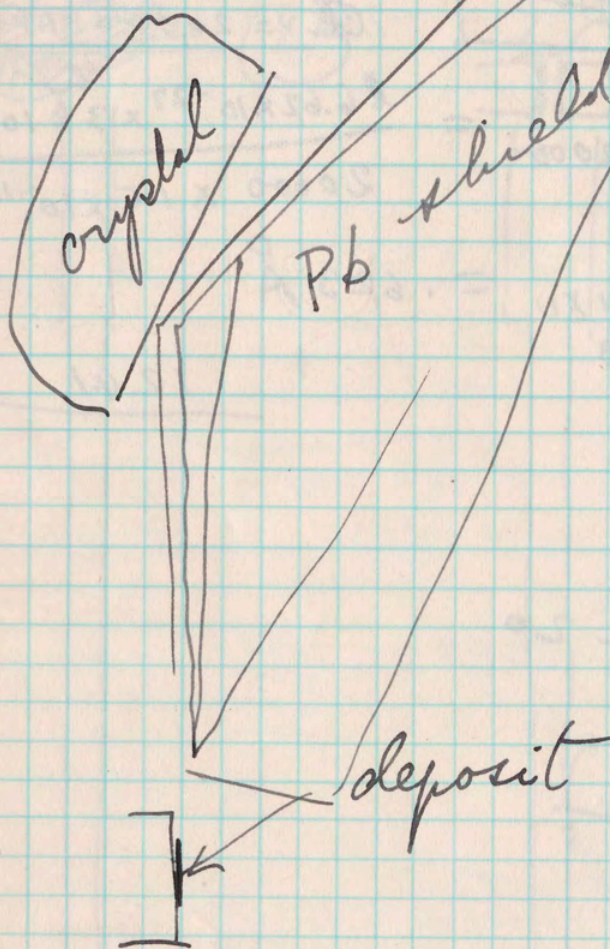
Mica 9.85

Quartz (1101) 3.336

NaCl 5.627/2

LiF 4.01/2

Film



According to Mrs Munn a good Molybdenum
K radiation picture can be obtained with
.001 Coulomb at 50000 volts
assuming yield $\frac{1}{1000}$ this is 6×10^{12} disintegrations
or about 50 mC x hour

Example 5 Kg uranyl nitrate

a) Dissolve in ether and eliminate most
of water

b) Irradiate powdery etherate with 100 kW_H ^(3×10^{15} fissions)

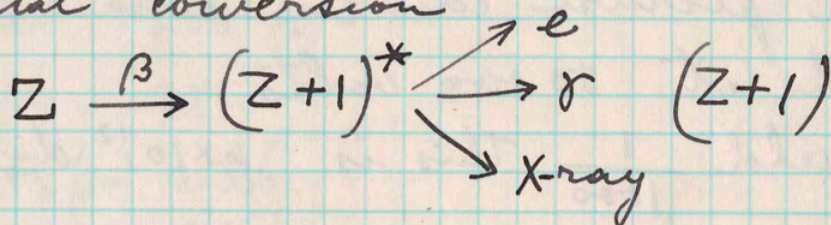
c) Dissolve in ether and extract with
20 cc water

Precipitates { $\text{Ba}^{86\text{min}}$ as sulphate (Dilute to 150 cc
add 10 mg BaNO_3 add H_2SO_4
Centrifuge
or 60 Min Te add Tellurous Acid
Reduce with SO_2
74 min (3.5 hr) La Dilute in 2 N nitric
Precipitate with HF

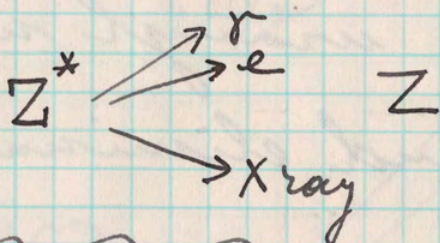
It should be possible to collect
 5×10^{13} disintegrations or perhaps
 10^{12} X-ray photons

December 24 1943

Internal conversion



Isomeric transition



$$\frac{\mu \text{ sec}}{m} = 10^{x/12.7}$$

$$10^{.07874 x}$$

$$eV = \frac{5228}{.15748 x}$$

5220

5200

5220

5240

5400

5290

$$1.602 \times 10^{-12}$$

5228

$$\frac{1}{2} \frac{1.675 \times 10^{-24}}{1.602} = V \mu^2$$

3204

1.39

.13

1.26

$$1.43 = \frac{1.55 \times 10^{-2}}{.106^2}$$

$$1.15 = \left(\frac{.106}{r} \right)$$

$$\begin{array}{r} 12.7 \\ 25.4 \\ 38.1 \\ \hline 10 \end{array}$$

$$23.0 \quad .0950$$

$$23.4 \quad .032$$

$$25.0 \quad 7.9375$$

$$1.25$$

$$1.09 \quad 16$$

$$.87 \quad 22$$

19.9

20.8

$$\frac{5228}{600^2} = .0145$$

3.1340

3.276

.580 3.83

441 2.77

$$\sigma_B \times V = 1.55 \times 10^6 \quad \text{Barns} \times \frac{m}{sec}$$

$$\sigma_{25} \times V = 1.43 \times 10^6$$

$$10^{10.6/12.7}$$

$$1.3075$$

$$10^{10.6/12.7 + A} = 1.43 \times 10^6$$

$$6.155 - .835$$

π	1.575π	$R(eV)$	Γ	$\sigma_0 V$
29.8	4.6935	.106	.27	1.65×10^6
23.4	3.6855	1.08	.19	1.25×10^6
20.35	3.2051	3.26	.4	$.90 \times 10^6$
17.4	2.7405	9.5		

$$\frac{\pi \sigma_0 V \Gamma}{\Delta} = 4 \times 10^6$$

$$\frac{.7}{.31} = \frac{.13}{.16}$$

$$\Delta = 1$$

$$\Gamma = .3$$

$$V \sigma_0 = 6.4 \times 10^6$$

$$\frac{2.6 \times 10^6}{R(\text{volts})} \frac{\Gamma_n \Gamma_c}{\Gamma^2}$$

$$\frac{1}{\pi} \frac{\Gamma_n \Gamma_c}{\Gamma^2 + \Delta E^2} = \sigma_c$$

$$\frac{6.4 \times 10^6}{E_0^2} \frac{1}{\Gamma^2} = \frac{6.4 \times 10^6}{1.26 E_0}$$

$$\sigma_c V \approx \frac{2^{3/2} \pi \hbar^2}{m^{3/2} \sqrt{R}} \frac{\Gamma_n \Gamma_c}{\Gamma^2 + \Delta W^2}$$

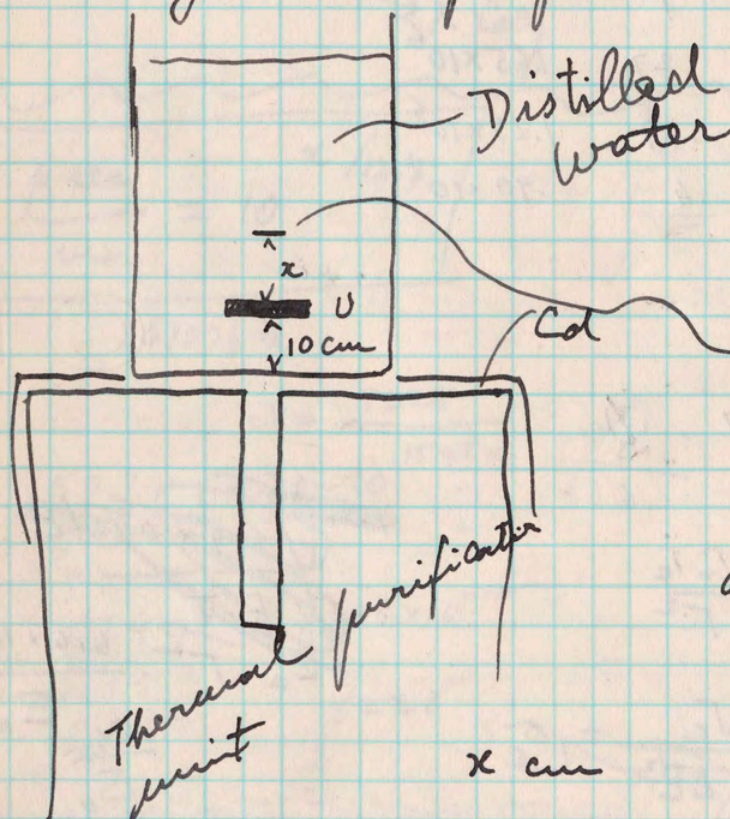
$$\frac{2^{3/2} \pi \hbar^2}{m^{3/2}} = 4.56 \times 10^{-18}$$

$$3.52$$

46

 λ (Kev)Se 34
Rh 45Sb 51
Nd 60Se 1.10
Rh .62Sb .47
Nd .33

December 27 1943 (Expt performed 12/26)
 Slowing down of fission neutrons in water



U-plate 6" ϕ
 .5 cm thick
 1690 grams

Cd In Cd standard detector

Irradiation
 about 10 KWH

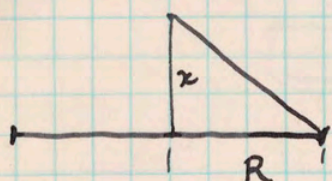
x cm

cpm initial

3
 6
 9
 14.9
 20.9

2462-5
 1350-2
 650.6-1
 113.6-.5
 28.9-.2

$$\int_x^R \frac{f(r)}{\sqrt{r^2 + R^2}} r dr$$



$$R = 3'' = 7.62$$

$$\begin{array}{r} 5.75 \\ 5.42 \end{array} \begin{array}{r} 15.82 \\ 21.57 \end{array} \quad 21.4$$

r	$\sqrt{r^2 + R^2}$	$f(r)/r$	$f(r)r$
3	8.185	5.185	473.9 473.9
6	9.695	3.695	364.8 364.8
9	11.890	2.790	233.2 232.8
14.9	16.733	1.833	62.0 61.7
20.9	22.244	1.344	21.5 21.4

Interpolated values

r	$r f$	$r^2 f$	$r^4 f$
0	0	0	0
1	276	276	276
2	434	868	3470
3	508	1524	13700
4	534	2136	34200
5	508	2540	63500
6	464	2784	100200
7	408	2856	139900
8	349	2792	178700
9	294	2646	214300
10	245	2450	245000
11	198	2178	263500
12	158	1896	273000
13	124	1612	272400
14	96	1344	263400
15	78	1170	263200
16	60	960	245800
17	50	850	245600
18	41.5	747	242000
19	34.5	655	236500
20	28.7	574	229600
21	23.9	502	221400
22	19.9	438	212000
23	(16.5)	380	201000
24	(13.7)	329	189500
25	(11.4)	285	178100
26	(9.5)	247	167000
27	(7.9)	213	155300
28	(6.6)	185	145000
29	(5.5)	160	134600

$$\int_0^{20} r^2 f dr = \frac{35674}{726} = 36300$$

$$\int_0^{20} r^4 f dr = \frac{5296900}{1019800} = 6316760$$

$$r^2 = 174$$

$$\begin{array}{r} 120 \quad 260 \\ 113 \quad 160 \\ 110 \quad 110 \\ 127 \quad 90 \\ 140 \quad 70 \\ 224 \quad 91 \end{array}$$

$\overline{E^2}$ in water from Bloch's spectrum

E

.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0

$$\int \pi(E) dE = 2.213$$

$$\int \sqrt{E} \pi(E) dE = 333$$

$$\overline{E^2} = \frac{333}{2.213} = \underline{\underline{150.5}}$$

$$\begin{array}{ccc} 1416 & (88) & \\ 34.3 & 176 & 150.4 \\ 35.6 & 1856 & 174 \end{array} \quad \begin{array}{c} 440 \\ 88 \\ 23.6 \end{array} \quad \begin{array}{c} 86 \\ 27\% \end{array}$$

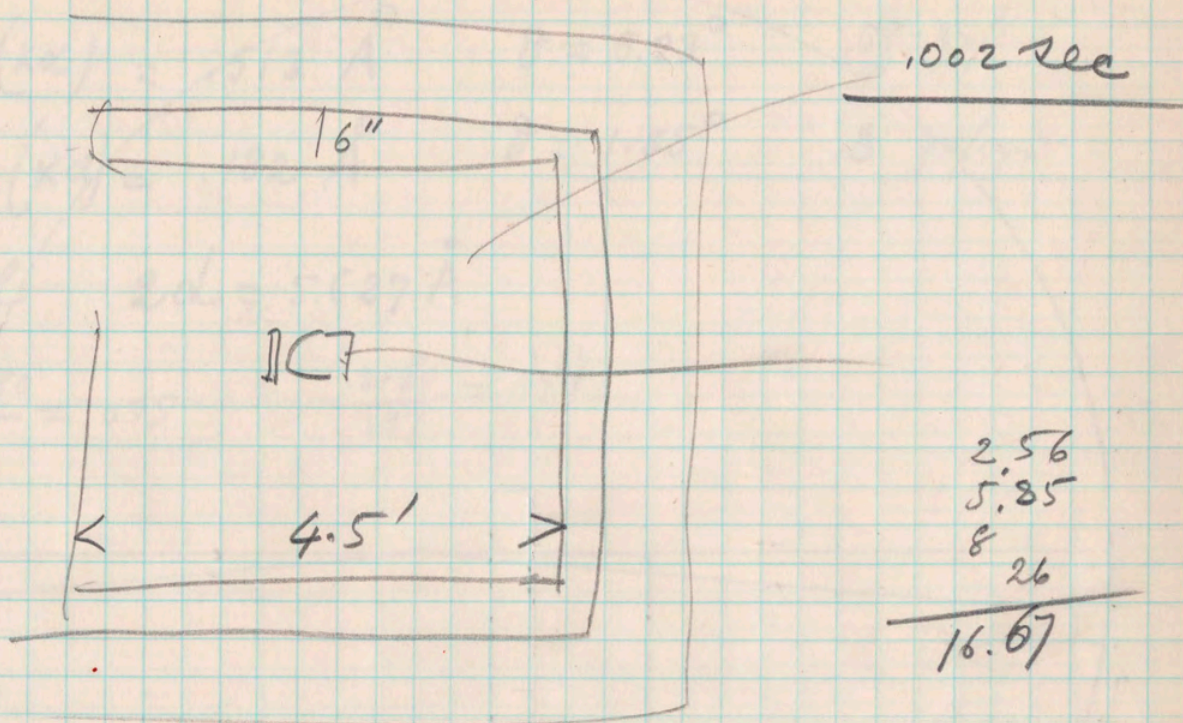
$$\text{Li F} \quad \frac{1}{2} \quad 4.01$$

in θ ~~to~~ θ

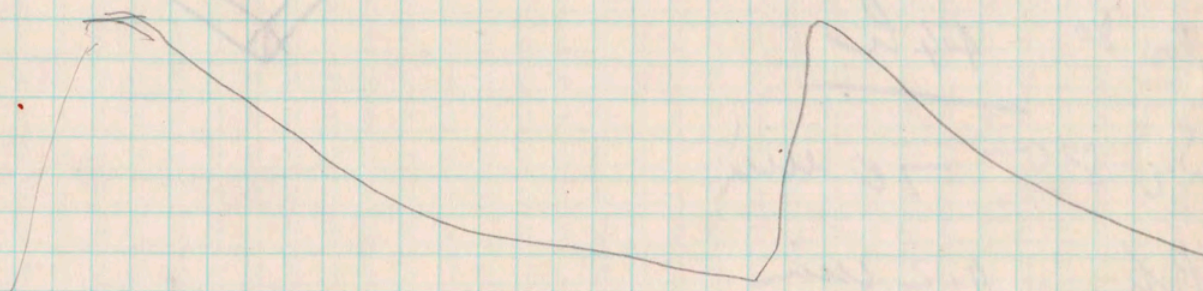
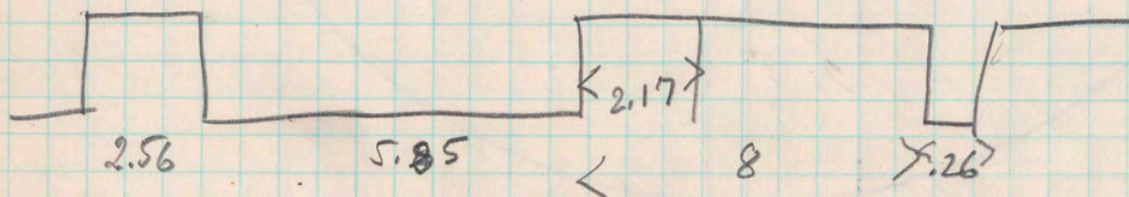
1.10	.274	15.9°	.285
.61	.152	8.75°	.154
.47	.117	6.72°	.117
.33	.082	4.70°	.082

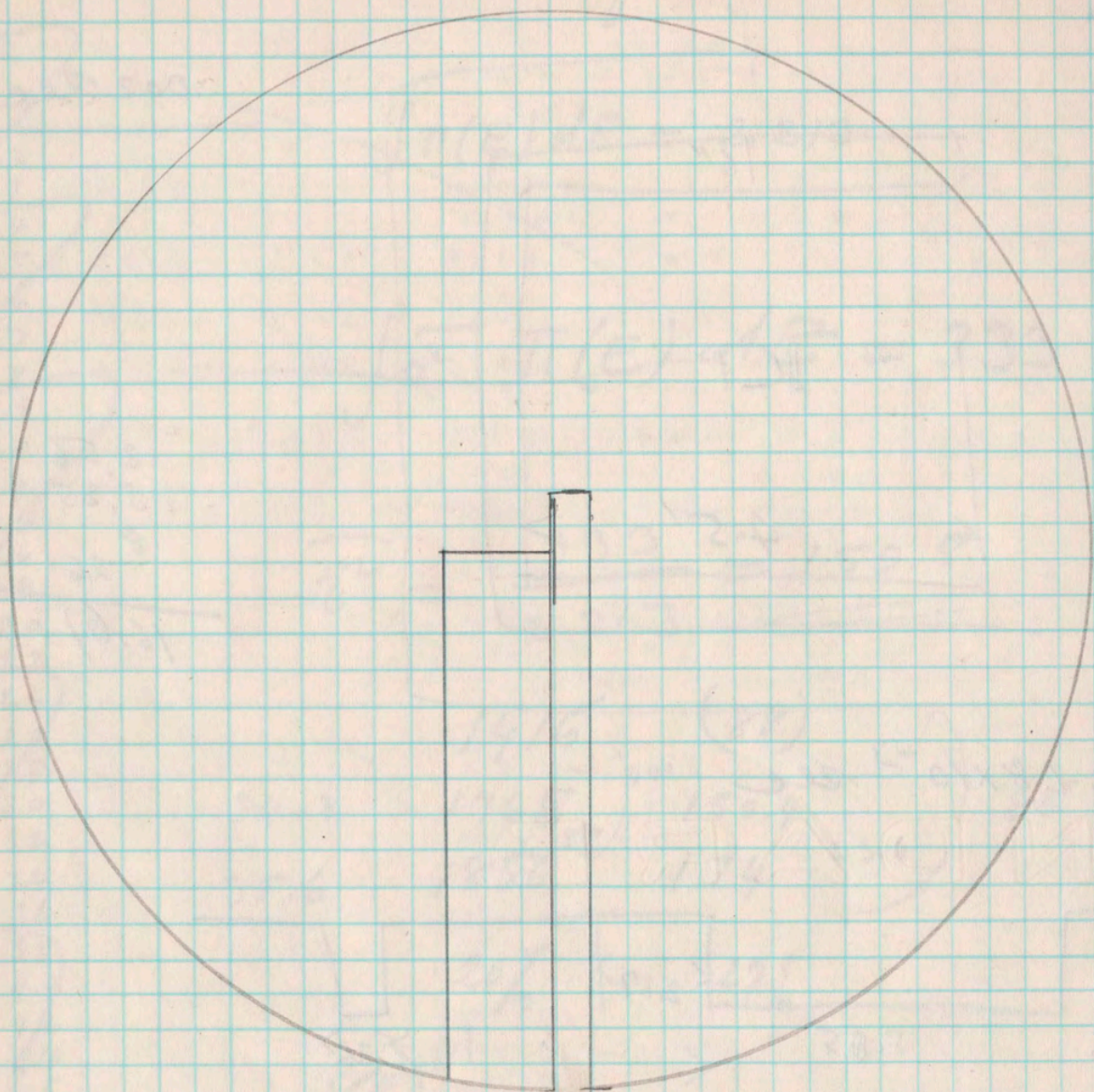
$$\lambda = 2d \sin \theta$$

$$\frac{\lambda}{2d}$$



$$\tau = 1.8 \times 10^{-3} \text{ sec}$$



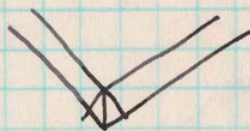


Bz 80 4.4 h

Sr 85 70 min

Rh 4.2 min

I



12/29/1945

51

Ir $\lambda(K\alpha) = .513 \text{ \AA}$ $\theta = 5.23^\circ$.08 gr/cm²

Au $\lambda(K\alpha) = .182 \text{ \AA}$ $\theta = 1.85^\circ$.3 gr/cm²

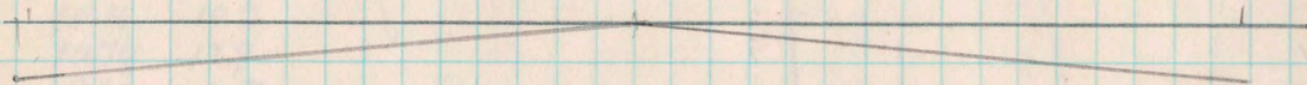
NaCl $2d = 5.627 \text{ \AA}$

$$\frac{.08 \times 80}{115} = .055$$

$$\frac{.3 \times 80}{197} = .077$$

13.3

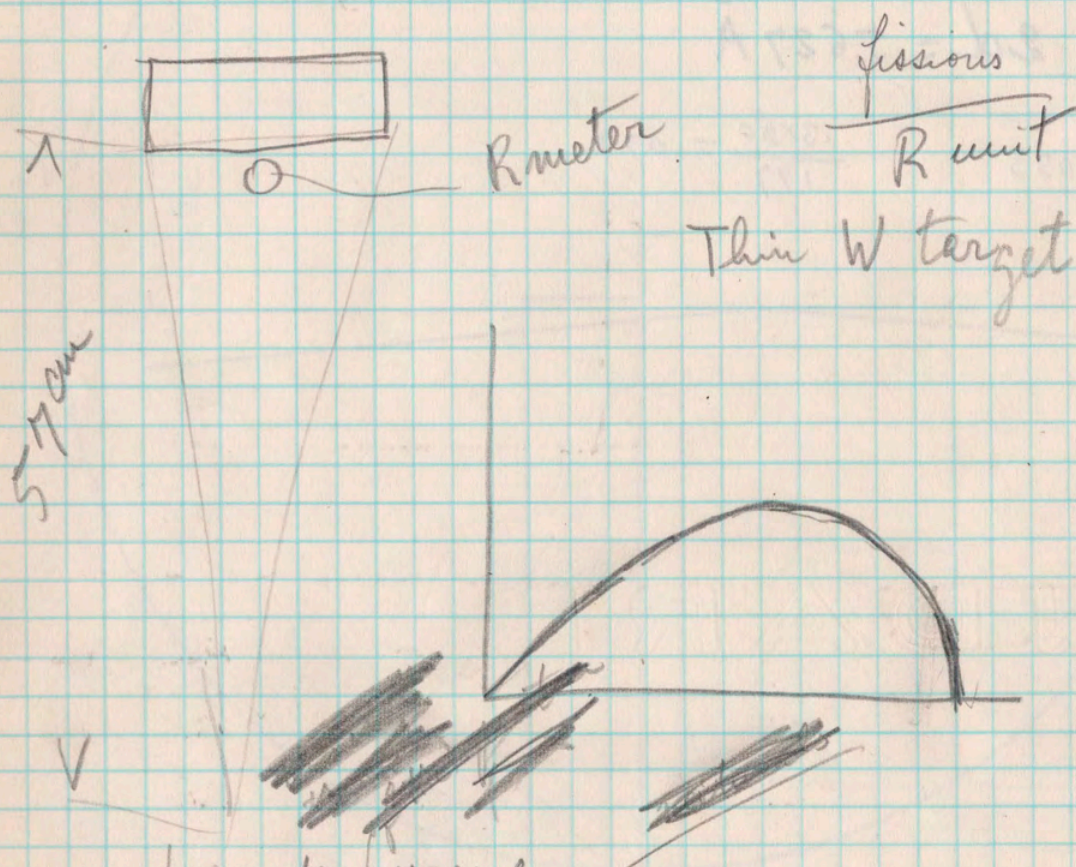
3.6



12/29/43

Koch

ϕ 2.5" Two faces coated 3gr metal
 $\sim 64 \text{ cm}^2$ 47 ang/cm²



MeV	Pulses/R	No of pulses
5.43	.21	1 / 5300 sec
5.55	1.19	7 / 7700 sec
5.66	1.72	8 / 5415 sec
5.78	2.86	13 / 5652
6.00	4.71	12 / 2711
6.23	7.60	12
6.47	22.9	30
6.69	27.9	60
7.28	41.3	90
7.87	35.4	108
8.44	31.8	160
9.01	26.0	156
9.59	20.0	38
8.66	38.1	40
9.77	44.4	40
10.87	66.9	40
11.96	113.1	80
12.61	160	60

$$\frac{7700 \times 6 \times 2}{10 \times 1000}$$

$$\boxed{10^4}$$

$$\frac{.1}{240}$$

$$\frac{4700 \times 2 \times 6}{7700 \times 2 \times 6}$$

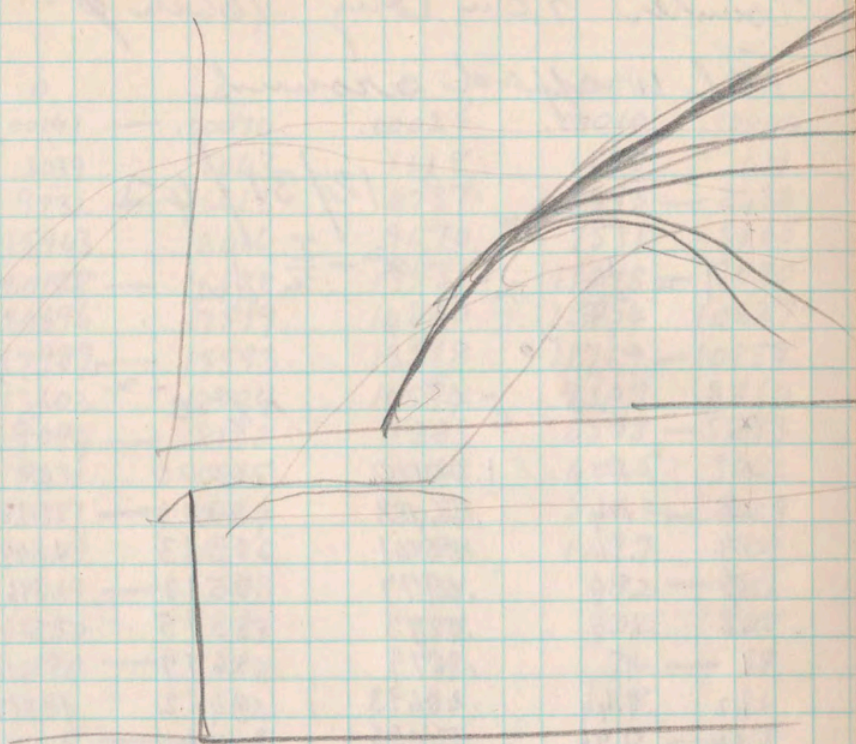
$$\frac{1000}{10^4}$$

West

$$6.3 \quad 3.5 \times 10^{-27}$$

The oxide

MeV	pulses/R
5.88	.20
6.0	.79
6.12	.81
6.23	3.76
6.69	11.2
7.28	20.6
7.87	20.5
8.44	13.7
9.01	11.5
9.59	12.0
10.16	10.3
10.74	13.9
8.66	14.7
9.77	14.3
10.87	19.8
11.96	16.0
12.61	13.5



	Thresholds	MeV	From masses
C	C ¹¹ 21 mm	18.7 - 19.4	19.0
N	N ¹³ 10 mm	11.1 ± .5	10.7
O	O ¹⁵ 2.1 m	16.3 ± .4	15.6
Fe	Fe ⁵³ 9 m	14.2 ± .4	
Cu	Cu ⁶² 10.3	10.9 ± .2	
Zn	Zn ⁶³ 39 m	11.6 ± .4	
Se	Se ^{79 or 81} 17 m	9.8 ± .5	
	57 m	higher	
Mo	Mo ^{91 or 93} 17 m	13.5 ± .4	
Ag	Ag ¹⁰⁸ 2.3 m	9.3 ± .5	
	Ag ¹⁰⁶ 24.5 m	~ 9.55	

Counter 3 cm long 1.6 cm ϕ
 Foil wrapped around

$$\frac{4}{\sqrt{\pi}} \left(\frac{\sqrt{\pi}}{4} - \sum \frac{1}{2} + \frac{\sum^2}{2} \frac{\sqrt{\pi}}{2} \right)$$

$$0 - \frac{\sum^2}{2} + \frac{\sum^2}{2}$$

12/31/43

$$T = \frac{4}{\sqrt{\pi}} \int_0^{\infty} x^2 e^{-x^2 - \frac{\sum}{x}} dx$$

$$1 - \frac{2}{\sqrt{\pi}} \sum$$

x	x^2	e^{-x^2}	$x^2 e^{-x^2}$	$e^{-\frac{\sum}{x}}$		
0	0	1.0000	.0000	∞	0	0
.2	.04	.9608	.0384	2.718	.01413 -	7.389
.4	.16	.8521	.1363	1.649	.8266	2.718
.6	.36	.6977	.2512	1.396	17994 -	1.949
.8	.64	.5273	.3375	1.284	26285	
1	1	.3679	.3679	1.2215	30118 -	
1.2	1.44	.23693	.3412	1.1812	28883	
1.4	1.96	.14086	.2761	1.1535	23936 -	
1.6	2.56	.07730	.1979	1.1332	17462	
1.8	3.24	.03916	.1269	1.1175	11356 -	
2	4	.01832	.0733	1.1051	6633	
2.2	4.84	.00791	.0383	1.0950	3498 -	
2.4	5.76	.315	.0181	1.0869	1665	
2.6	6.76	.116	.78	1.0799	721 -	
2.8	7.84	.39	.31	1.0739	289	
3	9	.000123	.11	1.0689	103 -	
3.2	10.24	.000035	.4	1.0644	38	
3.4	11.56	.9	.1	1.0605	9 -	
3.6	12.96	.2				
3.8	14.44					
4	16					

$\sum$ small

$$T = 1 - \frac{2}{\sqrt{\pi}} \sum + \sum^2 - \dots$$

$\sum$ large

$$T = \frac{4}{\sqrt{3} 2^{2/3}} \sum^{2/3} e^{-\frac{3}{2^{2/3}} \sum^{2/3}}$$

$$\frac{\sqrt{\pi}}{2} =$$

$\sum$.2 .4 .6 .8 1.0 1.2

$T(\sum)$.8063

$e^{-2/x}$ $\Sigma = .2$

.4

.6

.8

1.0

1.2

1.4

0	0	0	0	0	0	0	0	0
.2	.3679	.01413	— .00520	.00191	— .00070	.00026	.00010	.00004
.4	.6064	8265	5012	3039	1843	1118	678	411
.6	.7163	17993	— 12888	9232	— 6613	4737	3393	— 2430
.8	.7788	26285	20471	15943	12416	9670	7531	5865
1	.8187	30120	— 24659	20188	— 16528	13531	11078	— 9070
1.2	.8465	28883	24449	20696	. 17519	14830	12554	10627
1.4	.8669	23935	— 20749	17987	— 15593	13518	11719	— 10159
1.6	.8825	17465	15413	13602	12004	10594	9349	8250
1.8	.8949	11356	— 10162	9094	— 8138	7283	6518	— 5833
2	.9049	6633	6002	5431	4915	4448	4025	3642
2.2	.9132	3498	— 3194	2917	— 2664	2433	2222	— 2029
2.4	.9200	1665	1532	1409	1296	1192	1097	1009
2.6	.9260	722	— 669	619	— 573	531	492	— 456
2.8	.9312	289	269	250	233	217	202	188
3	.9355	103	— 96	90	— 84	79	74	— 69
3.2	.9395	38	36	34	32	30	28	26
3.4	.9430	9	— 9	8	— 8	7	7	— 7

535642	438152	362112	301600	252778	212980	180264
.35709	.29210	.24141	.20107	.16853	.14199	.12018
.8059	.6592	.5448	.4538	.3803	.3204	.2712

 $T(\Sigma)$ $\log_{10} \frac{1}{T}$ $\ln \frac{1}{T}$ Σ $\ln \frac{1}{T}$ $\frac{\sqrt{x}}{2}$

.09372	.18098	.26376	.34314	.41987	.49431	.56671
.2158	.4167	.6073	.7901	.9668	1.1382	1.3049
.9268	.9599	.9880	1.0125	1.0343	1.0543	1.0729

$$x - x^5$$

$$1 - 5x^4$$

.669

.134

.535

.508

.31

.459

.667

.132

.535

58

157

30

6

1/6/44

Wiggling of κ

$$\frac{d\rho}{dt} = -\frac{\rho}{\tau} n + \frac{\epsilon e^{i\omega t}}{\tau} n + D$$

1/27/44

 γ from heating8050 cal
126403.59 α cts/min cal

atoms of 49

$$\frac{3.59 \times 10^{-6} \times .6023 \times 10^{24}}{71000 \times 239} = 1.274 \times 10^{-11}$$

$$A + 0B = 13.6$$

$$A + B$$

$$2B$$

$$3B$$

$$4B$$

$$5B$$

$$6$$

Duckworth
Phy Rev
1 year ago

$$\begin{array}{r} 141 \\ 93 \\ \hline 234 \end{array}$$

Mo

PE

$$\begin{array}{r} 14 \\ 0 \\ 14 \\ 7 \times 15 \end{array}$$

$$15A + 105B = 234.5$$

$$105A + 1015B = 1719.7$$

$$A + 7B = 15.633$$

$$17.25$$

$$A = \frac{57449}{4200} = 13.68$$

$$B = .2793$$

$$\begin{array}{r} 13.68 \\ - 4.82 \\ \hline 7.86 \end{array}$$

$$15B$$

$$\sigma = 13.68 + .2793 \left(\frac{10^6}{V} = \frac{1725}{5.4} \right) \frac{5.4}{100}$$

~~142~~

13.68
4.82

$$\sigma = \frac{15080}{V} + 8.86$$

4.7
~~4.85~~

15.7
8.
235 + 5.38
141 - 3.03
93 - 6.17

125.49
~~42.72~~
57.38
8.9

140 3.13
141 3.03

$$(25) + 1n = 2n + (141) + (93)$$

17 17

+ 125.49
+ 42.72
+ 57.38
- 8.9

[Signature]

$$216.7 \times .931 = 201.7$$

short heating

KE of frame
Inst γ rays
 β energies
neutrinos
 γ energies
KE of 2 neut

170
10
6
8
4
4
202

170
8
3
0
2
1

neutron capture + 5

$$\frac{\text{fiss}}{\text{cal}} = 1.38 \times 10^{-11}$$

$$\frac{4.185 \times 10^7}{189 \times 1.6 \times 10^{-6}} = 1.38 \times 10^{-11}$$

189

49
fiss = .923

$$1.09 \times .923 = 1.006$$

$$1.006 = \frac{\gamma}{\eta} - 1 - \alpha + .98(1-p)(1.09\gamma - .09)$$

$$\begin{array}{c} .11 \\ .12 \end{array}$$

$$2.006 + \alpha = .758\gamma + \frac{.1078}{.1176}(1.09\gamma - .09)$$

$$.117\gamma - .010$$

$$.128\gamma - .011$$

$$\frac{2.016 + \alpha}{.875} = 2.30 + 1.1\alpha$$

$$214$$

$$218$$

$$228$$

$$\frac{2.017 + \alpha}{.886} = 2.28 + 1.1\alpha$$

1/28/44

Stripping at Clinton

22 ih

$$\delta\Delta \times 10^6 = -.4235 \delta ih$$

$$\delta\Delta = 9.3 \times 10^{-6}$$

~~3~~ ~~Δ~~

$$\Delta n + \frac{k-1}{2} n + \frac{\Lambda}{v M^2} q = 0$$

Q28 $J_0 + A Y_0 \left(\sqrt{\frac{1}{c^2} - \frac{\pi^2}{H^2}} z \right) = \begin{cases} 0 & \text{for } z = z_0 \\ 0 & \text{for } z = R \end{cases}$

$Y_0(\varepsilon) = \frac{2}{\pi} \left[\gamma + \log \frac{\varepsilon}{2} \right]$ $J_0'(2.405) = -.519$

$Y_0(2.405) = .510$

$1 + \frac{2}{\pi} A \left[\log \left(\frac{z_0}{R} \sqrt{\frac{1}{c^2} - \frac{\pi^2}{H^2}} \right) - \log 2 \right] = 0$

$\sqrt{\frac{1}{c^2} - \frac{\pi^2}{H^2}} = \alpha$

$1 + \frac{2}{\pi} A \log \frac{\alpha z_0}{3.56} = 0$

$-.519 (\alpha R - 2.405) + .510 A = 0$

$2.447 + A = 1.018 \alpha R$

$\frac{\pi \cdot .510}{2 \cdot .519} = 1.544$

$2.447 = \frac{\pi}{2 \log \frac{\alpha z_0}{3.56}} + 1.018 \alpha R$

$2.405 = \alpha R + \frac{1.544}{\log \frac{\alpha z_0}{3.56}}$

$\alpha \approx \frac{2.405}{R} \cdot \frac{1.544}{R \log \frac{.676 z_0}{R}} = \sqrt{\Delta - \frac{\pi^2}{H^2}}$

$$\Delta = \frac{\pi^2}{H^2} + \frac{5.784}{R^2} + \frac{7.43}{R^2 \log \frac{1.48 R}{r_0}}$$

$$100.4 \times 10^{-6} = \frac{\pi^2}{718^2} + \frac{5.784}{R^2}$$

19.2×10^{-6}

$$\frac{578.4 \times 10^4}{81.2}$$

$$7.123 \times 10^4 = R^2$$

$$R = 267$$

$$\frac{7.43}{\log \frac{395.2}{r_0}} = \frac{.93 \times 10^{-6} \cdot 7.129 \times 10^4}{7.43}$$

$$\log \frac{395.2}{r_0} = \frac{112}{6}$$

$\frac{6}{106}$

$$\frac{.11600}{.000356} = 330$$

$$\frac{.009}{.005}$$

$$n = 2 \log r + 106$$

$$n = B \ln \frac{r}{r_0}$$

$$.0027 \times \frac{1.6}{12}$$

$$\frac{v L^2}{\Lambda}$$

$$\frac{\partial n}{\partial r} = \frac{B}{r}$$

$$.000356$$

$$\frac{v L^2}{\Lambda} \frac{B}{r} 2\pi \Delta \frac{r}{\ln \frac{r}{r_0}} = \sigma_l$$

$$\frac{L^2}{\Lambda} \frac{2\pi}{110} = \sigma_l$$

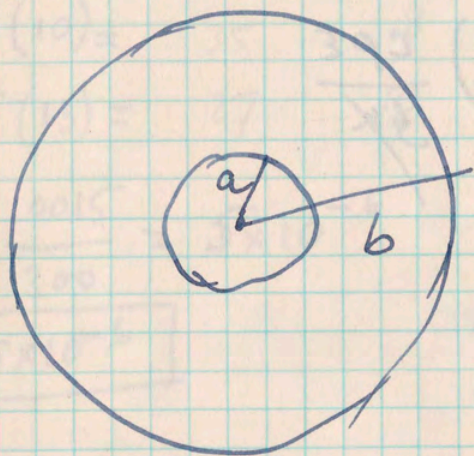
$$\frac{635}{313} \frac{2\pi}{110} = .116$$

$$= .000356 S$$

$$S = 330 \text{ cm}^2$$

1/30/44

Diff. heating



$$q = \frac{c_m M_m}{\tau} \quad c_p \frac{\partial T}{\partial t} = \kappa \Delta T$$

$$-4\pi r^2 \kappa \left(\frac{\partial T}{\partial r} \right)_a = q$$

$$T = T(r) + \epsilon t$$

 ϵ

$$\left(\frac{\partial T}{\partial r} \right)_b = 0$$

$$\frac{c_p \epsilon}{\kappa} = T'' + \frac{2}{r} T' = \frac{1}{r} (rT)''$$

 ~~$c_p \epsilon$~~

$$\frac{c_p \epsilon}{\kappa} r = (rT)''$$

$$\frac{c_p \epsilon}{\kappa} \left(\frac{r^2}{2} + A \right) = (rT)'$$

$$T = \frac{c_p \epsilon}{\kappa} \left(\frac{B}{r} + A + \frac{r^2}{6} \right)$$

$$\frac{c_p \epsilon}{\kappa} \left(\frac{r^3}{6} + Ar + B \right) = rT$$

$$\frac{c_p \epsilon}{\kappa} \left(\frac{B}{a^2} - \frac{a}{3} \right)$$

$$T = \frac{c_p \epsilon}{6\kappa} \left(\frac{2b^3}{r} + r^2 + \frac{3b^2}{r} \right) + \epsilon t$$

$$\frac{B}{b^2} = \frac{b}{3}$$

$$B = \frac{b^3}{3}$$

$$T = \frac{c\rho\varepsilon}{6k} \left(\frac{2b^3}{z} + z^2 - 3b^2 \right) + \varepsilon t$$

$$\frac{c_m m_u T_0}{\tau} = + 4\pi \cancel{q^2} k \left(\frac{\cancel{1} b^3}{\cancel{q^2}} - \cancel{1} a^3 \right) \frac{c\rho\varepsilon}{\cancel{3k}}$$

$$\frac{c_m m_u T_0}{\tau} = \frac{4\pi}{3} (b^3 - a^3) c\rho\varepsilon$$

Example

$$b = 13 \text{ cm}$$

$$\tau = 600 \text{ sec}$$

$$a = 4 \text{ cm}$$

$$c_m m_u = 76$$

$$T_0 = 1$$

$$\frac{c_m m_u}{\tau} = .127$$

$$\rho = 1.6$$

$$c = 17$$

$$k = .3$$

$$\frac{4\pi}{3} (b^3 - a^3) = 8935$$

$$\begin{array}{r} 2197 \\ 64 \\ \hline 2133 \end{array}$$

$$c\rho = .272$$

$$\& \frac{.127}{2430} = 5.23$$

$$\varepsilon = 5.23 \times 10^{-5}$$

$$\frac{c\rho\varepsilon}{6k} = \frac{.272 \times 5.23 \times 10^{-5}}{6 \times .3} = 7.90 \times 10^{-6}$$

$$T = 7.90 \times 10^{-6} \left[\frac{4394}{z} + z^2 - 507 \right] + 5.23 \times 10^{-5} t$$

$$T = \frac{.0347}{z} + 7.9 \times 10^{-6} z^2 - .00400 + 5.23 \times 10^{-5} t$$

$$T(4) = .0087 + .0001 - .0040 = .0048 + 5.23 \times 10^{-5} t$$

$$T(7) = 50 \quad 24 \quad 40 \quad 14 + 11$$

$$T(10) = 35 \quad 8 \quad 40 \quad 3 + 11$$

$$T(13) = 27 \quad 13 \quad 40 \quad 0 + 11$$

$$\frac{.0015}{300} = 5 \times 10^{-6}$$

$$10^{-5}$$

$$5 \times 10^{-6}$$

$$1.65$$

$$1.663$$

$$8 \times 10^{-5} \times .0015$$

$$-.07 - .012$$

$$8 \times 10^{-5} \text{ level}$$

-4	leak
-1.5	res
-6.5	η
-4	tot

$$\frac{2.6 \times 10^{-18}}{\sqrt{ER}} \frac{\Gamma_m \Gamma_c}{\Gamma^2 + (E-R)^2} = \sigma$$

$$\int \sigma \sqrt{E} dE = \frac{2.6 \times 10^{-18}}{\sqrt{R}} \frac{\Gamma_m \pi}{\pi} \pi$$

$$= \frac{2.6 \times 10^{-18} \pi}{\sqrt{R}} \Gamma_m = 8.2 \times 10^{-18} \frac{\Gamma_m}{\sqrt{R}}$$

$$3270 \int \frac{dE}{1 + \dots}$$

$$3270 \lambda .061 \times \pi = 626$$

$$\frac{\Gamma_m}{\sqrt{R}} \approx 6 \times 10^{-4}$$

1/31/44

$$\frac{33.7529}{8.5} = 3.97$$

$$\begin{array}{r} 29.78 \\ .21 \\ \hline 3.76 \end{array} \left. \begin{array}{l} (28) \\ (25) \end{array} \right\} \quad \text{29.99}$$

$$B^{10} (n\alpha) Li^7 \quad Q = 2.85 \quad \begin{array}{c} \cancel{1.81} \\ (1.81, 1.0) \end{array} \quad \begin{array}{c} \cancel{.86} \\ .86 \end{array}$$

$$Li^6 (n\alpha) H^3 \quad 4.57 \quad (1.96, 2.81) \quad 1$$

$$N^{14} (np) C^{14} \quad .62 \quad .042$$

$$O^{17} (n\alpha) C^{14} \quad 1.79 \quad .0044$$

$$\frac{29.99 \times .602}{281} = .0643 \quad \left\{ \begin{array}{l} \text{tot} \quad 1.71 \\ \text{abs} \quad .49 \end{array} \right\}$$

$$\frac{3.76 \times .602}{275} = .0082 \quad \left\{ \begin{array}{l} \text{tot} \quad 5.46 \\ \text{abs} \quad 5.29 \end{array} \right\} \quad 7.17$$

$$\begin{array}{r} 15.6 \\ 10.0 \\ \hline 266 \end{array} \quad \boxed{10 \text{ cc}}$$

$$\frac{2 \times 10^4 \times 0.01 \times 5 \times 4.6}{240} = 1.2$$

55.2

20000
2 × 10⁴

10 15

150

2/1/44

With new data from Dempster

$$(25) + 'n = 2fr + 2'n + 214 \text{ MeV}$$

K.E of fragments	174	174
Inst γ rays	15	12
γ of radioactivities	5	2
β activities	7	4
neutrinos	9	0
K.E of 2 neutrons	4	1
Neutron capture	5	5
	214	198

$$\frac{f_{\text{ins}}}{\text{cal}} = \frac{4.185 \times 10^7}{198 \times 1.602 \times 10^{-6}} = 1.31 \times 10^{11}$$

$$\frac{(49)}{\text{cal}} = 1.27 \times 10^{11}$$

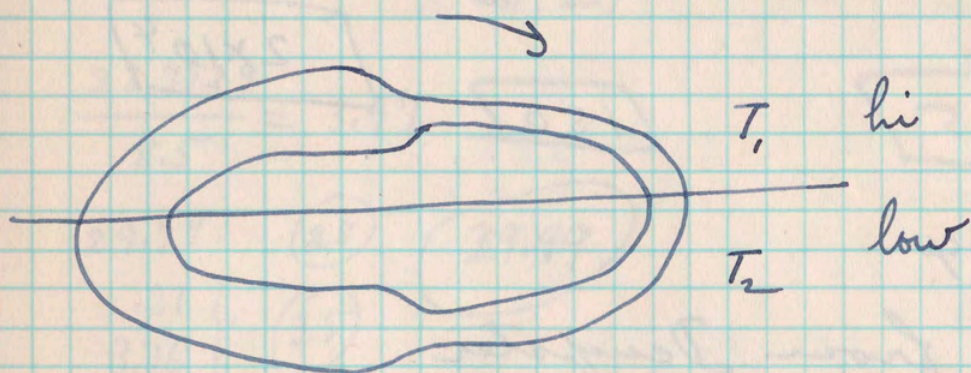
$$\frac{(49)}{f_{\text{ins}}} = \frac{1.27}{1.31} = .97$$

$$\alpha + 2.057 = \frac{\gamma}{\eta} - \alpha + .98 \times .12 (1.09 \gamma - .09)$$

$$.128 \gamma - .011$$

$$\gamma = \frac{2.068 + \alpha}{.886} = 2.33 + 1.1\alpha$$

2/3/44



$$\rho u du + dp = 0$$

$$\rho u s = Q$$

$$p = \frac{RT}{M} \rho$$

~~$$\rho \frac{du}{dt} = - \frac{\partial p}{\partial x}$$~~

$$\rho \frac{du}{dt} = - \frac{\partial p}{\partial x} - \underbrace{\frac{.2 \mu^{.265} p^{.735} u^{1.735}}{D^{1.265}}}_{(F)}$$

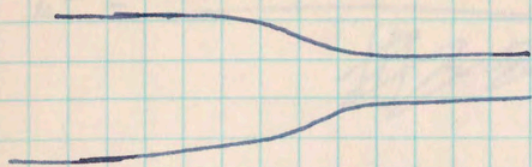
$$\frac{du}{dt} = u \frac{\partial u}{\partial x}$$

$$\rho u du + dp = - F dx$$

$$Q \frac{du}{s} + dp = - F dx$$

$$\oint \frac{du}{s} = + \oint \frac{u ds}{s^2} = \left(\frac{1}{s} - \frac{1}{s} \right)$$

$$\oint F dx = \oint u d \frac{1}{s}$$



$$\rho u du + dp = 0$$

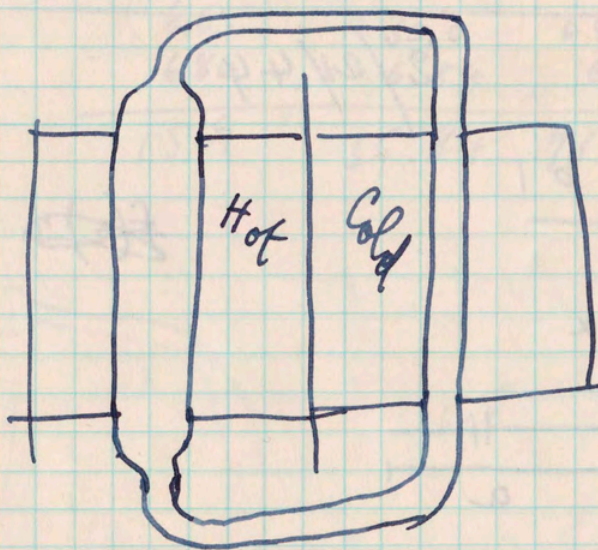
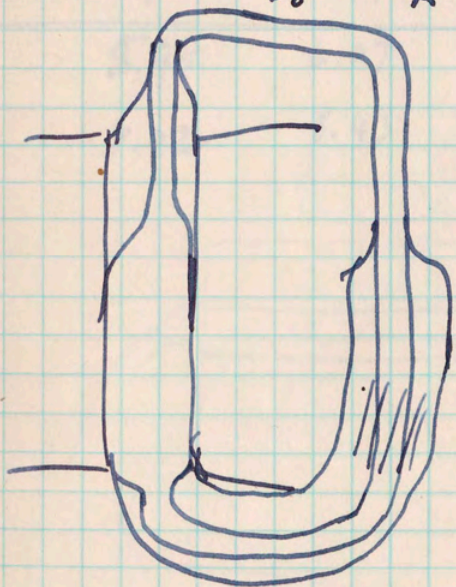
$$\rho u s = Q$$

$$p = p_0 \left(\frac{\rho}{\rho_0} \right)^{\kappa}$$

$$dp = \frac{p_0}{\rho_0^{\kappa}} \kappa \rho^{\kappa-1} d\rho$$

$$u du + \frac{\kappa p_0}{\rho_0^{\kappa}} \frac{d\rho}{\rho^{2-\kappa}}$$

$$\frac{u^2}{2} + \frac{\kappa p_0}{\rho_0^{\kappa}} \frac{\rho^{\kappa-1}}{\kappa-1} = \frac{u_0^2}{2} + \frac{\kappa}{\kappa-1} \frac{p_0}{\rho_0} = \frac{u_0^2}{2} + \frac{\kappa}{\kappa-1} \frac{R}{M} T_0$$



2/17/44

$$10^{18} = \text{not}$$

24000 yrs

$$\tau = 1.1 \times 10^{12}$$

~~3 x 10^8 x 10^10~~

$$\frac{1}{1.1 \times 10^{12}}$$

$$\approx 1200 \times 10^{-24} \times 10^{18}$$

$$\frac{.0012 \alpha}{\tau}$$

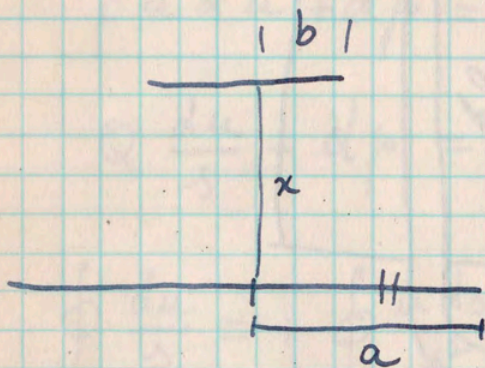
$$\frac{.0012 \alpha}{\tau} > \frac{1}{10} \frac{1}{1.1 \times 10^{12}}$$

$$\frac{1}{10^{10}}$$

$$\frac{\alpha}{\tau} > \frac{1}{10^{10}}$$

$$\boxed{\frac{\tau}{\alpha} < 10^{10}}$$

2/21/44

~~f(x,y)~~

$$\frac{2I}{\pi a^2 b^2} \int_0^a \int_0^{2\pi} \int_0^b dp d\alpha F(\sqrt{x^2 + z^2 + p^2 - 2zp \cos \alpha}) p z dr$$

$$u^2 = x^2 + z^2 + p^2 - 2zp \cos \alpha$$

$$u du = z dr - p \cos \alpha dr$$

$$\overline{u^2} = \frac{\iiint (x^2 + z^2 + \rho^2 - 2z\rho \cos \alpha) r dr \rho d\rho d\alpha}{\iiint r dr \rho d\rho d\alpha} = \frac{\pi}{2} a^2 b^2$$

$$\frac{2\pi \frac{a^2 b^2}{4}}{4} = \frac{\pi a^2 b^2}{2}$$

$$\overline{u^2} = \frac{x^2 \frac{\pi}{2} \frac{a^2 b^2}{4} + 2 \frac{\pi}{2} \frac{a^2}{4} + 2 \frac{\pi}{2} \frac{b^2}{4}}{\frac{\pi a^2 b^2}{2}} = x^2 + \frac{a^2 + b^2}{2}$$

$a = 2.3$

$b = 2.9$

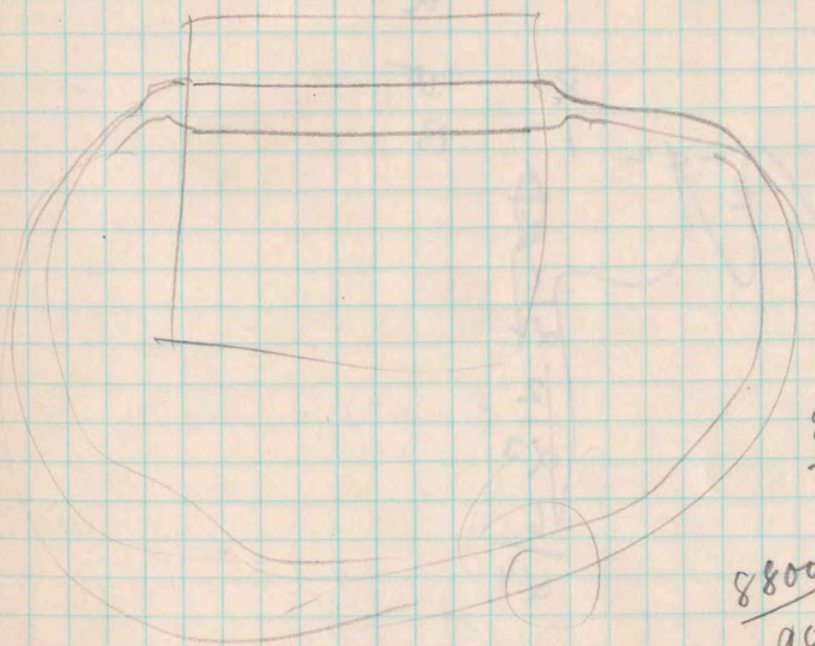
$\frac{a^2 + b^2}{2} = 6.84$ 2.54

$$\begin{array}{r} 2.94 \\ 2.54 \\ \hline 5.48 \\ 2.54 \\ \hline 8.02 \end{array}$$

$$\begin{array}{r} 5.29 \\ 8.39 \\ \hline 13.68 \\ 6.84 \end{array}$$

2.94	3.94
5.48	6.07
8.02	8.43

8.65	30.0	64.2
6.84	6.84	6.84
15.49	36.84	71.04



16.5

$$\frac{800 \times 44}{900} = 9.8$$

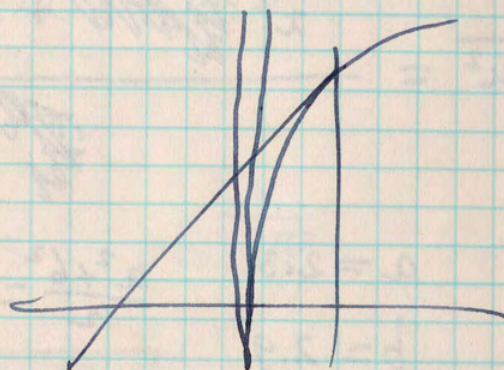
$$\frac{8800}{900}$$

$$\pi = \frac{272.2^2}{4} \left(\frac{1}{71.6^2} - \frac{1}{82.7^2} \right)$$

$$1.85 \times 10^4 (1.95 - 1.46) \times 10^{-4} = .91$$

.49 .056

$$e^{\frac{2\pi}{.91}} = 1000$$



3/1/44

$$\overline{r^2} = \overline{r^2}_q + \overline{r^2}_t = \overline{r^2}_q + \begin{cases} 6l^2 \\ 6l^2 \end{cases}$$

~~Antenna~~

$\int \frac{e^{-\frac{r^2}{2l^2}}}{x} r^2 dr$

$\frac{6e^{\frac{r^2}{2l^2}}}{l^2}$

$e^{-\frac{r^2}{2l^2}}$

$\frac{1}{R}$

$\frac{W}{B}$

$\frac{1}{2l^2}$

$\frac{2}{2l^3}$

$\frac{6}{2l^4}$

$$r_0^2 - r_\theta^2 = 6l^2 \left(1 - \frac{1}{R} \right)$$

$$\frac{R}{R-1} \frac{5r^2}{6}$$

$$4 \times 10^{17} \times 80 \times 10^{-24} \times \frac{\alpha}{\tau} < \frac{1}{100} 10 \frac{2}{2 \times 10^{15}}$$

$$\frac{\alpha}{\tau} < 3 \times 10^{-14}$$

$$\tau > 3 \times 10^{13} \alpha \text{ sec}$$

~~3×10^{13}~~

⊗

$$\tau >$$

~~320×10^{-14}~~

$$\frac{10^{14} \alpha}{3 \times}$$

~~3×10^{13}~~

$$\frac{3 \times 10^{13}}{3 \times 10^{13}}$$

$$\frac{3 \times 10^{13}}{3 \times 10^7}$$

effect < 1% means ~~tau~~ $\tau > 10^6 \alpha \text{ yrs}$

$$\frac{1}{w} \quad \frac{R-1}{m} / R$$

$$\frac{R-1}{R} \quad \otimes$$

~~$\frac{R-1}{R}$~~

March 5 44

$$\textcircled{1} \quad 110 = R \quad H = 220$$

$$\frac{\pi^2}{220^2} + \frac{5.78}{110^2} = (204 + 478) \times 10^{-6} = 682 \times 10^{-6}$$

57.7

$$\frac{5.78}{57.7^2} = 1734 \times 10^{-6}$$

685

$$\begin{array}{r} 1734 \\ - 685 \\ \hline 1049 \end{array}$$

23.9

30.9

$$\begin{array}{r} 112 \\ 15 \\ \hline 127 \end{array}$$

 1.5×10^4

$$\begin{array}{r} 1734 \\ 612 \\ \hline 2346 \end{array}$$

$$\boxed{3.43}$$

$$\frac{80}{23.9}$$

28.4

 $5 \frac{1}{8}$

$$\frac{80}{30.9}$$

13.3

11.8

$$\boxed{2.13}$$

1.1"

 $5 \frac{3}{8}$

a = 1.4 cm

b = 7.7 cm

5.5

5.125

$$\begin{array}{r} 5.125 \\ 25 \\ \hline 5.375 \end{array}$$

$$\boxed{\begin{array}{l} p = .912 \\ f = .979 \end{array}}$$

.94

1.0613

$$613 \times \frac{4}{11.8} = 208$$

$$2.4 \sqrt{\frac{24}{3} 3500} = 82$$

2.4

$$\begin{array}{r} 14000 \\ 4 \\ \hline 3500 \end{array}$$

$$\begin{array}{r} 5 \\ 4 \\ \hline 14 \end{array}$$

$$\frac{5.72 \times 10^3}{3.33} = 1734$$

$$\textcircled{24} \quad 24$$

$$b_0 = 24.0 \quad 30.8$$

$$30.8$$

$$\begin{array}{|c|} \hline 120 \\ 150 \\ \hline 270 \\ \hline \end{array}$$

$$\begin{array}{r} 1734 \\ 682 \\ \hline 1052 \end{array}$$

$$1734$$

$$\sqrt{l > 80}$$

$$2.4 \sqrt{\frac{N}{3}} > 80$$

$$N > \frac{6400 \times 3}{2.4^2} = 8000$$

$$N > 8000$$

$$\sigma_{20} < \frac{16}{8000} = 2 \times 10^{-27}$$

$$\textcircled{99.8}$$

$$\textcircled{99.75}$$

$$110$$

$$110$$

$$12100$$

$$99.8\%$$

$$\frac{2 \times 6 \times 10^{-27}}{1000} = 1.2 \times 10^{-27}$$

$$\textcircled{80 \times 10^{-5}}$$

$$\begin{array}{r} .0005 \\ .5 \end{array}$$

$$5.5$$

$$.0006$$

$$5.5$$

$$.0006$$

$$4.2$$

$$.0015$$

$$15.2$$

$$.0027$$

$$\frac{\sqrt{\pi}}{2}$$

$$\frac{15.2}{.0024} = 6300 = N$$

$$\begin{array}{|c|} \hline 1.0125 \\ .9875 \\ \hline .0024 \\ \hline \end{array}$$

$$l = 2.4 \sqrt{\frac{6300}{3}} = 110$$

$$\frac{1}{l^2} = 82 \times 10^{-6}$$

$$\begin{array}{r} 1734 \\ 82 \\ \hline 1816 \end{array}$$

$$\begin{array}{r} 24.0 \\ 23.5 \end{array}$$

$$21.7$$

$$20$$

$$3.01705$$

$$2.01473$$

$$1.00897$$

$$3.02370$$

$$3.01705$$

$$0.00665$$

6.2 MeV

$$30.8$$

$$24$$

60 cm

$$6.8 \pm .6$$

$$14.6$$

$$18$$

$$326$$

$$14.6$$

$$2.92 \times 10^{-27} \frac{x^{3/2}}{(1+x)^2}$$

$$8.05$$

$$8 \times 10^{-3} \times \frac{1}{8} \times 20 \times .6 = 12 \times 10^{-3} = .012$$

$$100.0$$

$$4.6$$

$$3.3$$

$$1.3$$

$$2.2$$

$$6.8$$

$$15.4$$

$$6.8$$

$$8.6$$

$$6.8$$

$$6.0$$

$$14.6$$

$$\frac{0}{L} = \frac{14.6}{.914} = 16.0$$

$$2.433 = N$$

$$\frac{2N}{N-1} = \frac{4.866}{1.433} = 3.393 = \frac{1}{a} \log \frac{1+a}{1-a}$$

$$a = .914$$

$$.95$$

$$3.855$$

$$.94$$

$$3.700$$

$$.93$$

$$3.57$$

$$.92$$

$$3.455$$

$$.91$$

$$3.355 \quad .100$$

$$\begin{array}{r} 3393 \\ 3355 \\ \hline 38 \end{array}$$

$$.914$$

$$\sqrt{3 \times 14.6 \times 6.0} \left(1 - \frac{2}{5} \frac{6}{14.6}\right)$$

~~16.2~~

$$16.2 \times .836 = 13.6$$

914

14.6

1000

164

836

$$14.6 \times 914 = 13.3$$

~~2111~~~~1000~~~~1000~~~~600 x~~~~6000000~~~~3~~

$$\frac{M^2}{\Lambda} \Delta(vn) + \frac{(k-1)vn}{\Lambda} + q = 0$$

$$\Delta = -\frac{5.78}{R^2} + \frac{d^2}{dz^2}$$

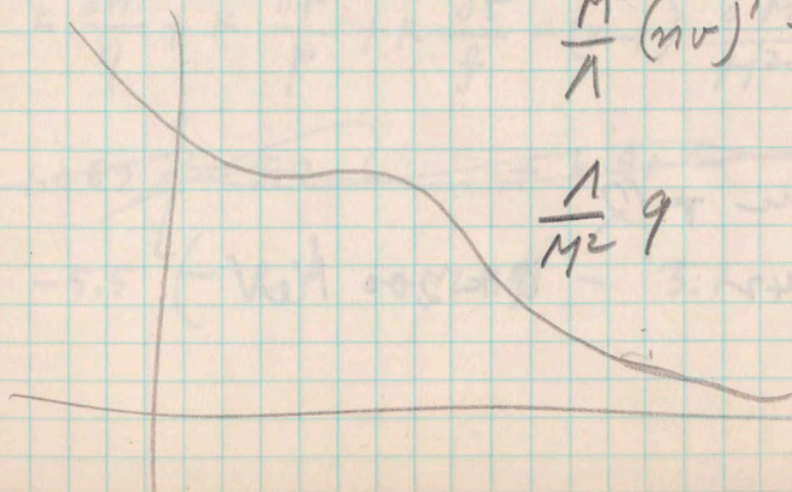
280

$$\frac{M^2}{\Lambda} (vn)'' + \left(\frac{k-1}{\Lambda} - \frac{5.78}{R^2} \frac{M^2}{\Lambda} \right) vn + q = 0$$

$$\frac{M^2}{\Lambda} (nv)'' - \frac{M^2}{\Lambda} \frac{1}{b^2} nv + q = 0$$

$$\frac{M^2}{\Lambda} (nv)' = \frac{\lambda_0}{3} (nv)'_0$$

$$\frac{\Lambda}{M^2} q$$



76

$$(vm)^4 - \frac{vm}{b^2} + \frac{\lambda}{M^2} q$$

$$Ae^{\frac{2}{b}} \quad Ae^{-\frac{2}{b}}$$

$$2 \frac{M^2}{\lambda} \frac{vm}{b} =$$

$$\begin{array}{r} 280 \\ 120 \\ \hline 160 \end{array}$$

$$\underline{200}$$

$$\frac{\lambda b}{M^2} \frac{nv \cancel{20} \lambda}{3 \cancel{b}} = nv$$

$$\frac{\lambda \lambda}{3 M^2} = \frac{nv}{nv}$$

March 12 1944

Packing fractions

German data of feb/44

90	-6.75×10^{-4}
91	-6.75
94	-6.43
140	-3.1
143	-2.49
144	-2.49
234	5.17
235	5.29
238	5.61

$$(25) = 2fr + 1u + Q$$

$$\frac{5.29 \times 235 \times 10^{-4}}{235} = .1242$$

$$Q \approx 200 \text{ MeV}$$

$$200-13 \text{ MeV} = 187$$

See data 1/6/44

77

$$\frac{\text{fiss}}{\text{cal}} = 1.395 \times 10^{11}$$

$$1 \text{ cal} = 2.61 \times 10^{13} \text{ MeV}$$

$$\frac{(49)}{\text{cal}} = 1.27 \times 10^{11}$$

$$\frac{(49)}{\text{fiss}} = \frac{1.27}{1.395} = .91$$

$$1.09 \times .91 = \frac{\gamma}{1.32} - 1 - \alpha + .98 \times .12 \quad (1.09\gamma - .09)$$

$$\gamma = 1.32$$

$$1-p = .12$$

$$.886\gamma - \alpha = 1 + .992 + .011 = 2.003$$

$$\gamma = 2.26 + 1.13 \alpha$$

$$f = .891 (1 + 6.91 \times 10^{-5} t)$$

$$M^2 = 350 + 2500 (1 + .001706 t) (.109 - .891 \times 6.91 \times 10^{-5} t)$$

$$\overset{566}{1140} \quad 56.6$$

$$\cancel{3622.5} + 2500 \cancel{(1 \times .109)} = 622.5 + 272.5 (114 \times 10^{-5} t)$$

$$k \frac{\delta \eta}{\eta} + k \frac{\delta p}{p} + k \frac{\delta f}{f} - (k-1) \frac{\delta M^2}{M^2}$$

$$1.062 \cancel{- 5.2} + 6.91 \cancel{-}$$

$$-5.5 (-2) + 7.3 - 3.1$$

$$\begin{array}{r} .0691 \quad 62 \\ (50 \quad 50) \\ \hline 3453 \quad 310 \\ 6.91 \\ \hline 1.062 \\ \hline 1382 \\ 4146 \\ \hline 691 \\ \hline 733842 \end{array}$$

$$\int \sigma \frac{dE}{E} = f(\text{scatt cross sect})$$

$$\sigma \neq \beta$$

$$f = f(\sigma_{sc})$$

$$\text{Log } f = \text{Log } \sigma_{sc}$$

$$1 \quad 1.117$$

$$2 \quad 3.220$$

$$\begin{array}{r} 3220 \\ 1117 \\ \hline 2103 \\ 1117 \\ \hline 986 \end{array}$$

$$\begin{array}{r} 4206 \\ 986 \\ \hline 3.220 \end{array}$$

$$\text{Log } f = -.986 + 2$$

$$\text{Log } \sigma_{sc} = -.986 + 2.103 \text{ Log } f$$

$$\sigma_{sc} = .103 \times \left(\int \sigma \frac{dE}{E} \right)^{2.103}$$

$$\begin{array}{r} 2103 \\ 986 \\ \hline 1117 \end{array}$$

$$90000 \times 1.8$$

$$1.62 \times 10^5$$

$$50$$

$$43.7$$

$$4 \text{ CO}_2$$

$$8.59 \text{ gr/cm}^2$$

$$\frac{8.59 \times .6023}{12} \sigma = \log$$

$$\frac{2.32}{\log}$$

$$73.8^\circ$$

$$3800$$

$$\begin{array}{|c|} \hline 100 \\ \hline 200 \\ \hline \end{array}$$

3/30/44

Intensity

Amplitude diffused by single plane

$$\left[nXY \sqrt{\frac{\sigma}{4\pi}} \frac{\sin\left(\frac{2\pi X}{\lambda} \sin \theta \epsilon\right)}{\frac{2\pi X}{\lambda} \sin \theta \epsilon} \frac{\sin\left(\frac{2\pi d M \cos \theta \eta}{\lambda}\right)}{\frac{2\pi d}{\lambda} \cos \theta \eta} \right]^2$$

n = atoms / unit surface of plane θ = Bragg angle

X, Y dimensions in plane

M layers

Average on ϵ

$$\int \frac{\epsilon d\epsilon}{2} \frac{\sin^2 A\epsilon}{A^2 \epsilon^2} = \int \frac{d\epsilon}{2A^2} \frac{\sin^2 A\epsilon}{\epsilon} \approx \frac{1}{2A^2} \log A$$

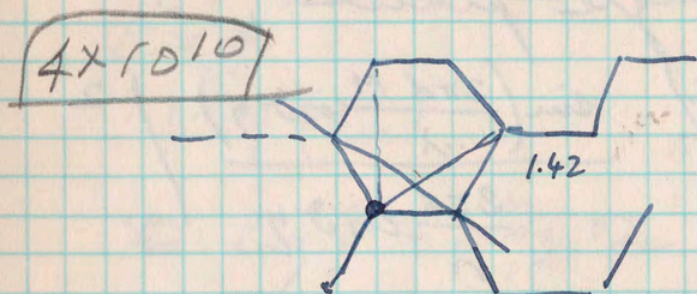
Integral on solid angle

$$\frac{2\pi \sin 2\theta \times 2 d\eta}{B^2 \eta^2} \frac{\sin^2 B M \eta}{B^2 \eta^2} = \frac{4\pi^2 \sin 2\theta \times M}{B}$$

$$\frac{nXYMx}{\sigma_{\text{eff}}} = n^2 X^2 Y^2 \frac{\sigma}{4\pi} \frac{\lambda^2 \log \frac{2\pi X \sin \theta}{\lambda}}{2 \times 4\pi^2 X^2 \sin^2 \theta} 8\pi^2 \sin \theta \cos \theta \frac{M \lambda}{2\pi d \cos \theta}$$

$$\sigma_{\text{eff}} = \sigma \frac{n\lambda^2}{4\pi^2} \log\left(\frac{\pi X}{d} \times \text{number}\right)$$

$$\frac{60000}{15} = 4000$$



3.40

$$\frac{1.42}{71} = 2.13$$

2d

~~10240~~

10-10

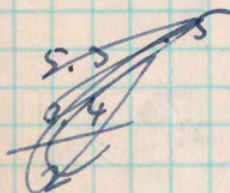
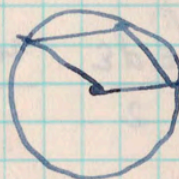
$$\frac{2}{2.13 \times 3.40} = .276$$

~~2.46~~ $\lambda = 2.46$

$\lambda = .392$

~~.0425 \times \log~~

$$\frac{1}{2.46 \times 3.40} = .1197$$



$\lambda = 4.26$

.05

$$4/4/44$$

$$M^2 = 622(1 + 50t)$$

$$f = .821(1 + 6.91t)$$

1.062~

$$7.35 \checkmark$$

$$-3.12 \checkmark$$

$$-2 \checkmark$$

$$-5 = 5 \checkmark$$

$$3.12$$

$$\frac{2}{553}$$

$$1065$$

$$735$$

$$330$$

$$\frac{e^{i\alpha A \frac{N+1}{2}} - e^{-i\alpha A \frac{N+1}{2}}}{e^{i\alpha A \frac{N}{2}} - e^{-i\alpha A \frac{N}{2}}}$$

$$\frac{\sin \alpha A \frac{N+1}{2}}{\sin \frac{\alpha A}{2}}$$

$$\sin \alpha A \frac{N+1}{2}$$

$$\sin \frac{\alpha A}{2}$$

$$\sum_{n,m} \frac{x}{2R \sin \theta} \sin \frac{2 \sin \theta R_{nm}}{x}$$

$$\sum_{nm} \frac{1}{x^2 r_{nm}} \sin \alpha r_{nm} = N + \frac{1}{\alpha} F''(\alpha)$$

$$\sum_{n \neq m} \frac{1}{r_{nm}^3} \sin \alpha r_{nm} = F(\alpha)$$

$$\frac{6.69}{2}$$

$$3345$$

$$\frac{F''(\alpha)}{\alpha} = \sum_{n \neq m} \frac{1}{x^2 r_{nm}} \sin \alpha r_{nm}$$

$$\frac{e^{i\alpha r \cos \theta}}{e} = \frac{1}{2} \int_{-1}^1 e^{i\alpha r \cos \theta} d \cos \theta = \frac{\sin \alpha r}{\alpha r}$$

$$\sum_{n,m} e^{i\alpha(x_n - x_m)} = \left| \sum_n e^{i\alpha x_n} \right|^2$$

$$x_n = A_x n_1 + B_x n_2 + C_x n_3 + D_x q$$

$$\sum_{n_1, n_2, n_3, q} e^{i\alpha A_x n_1 + i\alpha B_x n_2 + i\alpha C_x n_3 + i\alpha D_x q}$$

$$\left| \sum_q e^{i\alpha D_x q} \left(\sum_n e^{i\alpha A_x n_1} \right) \right|^2$$

$$\left| \sum_q e^{i\alpha D_{xq}} \right|^2 \frac{\left[\sin^2 \frac{\alpha A_x}{2} (N+1) \right]}{\sin^2 \frac{\alpha A_x}{2}} \times \dots \times$$

$$\alpha = \frac{2\sin\theta}{\lambda}$$

$$\int \frac{\sin^2 Nx}{\sin^2 x} dx = \pi N$$

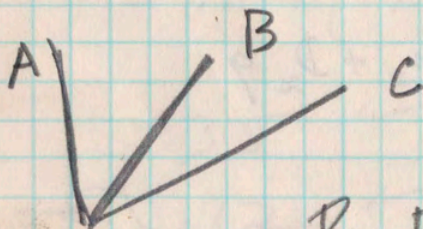
$$\int \delta(\alpha x) dx = \frac{1}{\alpha} \delta(x)$$

~~$$\int \frac{\sin^2 Nx}{\sin^2 x} dx$$~~

$$\pi^3 N \left| \sum_q e^{i\alpha D_{xq}} \right|^2 \delta\left(\alpha \frac{A_x}{2}\right) \delta\left(\alpha \frac{B_x}{2}\right) \delta\left(\alpha \frac{C_x}{2} - n\pi\right)$$

$$\frac{8}{\alpha^3} \pi^3 N \left| \sum_q e^{i\alpha D_{xq}} \right|^2 \delta(A_x) \delta(B_x) \delta\left(C_x - \frac{2\pi n}{\alpha}\right)$$

$$\delta(A_x) \delta(B_x)$$



$$\frac{D}{2A} B \sin \varphi \sin \rho$$

$$\frac{1}{2A}$$

$$\frac{1}{\pi B \sin \varphi}$$



$$\frac{1}{\pi B \sin \varphi} \frac{1}{2A} = \frac{1}{2\pi AB \sin \varphi}$$

$$\frac{8\pi^3}{\alpha^3} N \left| \sum_q \right|^2 \frac{1}{2\pi AB \sin \varphi} \delta\left(d - \frac{2\pi n}{\alpha}\right)$$

$$\frac{4\pi^2}{\alpha^3} N \left| \sum_q \right|^2 \frac{1}{AB \sin \varphi} \delta\left(d - \frac{2\pi n}{\alpha}\right)$$

4/3/44

$$e^{\frac{i}{\lambda} x} \text{ primary}$$

$$\sqrt{\frac{\sigma}{4\pi}} \frac{1}{r} e^{\frac{i}{\lambda} r} \text{ scattered}$$

$$|B| = 2 \sin \frac{\theta}{2}$$

$$\frac{1}{2} \sqrt{\frac{\sigma}{4\pi}} \sum \cancel{e^{i(\vec{P}, \vec{w}_m)}} e^{i(\vec{P}, \vec{w}_n)}$$

$$|P| = \frac{2}{\lambda} \sin \frac{\theta}{2} = P$$

$$\cancel{P} \quad (\vec{P}, \vec{w}_m) = (\vec{P}, \vec{A}) n_1 + (\vec{P}, \vec{B}) n_2 + (\vec{P}, \vec{C}) n_3 + (\vec{P}, \vec{D}_q)$$

$$\frac{1}{2} \sqrt{\frac{\sigma}{4\pi}} \frac{e^{i(\vec{P}, \vec{A}) N_1} - 1}{e^{i(\vec{P}, \vec{A})} - 1} \times \dots \times \dots \times \sum e^{i(\vec{P}, \vec{D}_q)} \text{ amplitude}$$

$$\frac{\sigma}{4\pi r^2} \left| \sum_q e^{i(\vec{P}, \vec{D}_q)} \right|^2 \frac{\sin^2 \frac{N_1 (\vec{P}, \vec{A})}{2}}{\sin^2 \frac{(\vec{P}, \vec{A})}{2}} \times \dots \times \dots \text{ intensity}$$

~~sin~~ $P \parallel$ to x axis

$$\frac{\sigma}{4\pi} \left| \sum_q \right|^2 \frac{\sin^2 \left(\frac{N_1 P}{2} A_x \right)}{\sin^2 \frac{P}{2} A_x} \times \dots \times \dots$$

$$\frac{\sin^2 N x a}{\sin^2 x a} \approx \pi N \sum_{s=-\infty}^{\infty} \delta(x - \pi s) = \frac{\pi N}{a} \sum_{s=-\infty}^{\infty} \delta\left(x - \frac{\pi s}{a}\right)$$

$$\frac{\sigma}{4\pi} \left| \sum_q \right|^2 \frac{8\pi^3 N_1 N_2 N_3}{p^3} \delta\left(A_x - \frac{2\pi s_1}{p}\right) \delta\left(B_x - \frac{2\pi s_2}{p}\right) \delta\left(\frac{B - 2\pi s_3}{p}\right)$$

$$\frac{2}{\lambda} \sin \frac{\theta}{2}$$

$$\frac{2 \sin \frac{\theta}{2} \lambda}{2 \sin \frac{\theta}{2}}$$

$$\frac{4\pi}{\lambda} \sin \frac{\theta}{2}$$

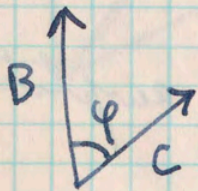
$$\frac{\sigma}{4\pi} \left| \sum_q \right|^2 \frac{\lambda^3 N}{8 \sin^3 \frac{\theta}{2}} \sum_{s_1, s_2, s_3} \delta\left(A_x - \frac{\lambda}{2 \sin \frac{\theta}{2}} s_1\right) \delta\left(B_x - \frac{\lambda s_2}{2 \sin \frac{\theta}{2}}\right) \delta\left(\frac{C - \lambda s_3}{2 \sin \frac{\theta}{2}}\right)$$

~~prob~~

$$s_2 = s_3 = 0$$

$$A_x = d$$

$$\frac{\delta(B_x) \delta(C_x)}{2\pi C \sin \varphi} = \frac{2}{2\pi C \sin \varphi} \times \frac{2\pi B}{4\pi B^2} = \frac{1}{2\pi B C \sin \varphi}$$



L

$$\frac{\sigma |\Sigma_g|}{64\pi^2 BC \sin \widehat{BC}} \frac{\lambda^3 N}{\sin^3 \frac{\theta}{2}} \delta \left(d - \frac{\lambda n}{2 \sin \frac{\theta}{2}} \right)$$

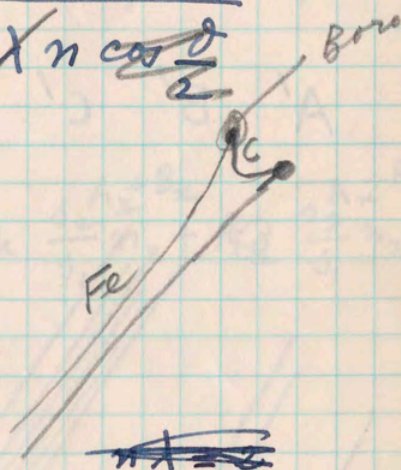
$$\frac{1}{2} \frac{\lambda n}{2 \sin^2 \frac{\theta}{2}} \cos \frac{\theta}{2}$$

$$2\pi \sin \theta d\theta$$

$$\frac{\sigma |\Sigma_g|}{64\pi^2 BC \sin \widehat{BC}} \frac{\lambda^3 N}{\sin^3 \frac{\theta}{2}} \frac{2\pi \sin \theta}{\sin \theta} \frac{4 \sin^2 \frac{\theta}{2}}{\lambda n \cos \frac{\theta}{2}}$$

$$\frac{N \sigma |\Sigma_g|^2 \lambda^2}{4\pi BC \sin \widehat{BC} \times n}$$

$$\frac{\lambda^2 |\Sigma_g|^2}{4\pi n BC \sin \widehat{BC}}$$



1.42

3.4

$$\frac{d^2 |\Sigma_g|^2}{\pi n^3 Q BC \sin \widehat{BC}}$$



IS

.48 x .276

$$= \frac{.130}{n}$$

2

.64

April 5 44

$$\delta(A_x - l s_1) \delta(B_x - l s_2) \delta(C_x - l s_3)$$

$$A_x = l s_1$$

$$B_x = l s_2$$

$$C_x = l s_3$$

$$s_2 A_x - s_1 B_x = 0$$

$$s_3 A_x - s_1 C_x = 0$$

$$A_x = l s_1$$

$$l = \frac{\lambda}{2 \sin \frac{\theta}{2}}$$

$$s_1 \neq 0$$

$$A' \quad B' \quad C'$$

$$A' = A$$

$$B' = s_2 A - s_1 B$$

$$C' = s_3 A - s_1 C$$

$$\delta(A, [B, C])$$

$$\delta(A, [B, C])$$

$$([A', B'], C')$$

$$s_1 = 1$$

$$+ s_1^2 ([A, B] C)$$

$$\frac{\sqrt{13}}{6} \frac{6}{\sqrt{13}}$$

$$\left(\frac{x}{2}\right)^2 + \left(\frac{x}{3}\right)^2 = 1$$

$$\frac{13}{36} x^2 \left(\frac{1}{4} + \frac{1}{9}\right) = 1$$

$$n_1 A + n_2 B + n_3 C = n'_1 A' + n'_2 B' + n'_3 C'$$

$$n_1 = n'_1 + n'_2 j_2 + n'_3 j_3$$

$$n_2 = -n'_2 j_1$$

$$n_3 = -n'_3 j_1$$

$$n'_2 = -\frac{n_2}{j_1}$$

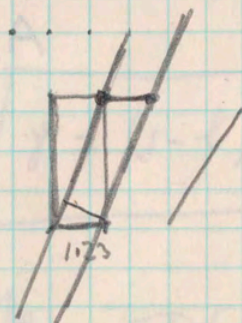
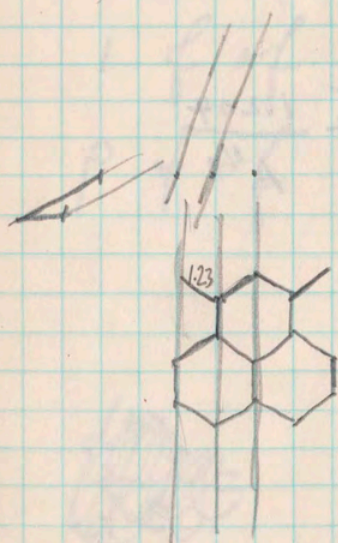
$$n'_3 = -\frac{n_3}{j_1}$$

$$n'_1 = n_1 - \frac{j_2}{j_1} n_2 - \frac{j_3}{j_1} n_3$$

$$n_1 = n'_1 - \frac{j_2}{j_1} n_2 - \frac{j_3}{j_1} n_3$$

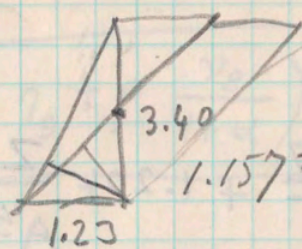
$$\sum_1^2$$

$$\sum_1 = \sum_{n_2=0}^{j_1-1} \sum_{n_3=0}^{j_1-1} e^{-i \frac{4\pi}{\lambda} \sin \frac{\theta}{2}} \left(\frac{j_2 A_x + B_x}{j_1} n_2 + \frac{j_3 A_x + B_x}{j_1} n_3 \right)$$



$$\frac{1.8 \times 1.6}{12} = 10$$

$$\frac{120}{1.6 \times 1.6} = 42$$



$$1.7$$

$$1.157 = \frac{1.23 \times 3.40}{\sqrt{1.23^2 + 3.40^2}}$$

$$\frac{1.51}{11.55} = 3.62^2$$

$$0.0395 \mu = 2d$$

$$\begin{array}{r} 151 \\ 289 \\ \hline 440 \end{array}$$

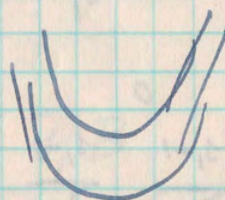
$$\begin{array}{r} 622 \\ 585 \end{array}$$

$$\sqrt{\frac{1.23 \times 1.7}{1.7^2 + 1.23^2}}$$

April 20 44

A	892A 164.16/A	1.204/A ^{1/3}	Sum
20	8.22	.44	8.66
40	4.11	.35	4.46
60	2.74	.31	3.05
80	2.05	.28	2.33
100	1.642	.259	1.901
120	1.369	.244	1.613
140	1.173	.232	1.405
160	1.027	.221	1.248
180	.916	.213	1.129
200	.822	.206	1.028
220	.747	.199	.946
240	.685	.194	.879

$$\begin{array}{r}
 14.66 \\
 1.4 \\
 \hline
 5864 \\
 1466 \\
 \hline
 20524
 \end{array}$$



$$+ 14.66 \times 1.40 \frac{(A-2Z)^2}{A} + .602 \frac{Z^2}{A^{1/3}}$$

$$20.52 \frac{(A-2Z)^2}{A} + .602 \frac{Z^2}{A^{1/3}}$$

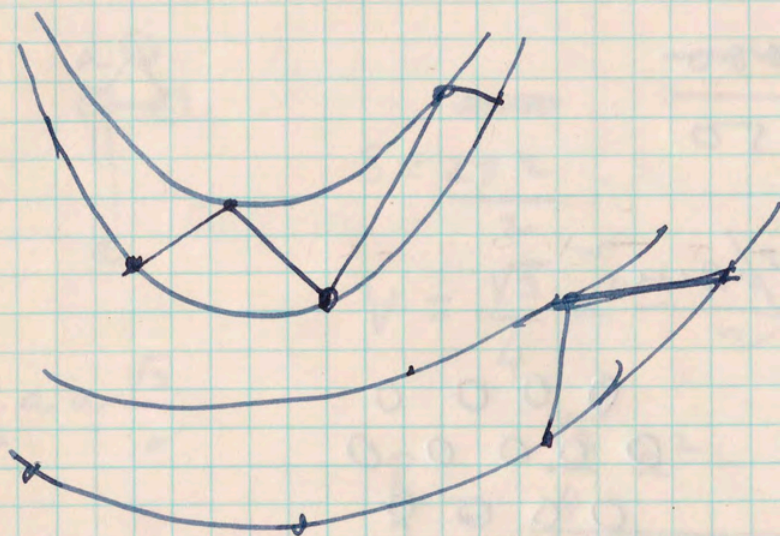
$$\frac{164.16}{A} + \frac{1.204}{A^{1/3}}$$

$$41.04$$

$$- 82.08 \frac{A-2Z}{A} + 1.204 \frac{Z}{A^{1/3}}$$

$$82.08 \left(\frac{A}{Z_0} - 2 \right) = 1.204 A^{2/3}$$

$$\left(\frac{\partial^2 E}{\partial z^2} \right)_A = \frac{164.16}{A} + \frac{1.204}{A^{1/2}}$$



100

101

42

44

44

45

120

121

50

51

52

April 24 1944

γ = ratio ~~of~~ produced / γ consumed

1 f of 9

ρ f of 8

$$(1-l)(\gamma_9 + \rho \gamma_8) - 1 - \alpha - \rho = (1+\alpha)\gamma$$

$$\gamma = (1-l) \left(\gamma_9 + \rho \frac{\gamma_8}{1+\alpha} \right) - 1 - \frac{\rho}{1+\alpha}$$

~~$\frac{dM}{dW}$~~

~~$\frac{dM}{dW}$~~ = ~~$\frac{dM}{dW}$~~

~~$\frac{dM}{dW}$~~ = ~~$\frac{dM}{dW}$~~

$\frac{W}{W} \frac{1+\alpha}{1+\rho} (\gamma-1) =$ increase of γ
~~after~~ when every
 W is developed

4-3

~~200000~~~~100000~~~~60000~~
~~11000~~

60 KW/m

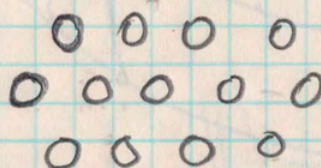
13.5

1350

~~60000~~

1350

4 or 5

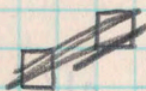
watts/cm²

100

.5

500000 m

2m

10000 KW/m³~~10000~~

$$\frac{\text{Volume}}{\text{surface}} = \frac{\pi R^2}{2\pi R} = \frac{R}{2} \quad \text{avg radius } R$$



$$S = \frac{2\pi r}{2}$$

$$V = \frac{\sqrt{3}}{4} a^2 - \frac{\pi r^2}{2}$$



$$\frac{1}{2} a a \frac{\sqrt{3}}{2}$$

$$\frac{R}{2} = \frac{\frac{\sqrt{3}}{4} a^2 - \frac{\pi}{2} r^2}{\pi r} = \frac{\sqrt{3}}{4\pi} \frac{a^2}{r} - \frac{r}{2}$$

$$a = 1$$

$$R = .15$$

$$\begin{array}{r} .92 \\ 7 \\ \hline .85 \end{array}$$

$$.138 \frac{a^2}{R} - \frac{r}{2}$$

$$\cancel{r \sim (1-e)(1+p)r - 1}$$

$$r \sim (1+p)\{(1-e)r - 1\}$$

92

April 27 1944

C
3456D + 2 Py
2866D B Col
6557 3704 8622.1 mm
1.1078 gr

$$\frac{\pi}{4} \times 2.21^2 = 3.83$$

$$6.43 \times 10^{-4}$$

$$\frac{1.1078 \times .6027}{271 \times 3.83} = .000647$$

$$\begin{array}{r} 3456 \\ 86 \\ \hline 3370 \end{array} \quad \begin{array}{r} 2866 \\ 86 \\ \hline 2780 \end{array} \quad \begin{array}{r} 6557 \\ 86 \\ \hline 6471 \end{array}$$

$$\log 2.324 = .843$$

$$\begin{array}{r} 41 \\ 802 \end{array}$$

2080

$$\begin{array}{r} .653 \\ 10 \\ \hline 643 \end{array} \times .99$$

935

~~Convection~~
Convection

May 15 1944

93

$$\frac{h_c N}{K} = .548 \left[\left(\frac{c_p \mu}{K} \right) \left(\frac{N^3 \rho^2 \beta g (\Delta t)}{\mu^2} \right) \right]^{1/4}$$

$$y = \log_{10} \frac{h_c D}{K_f}$$

$$x = \log_{10} \left[\frac{D^3 \rho^2 \beta g \Delta t}{\mu_f^2} \frac{c_p \mu_f}{K_f} \right]$$

x	y
-4	-.31
-3	-.26
-2	-.18
-1	-.075
0	+.035
1	.18
2	.325
3	.50
4	.73
5	.97
6	1.21
7	1.46
8	1.71

β = thermal coeff of expansion
(reciprocal temperature)

μ - .01 poises

$^{\circ}\text{C}$	$\frac{c_p \mu}{K}$
0	11
20	7
40	5
60	3
80	2

Btu/hr (sq ft) deg F

$\sim 50 \div 100$

$$x = \log_{10} D^3$$

D	y	10 ⁹	h
1	1.21	16	.022
2	1.44	28	.020
3	1.56	36	.017
4	1.66	46	.016

p. 93

$$\frac{D^3 \times 200 \Delta t}{.01} \times 3$$

$$D^3 \times 6 \times 10^4 \Delta t$$

$$D^3 \times 10^6 = ?$$

$$x = 6 + 3 \log_{10} D$$

$$y = \log_{10} \frac{h D}{.0014}$$

$$D = \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix}$$

$$3 \Delta 005, X$$

$$10.$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

$$3 \Delta 005, X$$

K (BTU/hr)(ft²)(deg F/ft)

32°F .337
146 .385

May 16 44

Vapors condensing on horizontal pipes

$$\frac{hD}{K} = .725 \left(\frac{D^3 \rho^2 g \gamma}{K \mu \Delta t} \right)^{1/4}$$

$$F = \mu L V$$

K [BTU]

K of condensate
 ρ " "
 γ = latent heat
 μ of condensate
 Δt vapor wall

$$\frac{D^3 \rho^2 g \gamma}{K \mu \Delta t}$$

2000

$D=1$ $\rho=1$ $g=1000$ $\gamma=500$

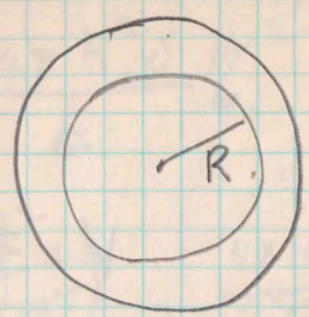
$K=.0014$ $\mu=.01$

$$h = .0014 \times .725 \left(\frac{500000000000}{.0014 \times .01} \right)^{1/4} \Delta t^{-1/4} = 4.4 \Delta t^{-1/4}$$

1.375×317

~~715000~~
25000

~~30/3/20~~



~~30/3/20~~

1 gr

20×10^6

$$\frac{1.2 \times 10^6 \times 1.5 \times 10^{+12}}{2.40}$$

~~30/3/20~~

$$+ \Delta n + \frac{k-1}{M^2} n$$

$$\frac{.8 \times 10^{18}}{8 \times 10^{17}}$$

$$\frac{8 \times 10^{17}}{2 \times 10^7} = 4 \times 10^{10}$$

$$\frac{\partial n}{\partial E} = \frac{\lambda v}{3} \Delta n + \frac{k-1}{\Lambda} v n$$

$$= n v \left[\frac{(k-1)}{\Lambda} - \frac{\lambda}{3} \frac{\pi^2}{R^2} \right]$$

$$\frac{1}{T} = \frac{1}{\tau} \left(k-1 - \frac{\pi^2 M^2}{R^2} \right)$$

$$\frac{\pi^2 M^2}{\tau} \left(\frac{1}{R_c^2} - \frac{1}{R^2} \right)$$

$$\mu = \pi^2 M^2 \left(\frac{1}{R_c^2} - \frac{1}{R^2} \right)$$

$$= 2 \pi^2 M^2 \frac{\delta R}{R^3}$$

$$m \left(\frac{R_c - R}{\delta T} \right)^2$$

$$\frac{M^2}{\tau} \frac{1}{R^3} \delta R = \frac{1}{T}$$

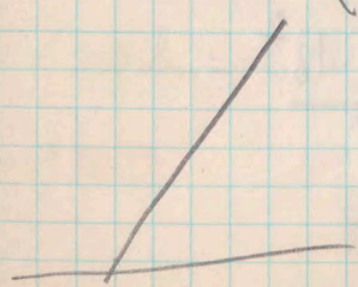
~~30/3/20~~

$$m \left(\frac{M^2 \delta R^2}{\tau R^3} \right)$$

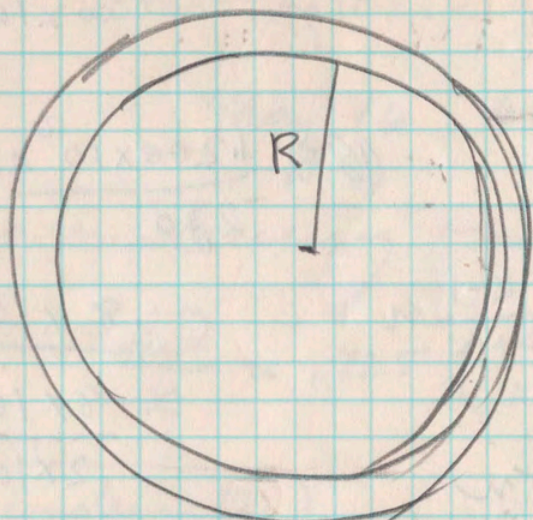
$$m \left(\frac{\mu}{\tau} \frac{\delta R}{\tau} \right)^2$$

$$m \left(\frac{\mu^2 R^3}{\tau M^2} \right)^2 \sim \frac{m R^6 \mu^4}{M^4 \tau^2}$$

~~30/3/20~~



M^3



$$V = \sqrt{\frac{E}{\rho}}$$

T.

~~50000~~

$$P \pi (R)^2 = T \times 2\pi R$$

$$P = \frac{2T}{R}$$

$$T = E \delta \frac{u}{R}$$

$$\frac{2T}{R} = E \delta \frac{u}{R}$$

$$\ddot{u} = -\frac{P}{\rho \delta} = -\frac{1}{\rho \delta} \frac{2}{R} E \delta \frac{u}{R}$$

$$\ddot{u} = -\frac{2E}{\rho R^2} u$$

$$u = u_0 \sin\left(\sqrt{\frac{2E}{\rho R^2}} t\right)$$

$$\frac{T_0}{\delta} = 0$$

$$\dot{u}_0 = \sqrt{\frac{2E}{\rho R^2}} u_0$$

$$K.E. = \frac{1}{2} M \frac{2E}{\rho R^2} u_0^2 = \frac{ME u_0^2}{\rho R^2}$$

$$\frac{4\pi R^2 \delta E}{\rho R^2} \frac{R^2 T_0^2}{E \delta}$$

$$W = \frac{4\pi R^2 T_0^2}{E \delta}$$

$$W = \frac{4\pi R^2 \delta}{E} \text{ g}^2$$

$$\frac{2 \times 10^{12}}{2 \times 10^9}$$

$$= \frac{30000 \times 453 \times 1000}{2.54^2}$$

97

$$\frac{(5 \times 10^5)^2 \times 8}{200 \times 10^{10} \times}$$

$$\frac{4 \times 10^{16}}{10^{12}} = \frac{4 \times 10^4 \times 5 \times 10^{18}}{2 \times 10^{12}} \times 10^2$$

$$\frac{4 \times 10^{16} \times 2 \times 10^{12}}{100 \times 4 \times 10^4 \times 4 \times 10^{18}} = 4 \times 10^4$$

$$\frac{12000}{37}$$

$$\frac{2660}{15000}$$

6°

$$\frac{37}{6}$$

12000

$$2660 \times 720 + 2660$$

37000

$$2220 + 12320 + 2900$$

62000

$$3720 + 29840 + 1380$$

$$\frac{37}{6} = 222$$

$$\frac{62}{6} = 372$$

5000

58

2

2000

69

138

Water pipes

$$\frac{(160 + 1.96 t) V_s^{.8}}{D^{.2}} = h$$

$V_s = \text{ft/sec}$

$D = \text{inches}$

$$h = \text{Btu/hr (sq ft (deg F))}$$

$$\frac{(160 + 1.96t') V_J'^{.8}}{D'^{1.2}} = h'$$

~~100~~

$$\frac{[160 + 1.96(32 + 1.8t)] \left(\frac{V}{30.48}\right)^{.8}}{\left(\frac{D}{2.54}\right)^{1.2} \times 7240} = h$$

$$\begin{array}{r} 160 \\ 688 \\ \hline 222.8 \end{array}$$

1 cal/sec cm²

$$\frac{3600 \times 30.48^2 \times \cancel{10}}{453} = 7240$$

$$30.48^{.8} = 15.4$$

242

$$2.54^{1.2} = 1.209$$

~~100~~

40 x 300

.12

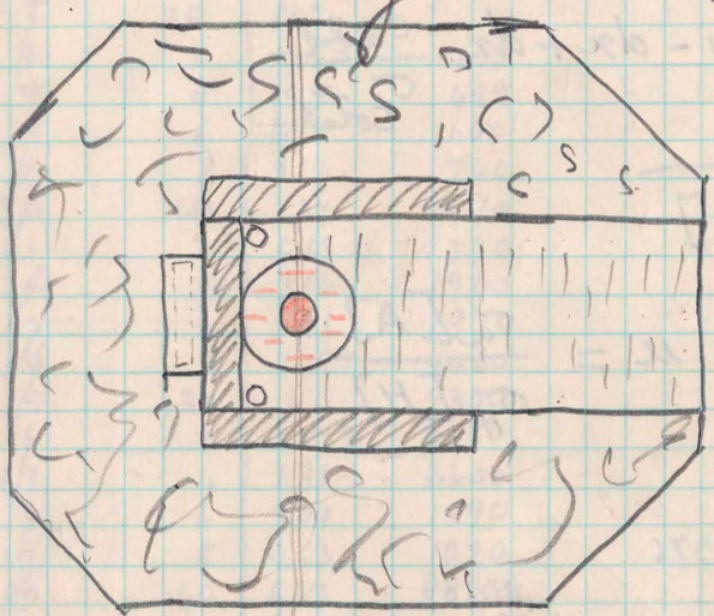
$$\frac{1.209}{7240} \frac{(222.8 + 3.53t)}{15.4} \frac{V^{.8}}{D^{1.2}}$$

$$h = (242 + 3.84t) \frac{V^{.8}}{D^{1.2}} \times 10^{-5}$$

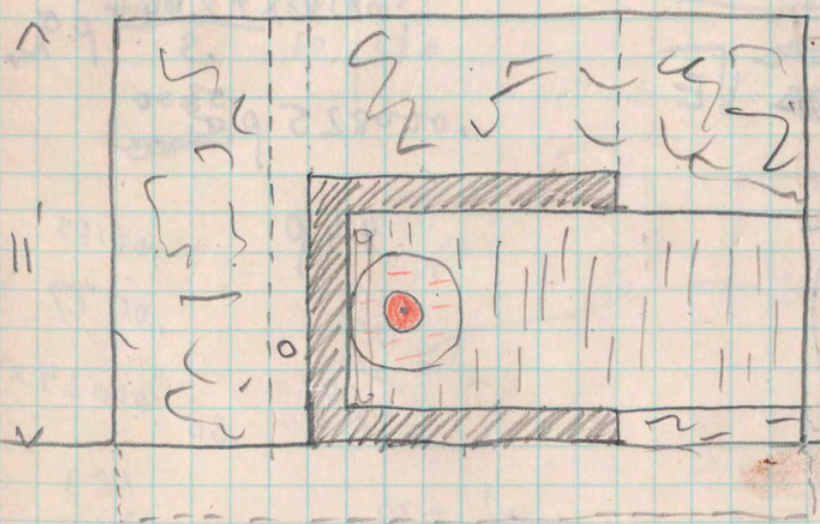
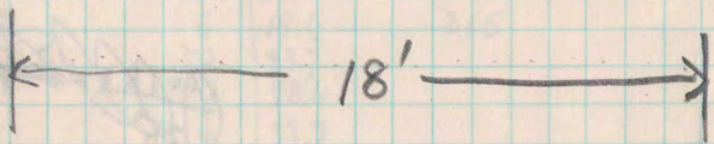
$.015 \times 30 = .45$

.45

May 21 1944

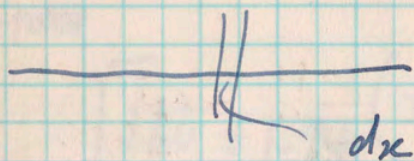


15'



May 27 1944

Resonance absorption of (49) in water



dx

$$1 - dx + dx \frac{\sigma_a}{\sigma_{\text{Total}}}$$

$$1 - dx \frac{\sigma_a [A]}{\sigma_H [H] + \sigma_a [A]}$$

$$e^{-\int \frac{u}{1+u} dx}$$

$$u = \frac{\sigma_a [A]}{\sigma_H [H]}$$

~~26.5~~

.0376

$$\frac{\sigma_A [A]}{\sigma_H [H]} = \frac{.0376}{20} \rho \sigma_a = .00188 \rho \sigma_a$$

~~38485000 = 20~~

$$\frac{40 \times 10^6}{1 + \left(\frac{E - .3}{.042} \right)^2} \frac{2900}{\sqrt{E}}$$

$$\frac{2900}{\sqrt{E} \left(1 + \left(\frac{E - .3}{.042} \right)^2 \right)}$$

$$v p f (1-p)$$

$$v [p f + (1-p)]$$

$$.00188 \times \pi \times .042 \rho \sigma_{\text{max}}$$

$$.000825 \rho \sigma_{\text{max}}$$

4.4 p

.00153

.00177

30 .00024 x 30

1.83

2.1

(1050) .037

21

AE

E

$$1 + \frac{(E - .3)^2}{.042} \frac{2900}{\sqrt{E} \times \mu c}$$

5.5
40

.01
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

.00	52.0	
2	45.4	
4	39.3	
6	33.7	
8	28.4	
.10	23.7	
2	19.4	430
4	15.5	499
6	12.1	600
8	9.17	746
.20	6.87	970
2	4.63	1330
4	3.06	1940
6	1.91	2970
8	1.227	4460
.30	1	5300
2	1.227	4180
4	1.91	2600
6	3.04	1590
8	4.63	1020
.40	6.67	690
2	9.17	489
4	12.1	362
6	15.5	275
8	19.4	215
.50	23.7	
2	28.4	
4	33.7	
6	39.3	
8	45.4	
.60	52.0	

.037

$$\frac{1050}{.295} \times \frac{.037}{.239} = 5.0$$

$$\frac{1050 \times .037}{.295 \times 239} = 5.0$$

$$p \frac{5}{6} + 1 - p =$$

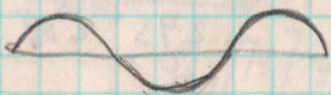
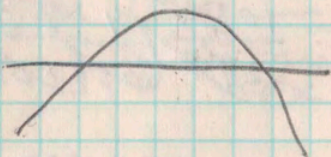
$$1 - \frac{1}{6} p$$

$$\sqrt{1 - \frac{1}{6} p}$$

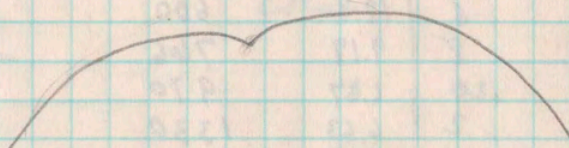
$$\begin{array}{r} 1 \\ - .145 \\ \hline .855 \end{array} \quad \begin{array}{r} .87 \\ - .139 \\ \hline .861 \end{array}$$

$$\sqrt{\frac{5}{6}} \quad \begin{array}{r} .855 \\ .833 \\ \hline .022 \end{array}$$

Water expt expt

4.4 p

1.512 cm radius

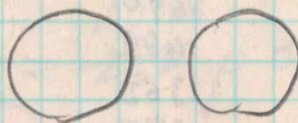
vol ratio $\frac{\text{water}}{\text{metal}} = 1.14$ 

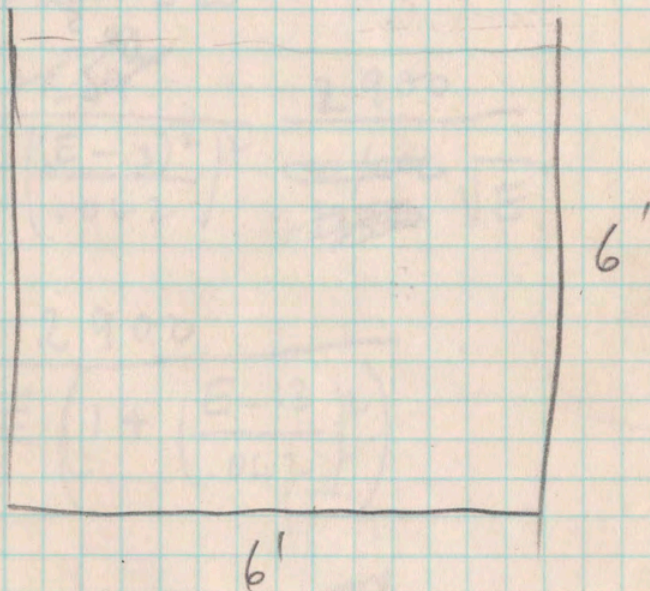
2.14

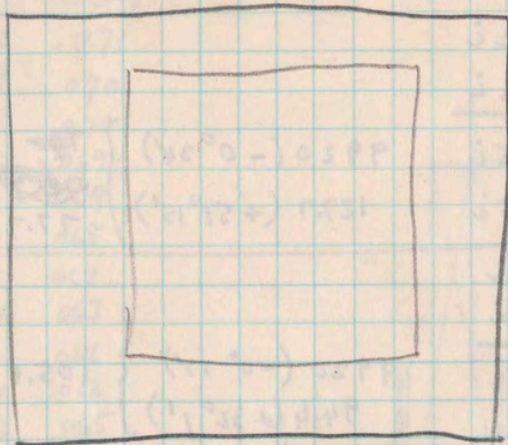
met radius 1.512 60" long

vol $\frac{\text{water}}{\text{metal}} = 1.14$

cell side = 3.899



$$\begin{array}{r} .875 \\ 1512 \\ \hline 1512 \\ \hline 3.899 \end{array}$$




$$48 \frac{3}{4}$$

$$49 \frac{1}{8}$$

$$49 \frac{1}{8}$$

$$50.5''$$

$$49.1$$

$$1024 \text{ rods}$$

$$L = 26.6$$

$$\Delta_{\text{weinberg}} = 453 \times 10^{-6}$$

$$\text{Theoretical side } 143.1$$

May 30 1944

$$\frac{(p, A)}{\hbar} = 2\pi n_1$$

$$K([A_1, A_2], A_3) =$$

$$\begin{cases} (p, A_1) = \hbar n_1 \\ (p, A_2) = \hbar n_2 \\ (p, A_3) = \hbar n_3 \end{cases}$$

$$B_1 = \frac{\hbar [A_2, A_3]}{\text{volume of cell}} = \text{fundamental vector of reciprocal lattice}$$

$$\vec{p}_i - \vec{p}_s - \vec{p}_e = \vec{B}$$

$$\frac{\hbar}{p_e} = \lambda$$

$$\lambda v = V$$

$$v_e = \frac{V}{\hbar} p_e$$

$$\frac{p_i^2}{2m} = \frac{p_s^2}{2m} + \hbar v_e$$

$$\boxed{\frac{p_i^2}{\hbar} = p_s^2 + 2m V p_e}$$

$$\begin{array}{r} 9920 - 99.2i \\ - .2i \\ - .1i \\ \hline \hline \end{array}$$

$\omega = 100$

$$\begin{array}{r} 9920.0 - 99.2i \\ .0 - .3i \\ \hline 9920.0 - 99.5i \\ 80.0 + 99.5i \end{array}$$

$$\left. \begin{array}{l} 9920 (-0^\circ 34') \\ 127.7 (+51^\circ 15') \end{array} \right\} \begin{array}{l} \cancel{77.7} (-51^\circ 49') \\ 77.7 \end{array}$$

$$\begin{array}{r} 9920 - 49.6i \\ - .4i \\ - .1i \\ \hline \hline \end{array}$$

$\omega = 50$

$$\begin{array}{r} 9920.0 - 49.6i \\ .0 - .5i \\ \hline 9920.0 - 50.1i \\ 80.0 + 50.1i \end{array}$$

$$\left. \begin{array}{l} 9920 (-0^\circ 17') \\ 94.4 (+32^\circ 11') \end{array} \right\} 105.1 (-32^\circ 18')$$

$$\begin{array}{r} 9920 - 19.84i \\ .1 - .92i \\ - .38i \\ - .02i \\ \hline \hline \end{array}$$

$\omega = 20$

$$\begin{array}{r} 9920.0 - 19.84i \\ .1 - 1.32i \\ \hline 9920.1 - 21.16i \\ 79.9 + 21.16i \end{array}$$

$$\left. \begin{array}{l} 9920.0 (-7') \\ 82.6 (14^\circ 48') \end{array} \right\} 120.1 (-14^\circ 55')$$

$$\begin{array}{r} 9920 - 9.96i \\ .3 - 1.82i \\ - .77i \\ - .04i \\ \hline \hline \end{array}$$

$\omega = 10$

$$\begin{array}{r} 9920.0 - 9.96i \\ .3 - 2.63i \\ \hline 9920.3 - 12.59i \\ 79.7 + 12.59i \end{array}$$

$$\left. \begin{array}{l} 9920.0 (-4') \\ 80.7 (8^\circ 58') \end{array} \right\} 122.9 (-9^\circ 2')$$

$$\begin{array}{r} 9920 - 4.96i \\ 1.0 - 3.43i \\ - 1.54i \\ - .09i \\ \hline \hline \end{array}$$

$\omega = 5$

$$\begin{array}{r} 9920.0 - 4.96i \\ 1.0 - 5.06i \\ \hline 9921.0 - 10.02i \\ 79.0 + 10.02i \end{array}$$

$$\left. \begin{array}{l} 9921 (-3') \\ 79.6 (+7^\circ 13') \end{array} \right\} 124.6 (-7^\circ 16')$$

$$\begin{array}{r} 9920 - 1.98i \\ 4.4 - 6.15i \\ .3 - 3.83i \\ - .22i \\ - .12i \\ - .01i \\ \hline \hline \end{array}$$

$\omega = 2$

$$\begin{array}{r} 9920.0 - 1.98i \\ 4.7 - 10.33i \\ \hline 9924.7 - 12.31i \\ 75.3 + 12.31i \end{array}$$

$$\left. \begin{array}{l} 9925 (-4') \\ 76.3 (+9^\circ 16') \end{array} \right\} 130.1 (-9^\circ 20')$$

$$\begin{array}{r} 9920 - 1.00i \\ 8.7 - 6.10i \\ 1.2 - 7.51i \\ - .44i \\ - .02i \\ \hline \hline \end{array}$$

$\omega = 1$

$$\begin{array}{r} 9920.0 - 1.00i \\ 9.9 - 14.07i \\ \hline 9929.9 - 15.07i \\ 70.1 + 15.07i \end{array}$$

$$\left. \begin{array}{l} 9930 (-5') \\ 71.7 (+12^\circ 7') \end{array} \right\} 138.5 (-12^\circ 12')$$

$$\begin{array}{r} 9920 - .50i \\ 11.6 - 4.1i \\ 4.3 - 14.1i \\ .1 - .64i \\ \hline \hline \end{array}$$

$\omega = .5$

$$\begin{array}{r} 9920.0 - .5i \\ 16.0 - 20.1i \\ \hline 9936.0 - 20.6i \\ 64.0 + 20.6i \end{array}$$

$$\left. \begin{array}{l} 9936 (-7') \\ 67.2 (+37^\circ 49') \end{array} \right\} 147.9 (-17^\circ 56')$$

$$\begin{array}{r} 9920 - .20i \\ 12.8 - 1.8i \\ 18.6 - 24.1i \\ .3 - 2.2i \\ \hline \hline \end{array}$$

$\omega = .2$

$$\begin{array}{r} 9920.0 - .2i \\ 31.7 - 28.2i \\ \hline 9951.7 - 28.4i \\ 48.3 + 28.4i \end{array}$$

$$\left. \begin{array}{l} 9952 (-10') \\ 56.0 (+30^\circ 25') \end{array} \right\} 177.7 (-30^\circ 35')$$

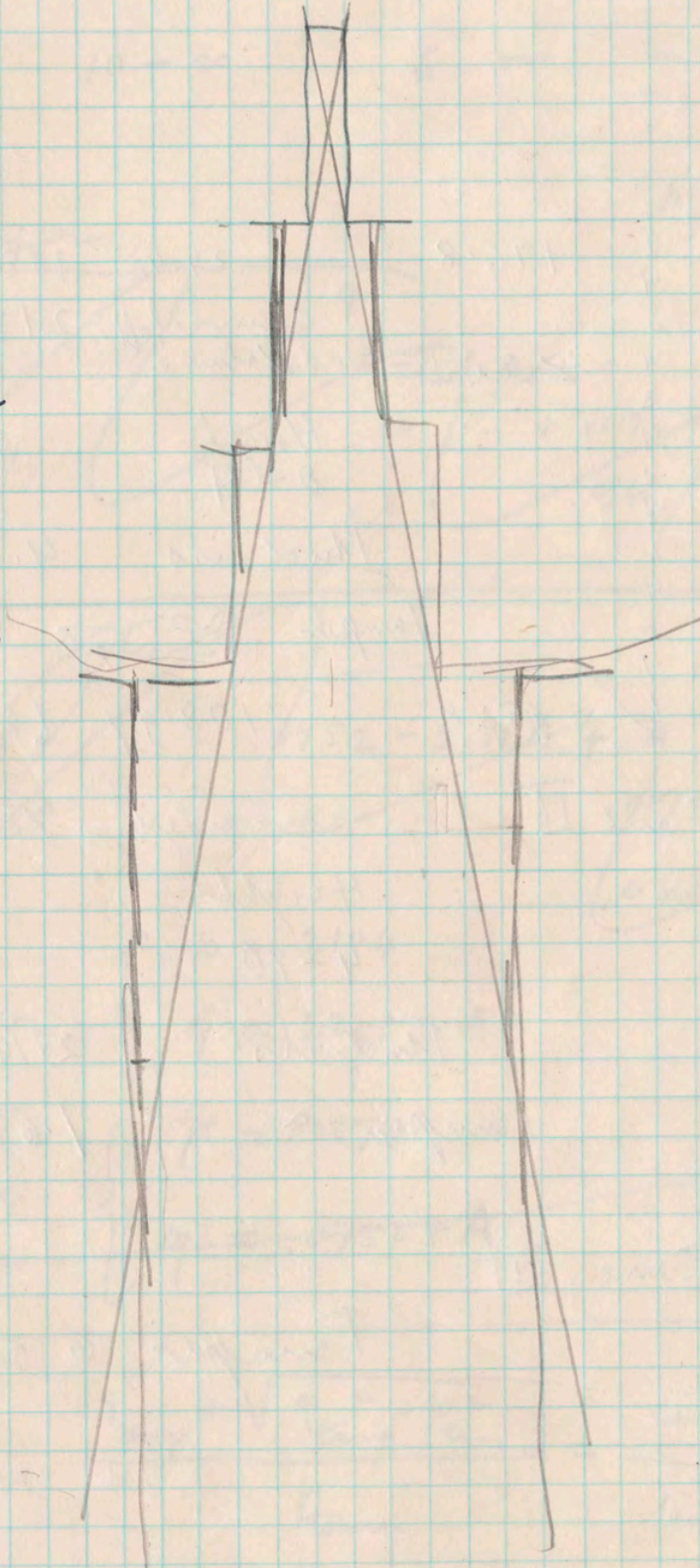
$$\begin{array}{r} 9920 - .10i \\ 12.9 - .9i \\ 34.9 - 22.7i \\ 1.2 - 4.1i \\ - .2i \\ \hline \hline \end{array}$$

$\omega = .1$

$$\begin{array}{r} 9920.0 - .1i \\ 49.0 - 27.9i \\ \hline 9969.0 - 28i \\ 31.0 + 28i \end{array}$$

$$\left. \begin{array}{l} 9969 (-10') \\ 41.8 (+42^\circ 4') \end{array} \right\} 239.1 (-42^\circ 14')$$

x	a	$-L(a)$
1.0	7.75	.071
1.1	7.69	.070
1.2	7.63	.070
1.3	7.57	.069
1.4	7.50	.069
1.5	7.42	.068
1.6	7.32	.068
1.7	7.24	.067
1.8	7.14	.066
1.9	7.04	.066
2.0	6.93	.065
2.1	6.81	.064
2.2	6.68	.063
2.3	6.55	.062
2.4	6.40	.060
2.5	6.24	.059
2.6	6.08	.058
2.7	5.90	.056
2.8	5.71	.054
2.9	5.51	.052
3.0	5.29	.050
3.1	5.05	.047
3.2	4.89	.046
3.3	4.52	.041
3.4	4.21	.037
3.5	3.87	.033
3.6	3.49	.030
3.7	3.04	.022
3.8	2.33	+.012
3.9	1.78	+.0062
4.0	0	-.0052
4.1		-.0052
4.2		"
4.3		"
4.4		
4.5		
4.6		
4.7		
4.8		
4.9		
5.0		
5.1		
5.2		
5.3		
5.4		
5.5		
5.6		
5.7		



thick x.thine

0	4.4	0	
.5	4.3	2.1	4
1	4.3	4.3	2
1.5	4.2	6.3	4
2	4.1	8.2	2
2.5	3.9	9.7	4
3	3.7	11.1	2
3.5	3.3	11.5	4
4	2.8	11.2	2
4.5	2.5	11.2	4
5	2.1	10.5	2
5.5	1.8	9.9	4
6	1.8	10.8	2
6.5	1.8	11.7	4
7	1.8	12.6	2
7.5	1.8	13.5	4
8	1.9	15.2	2
8.5	2.0	17.0	4
9	2.0	18.0	2
9.5	1.8	17.1	4
10	1.0	10.0	1
10.2	0		

176.8

29.46 185.1

connected
Volume 212

Zone I

Height
0-4

Thickness 4.22 cm

Tampers ∞ — ∞

653.8

108.97 684.8

Zone II

connected 789

Height

4-10

Thickness 2.19 cm

Tampers ∞ — 1.65 cm

Zone III

Tampers 6 cm

Zone I

0 - 4

 ∞ 4.22 ∞ $T_1 = .0385$

II

4 - 10

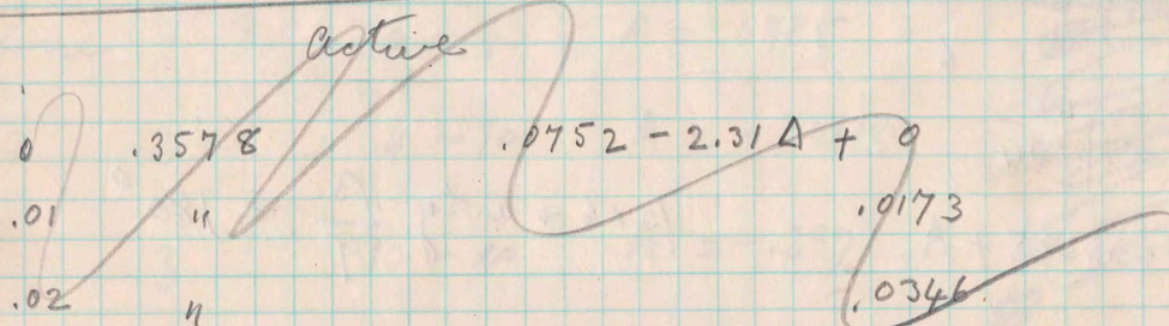
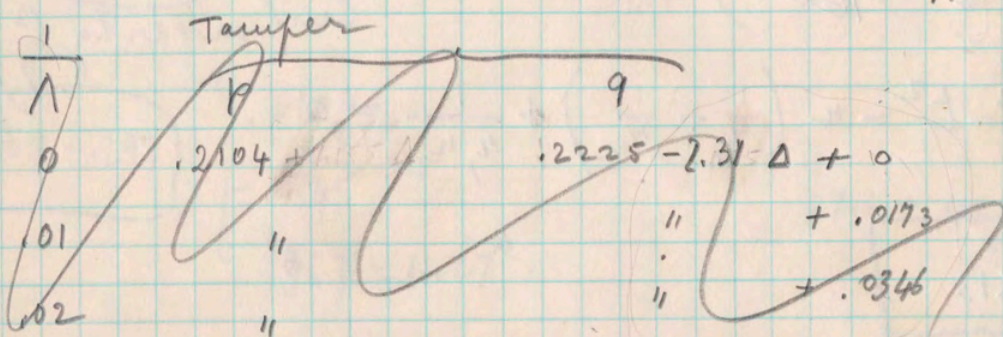
 ∞ 2.19 1.65

III

10 - ∞

6 - -

$$A = \frac{\sqrt{3}}{\Lambda} - 2.31 \Delta$$



Tamper

$$\begin{cases} p = .2104 \\ q = .2225 + A \end{cases}$$

Active

$$\begin{cases} p = .3578 \\ q = .0752 + A \end{cases}$$

$$\frac{(r+t)}{h} > \frac{1}{r_{tan}}$$

Zone I

$$\frac{q_{tamp} + \sqrt{q_{tamp}^2 - p_{tamp}^2}}{p_{tamp}} = \frac{\sin(\beta a) + \frac{\beta}{p}}{\sin(\beta a + \arctan(\frac{p}{q}))}$$

$$A = .0985$$

Zone II

 ∞ 2.19 1.65

$$\frac{1}{n_1} = \frac{p_t + \sqrt{q_t^2 - p_t^2}}{p_t}$$

$$n = \frac{\sin \beta a}{\sin(\beta a + \arctan \frac{\beta}{q})}$$

$$\frac{1}{n_2} = \frac{(q + \alpha) e^{2\alpha a_t} - (q - \alpha) e^{-2\alpha a_t}}{p(e^{2\alpha a_t} + e^{-2\alpha a_t})}$$

$$t = \frac{\beta/p}{\sin(\beta a + \arctan \frac{\beta}{q})}$$

crat
condition

$$n^2 - t^2 - n \left(\frac{1}{n_1} + \frac{1}{n_2} \right) + \frac{1}{n_1 n_2} = 0$$

$$A = -.00613$$

Zone III

6

$$p = .2104$$

$$q = .2225 + A$$

$$\beta \times 6 + \arctan \frac{\beta}{q} = 180^\circ$$

$$A = -.02$$

$$.2104$$

$$.2025$$

$$\beta = .0571 = 3.27^\circ$$

$$19.5 + 15.8 = 35.4^\circ$$

$$A = -.1$$

$$\left\{ \begin{array}{l} .2104 \\ .1225 \\ .1711 = 9.80^\circ \end{array} \right.$$

$$58.8 + 49.4 = 108.2^\circ$$

$$A = -.2$$

$$\left\{ \begin{array}{l} .2104 \\ .0225 \\ .2091 = 11.98^\circ \end{array} \right.$$

$$71.9 + 83.9 = 155.8^\circ$$

$$A = -.25$$

$$\left\{ \begin{array}{l} .2104 \\ -.0275 \\ .2087 = 11.96^\circ \end{array} \right.$$

$$71.8 + 97.5 = 169.3$$

$$\begin{array}{r} 16.78 \\ 12.25 \\ \hline 13.4 \\ 181.2 \end{array}$$

$$A = -.3$$

$$\begin{cases} .2104 \\ -.0775 \\ .1956 = 11.21^\circ \end{cases}$$

$$67.3 + 113.4 = 180.7$$

688

$$\frac{.035}{11.4}$$

$$\frac{.05 \times .7}{11.4}$$

$$\frac{189.5}{11.4}$$

$$\boxed{A = -.297} \begin{cases} .2104 \\ -.0745 \\ .1967 = 11.27^\circ \end{cases}$$

$$67.6 + 112.3 = 179.9$$

Zone 1 0 - 4 $A = .0985$

2 4 - 10 $A = -.00613$

3 10 - ∞ $A = -.297$

~~J (.3142)~~

~~K (.07842)~~

~~H (.5452)~~

$$A = \frac{\sqrt{3}}{\Lambda} - 2.31 \Delta$$

110

$$A = \frac{\sqrt{3}}{\Lambda} - 2.31L$$

$$\frac{1}{\Lambda} = 0$$

$$\sqrt{1L}$$

0

.0985

-.04264

.2055

$$K(x) = J_0(ix) \quad (226)$$

4

-.00613

+.002654

.0515

$$H(x) = H_0(ix) \quad (236)$$

10

-.297

+.12860

.3560

-.297
1.731

8

n

n'/n

.3773

0

$$J_0(.2055x)$$

$$J_0(.822) = .8380$$

$$-.2055 \frac{J_1(.822)}{J_0(.822)} = -.09252$$

4

$$K(.0515x) + A H(.0515x)$$

$$A = 1.969$$

$$.0515 \frac{K_1(.206) - A H_1(.206)}{K(.206) + A H(.206)} = -.09252$$

10

$$\left\{ \begin{aligned} \frac{n'}{n} &= .0515 \frac{K_1(.515) - 1.969 H_1(.515)}{K(.515) + 1.969 H(.515)} = \frac{-.09131}{2.196} = -.0416 \\ -.356 \frac{H_1(3.56)}{H(3.56)} &= -.356 \frac{.013202}{.011657} = -.4032 \end{aligned} \right.$$

$$H(.356x)$$

∞

.04529
0
12595

$$\frac{1}{A} = .01$$

$$\frac{\sqrt{2}}{L} = .01731$$

L

$$\sqrt{|L|}$$

0

$$-.03515$$

$$.1874$$

4

$$+.01015$$

$$.1008$$

10

$$+.13606$$

$$.3690$$

20

$$0 - 4 \quad J_0(.1874x)$$

.3490

$$4 \left\{ \begin{array}{l} -.1874 \frac{J_1(.7496)}{J_0(.7496)} = -.07567 \end{array} \right.$$

$$+.1008 \frac{\frac{.8643}{K_1} - A H_1}{K + A H(.4032)} = -.07567$$

.10411

.7057

$$A = 1.163$$

$$4 - 10 \quad K(.1008x) + 1.163H(.1008x)$$

$$10 \left\{ \begin{array}{l} .1008 \frac{.5708 - 1.163 \times .3780}{1.2706 + 1.163 \times .2650} = \frac{.01322}{1.5788} = +.0084 \\ -.369 \frac{.011353}{.010064} = -.416 \end{array} \right.$$

112

$$\frac{.02\sqrt{3}}{2.31} = .01499$$

$$\frac{1}{\Lambda} = -.02$$

$$\sqrt{141}$$

0

$$-.05763 \quad .2400$$

4

$$-.01234 \quad .1111$$

10

$$+.01181 \quad .3342$$

∞

$$4 \left\{ \begin{array}{l} -.2400 \quad .4268 \\ J_1(.96) \\ J_0(.96) \\ .7825 \end{array} \right\} = -.1309$$

$$-.1111 \frac{+J_1 + A N_1}{J_0(.4444) + A N_0} = -.1111 \frac{.2168 - A \times 1.627}{.9512 - A \times .5305}$$

$$A = -.9021$$

$$10 \left\{ \begin{array}{l} .4741 \quad (-.6894) \\ -.1111 \frac{J_1 - .9021 N_1}{J_0(1.111) - .9021 N_0} = \frac{-.1218}{.5612} = -.2168 \\ .7144 \quad .1698 \end{array} \right.$$

$$-.3342 \frac{.017037 \quad H_1(3.342)}{H_0(3.342)} = -.3813$$

$$.014934$$

$$\frac{1}{\Lambda} = -.03$$

L

$$0 \left\{ \begin{array}{l} - .06513 \end{array} \right.$$

$$4 \left\{ \begin{array}{l} - .01984 \end{array} \right.$$

$$10 \left\{ \begin{array}{l} + .10611 \end{array} \right.$$

$$\infty \left\{ \begin{array}{l} + .10611 \end{array} \right.$$

$$\frac{.03\sqrt{3}}{2.31} = .02249$$

$$\sqrt{1.41}$$

$$.2552$$

$$.1409$$

$$.3260$$

$$.4468$$

$$J_1(1.0208)$$

$$J_0(1.0208)$$

$$.7559$$

$$.2708$$

$$J_1 + A N_1$$

$$J_0 + A N_0(.5636)$$

$$.9221$$

$$.5435$$

$$J_1 - .7536 N_1$$

$$J_0 - .7536 N_0(1.409)$$

$$.5619$$

$$.3040$$

$$.01876$$

$$H_1(3.26)$$

$$H_0(3.26)$$

$$16401$$

$$.3422$$

$$.373$$

$$.417$$

$$.402$$

$$.374$$

$$.374$$

$$.374$$

$$.374$$

$$.374$$

$$.374$$

$$.374$$

$$\frac{1}{\Lambda} = -.029$$

L

$$- .06438$$

$$- .01909$$

$$+ .10686$$

$$.3267$$

$$.2537$$

$$.1381$$

$$.1496$$

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$$\sqrt{1.41}$$

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$$.2537$$

$$\frac{1}{\Lambda} = -.027$$

114

$$\frac{1}{\Lambda} = 0$$

$$L = -\frac{A}{2.31} + \frac{\sqrt{3}}{2.31} \frac{1}{\Lambda}$$

$$= \begin{Bmatrix} -.05948 \\ -.01922 \\ +.10649 \end{Bmatrix} + .7498 \frac{1}{\Lambda}$$

$$\frac{1}{\Lambda} = 0 \quad L \quad \sqrt{|L|}$$

$$-.05948 \quad .2438$$

$$-.01922 \quad .1387$$

$$+.10649 \quad .3263$$

$$.2438 \frac{J_0(.9752)}{J_0(.9752)} = .1387$$

.7760

$$.2668 \quad -1.347$$

$$J_1 + A N_1$$

$$J_0 + A N_0(.5548)$$

$$.9245 \quad -.353$$

$$A = -.6358$$

$$.4737 \quad -.6905$$

$$.1387 \frac{J_1 + A N_1}{J_0 + A N_0(1.1096)}$$

$$.7151 \quad +.1688$$

$$.6078$$

$$.04103 \quad .3263 \frac{H_1}{H_0(8.5192)}$$

$$2.6104$$

$$.03484$$

$$.2069$$

$$.3842$$

$$.384 - .207 = .177$$

$$\frac{1}{\Lambda} = .01$$

$$L \quad \sqrt{|L|}$$

$$-.06698 \quad .2588$$

$$-.02672 \quad .1634$$

$$+.09899 \quad .3147$$

$$1.0352$$

$$\begin{Bmatrix} .6536 \\ 1.3072 \end{Bmatrix}$$

$$2.5176$$

$$.2588 \frac{.4513}{.7550} = .1634 \frac{.3096 - A \times 1.172}{.8960 - A \times .244}$$

$$A = -.572$$

$$.1634 \frac{.5236 - A \times .5435}{.6164 + A \times .2883} = .3147 \frac{.04603}{.03887}$$

$$.4515$$

$$.302$$

$$.373$$

$$.373 - .302 = .071$$

$$\frac{1}{\Lambda} = -.017$$

$$-.07223 \quad .2688$$

$$-.03197 \quad .1787$$

$$+.09374 \quad .3062$$

$$1.075$$

$$.715$$

$$1.43$$

$$2.45$$

$$.364 - .397 = -.033$$

$$.2688 \frac{.4635}{.7316} = .1787 \frac{.3352 - A \times 1.083}{.8762 - A \times .1745}$$

$$A = .5452$$

$$.1787 \frac{.5472 + .5452 \times .4589}{.5505 - .5452 \times .3520} = .3062 \frac{5007}{4212}$$

$$.3586$$

$$\frac{1}{\Lambda} = -.015$$

$$\begin{array}{rcl} -.07073 & .2660 & 1.064 \\ -.03047 & .1745 & .698 \quad 1.396 \\ +.09524 & .3087 & 2.47 \end{array}$$

$$2660 \frac{4602}{7364} = 1745 \frac{3282 - A \times 11058}{8819 - A \times 1932} \quad A = -.5553$$

$$.1745 \frac{.5412 + .5553 \times .4819}{.5691 - .5553 \times .3360} = .3087 \frac{4883}{4113}$$

3825

$$366 - 369 = -.003$$

$$\left. \begin{array}{r} 10 \quad .212 \\ 0 \quad -.0121 \end{array} \right\} = \frac{\sqrt{3}}{\Lambda} - 2.14 L$$

$$L + \left\{ \begin{array}{r} .0991 \\ -.00565 \end{array} \right\} = \frac{.81}{\Lambda}$$

$$L = \left\{ \begin{array}{r} -.0991 \\ +.00565 \end{array} \right\} + \frac{.81}{\Lambda}$$

$$\frac{.81}{\Lambda} = .0235$$

$$L = \left\{ \begin{array}{r} -.0756 \quad .275 \\ +.02915 \quad .1706 \end{array} \right.$$

55

$$\begin{array}{r} 5374 \\ .275 \quad J_1() \\ \hline J_0(1.375) \\ 5804 \\ 2546 \end{array}$$

$$\begin{array}{r} 14968 \\ .1706 \quad H_1() \\ \hline H_0(.853) \\ 3322 \\ 2551 \end{array}$$

$$\Lambda = 34.5$$

$$250 \pi \times 19$$

14,923 gr

$$482 = \frac{\pi}{4} D^3$$

116

8.5

4.25

$$\frac{.195}{2.14}$$

$$L = \left. \begin{array}{l} -.09112 \\ +.00565 \end{array} \right\} + \frac{.81}{\Lambda}$$

.02

-.07112

.2669

1.134

+.02565

.1602

.681

$$\begin{array}{r} .2669 \quad 4806 \\ \hline 7035 \end{array}$$

$$\begin{array}{r} 1602 \quad 6956 \\ \hline 4335 \end{array}$$

.1823

~~1093~~ .2571

+ 748

.01

-.08112

.2850

1.211

+.01565

.1251

.532

$$\begin{array}{r} .2850 \quad 5010 \\ \hline 6656 \end{array}$$

$$\begin{array}{r} .1251 \quad 9734 \\ \hline 5561 \end{array}$$

2145

2190

+ 45

$$.0095 = \frac{.81}{\Lambda}$$

$$\Lambda = 85$$

(50)

6.13

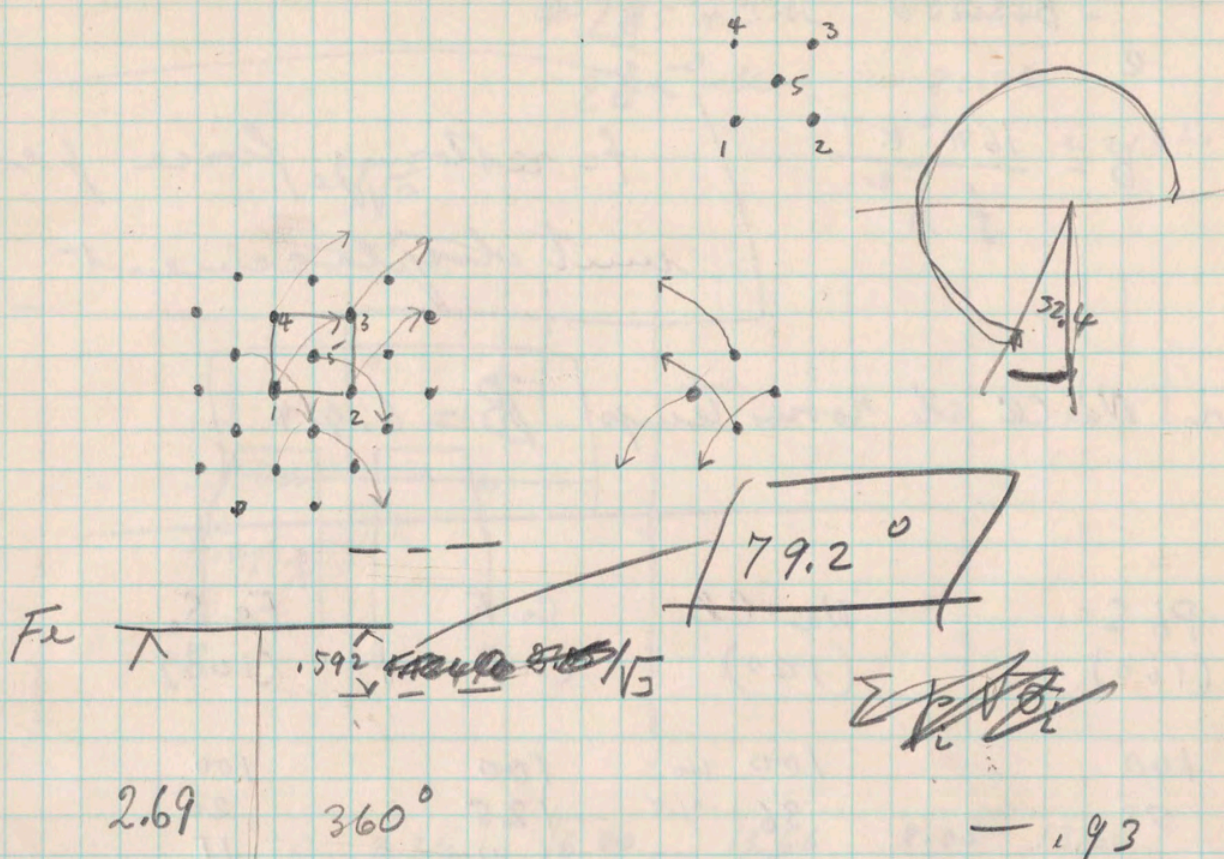
$$.2826 = \frac{\sqrt{3}}{\Lambda}$$

$$.25 + \frac{1}{\Lambda}$$

$$\cancel{.154} + \cancel{.5096} + \frac{1}{\Lambda} = \cancel{.154} + .096 \times 1.7 = 6.13$$

1.7

1.6



Fe ∇

I

1

$$2 \cos 79.2$$

II

1

$$2 \cos 158.4$$

III

1

$$2 \cos 237.6$$

9.2

1.3

Fe

3.04

$S \pm 1.116$

1

$$.375$$

1

$$-1.86$$

1

$$-1.07$$

Same phase opposite

$$3.41$$

$$2.59$$

12

$$1.0$$

1

$$5.0$$

$$1.9$$

4

$$4.1$$

$$e^{-B \sin^2 \theta}$$

$$B = \frac{16\pi^2 kT}{f \lambda^2}$$

f = restoring force per unit displacement

for NaCl at room temp $B = 6.44$

PbS
(100)

100
58
11

(111)

100
147
11
10

NaCl
(100)

100 100
36 91.8
8.3 99.6

(111)

100
116

CaF₂
(111)

100
125
7.9

FeS₂
(100)

100
20
11

$$225^\circ + 3u$$

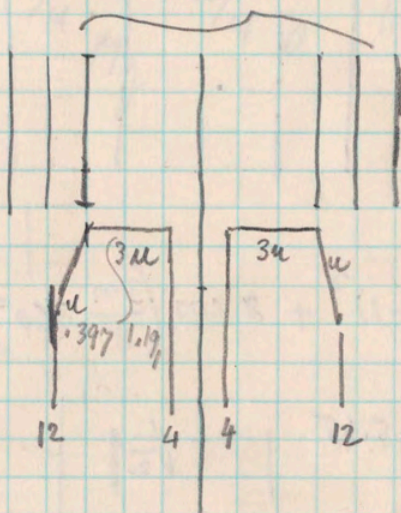
$$66.24$$

$$225^\circ - u$$

$$82.08$$

$$u = 142.92$$

$$a/\sqrt{3}$$



$$\frac{3u}{\sqrt{3}}$$

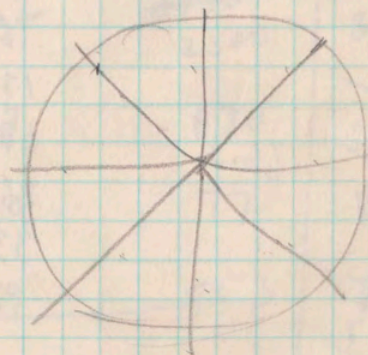
$$\frac{u}{\sqrt{3}}$$

2.34	16.00	13.66	8.00	13.66
4.18	-18.25	-11.04	12.61	14.28
6.52	2.25	2.62	20.61	27.94
1.84	34.25	24.70	4.61	.62

$$270$$

$$264.96$$

$$5.04$$



$$\begin{array}{r} 0 \quad 4 \\ \frac{3}{8} \quad 12 \\ 7 \quad 4 \\ \frac{8}{8} \\ 6 \quad 4 \\ \frac{8}{8} \end{array}$$

$$\begin{array}{r} 3u \quad 4 \\ -u \quad 12 \end{array}$$

$$u = .397$$

$$\begin{array}{r} \frac{3}{4} - 3u \quad 4 \\ \frac{3}{4} + u \quad 12 \end{array}$$

$$\left. \begin{array}{r} -\frac{1}{2} \quad 2 \\ -\frac{3}{8} \quad 4 \\ 0 \quad 12 \\ +\frac{3}{8} \quad 4 \\ \frac{1}{2} \quad 2 \end{array} \right\}$$

2000

$$12 + 4(-1)^n + 8 \cos\left(\frac{3n}{8} 360^\circ\right)$$

$$8 - 5.65$$

$$-\frac{1}{\sqrt{2}}$$

$$2.35 \text{ Fe} + 3.18 \text{ O}$$

$$16 + 0$$

$$0$$

$$16 \text{ Fe} - 14.21 \text{ O}$$

$$8 + 5.65$$

$$\frac{1}{\sqrt{2}}$$

$$13.65 \text{ Fe} - 8.67 \text{ O}$$

$$16 - 8$$

$$-1$$

$$8 \text{ Fe} + 9$$

$$8 + 5.65$$

$$\frac{1}{\sqrt{2}}$$

$$13.65 \text{ Fe}$$

$$3u - \frac{3}{8}$$

$$\frac{3}{8} - 3u$$

$$-u - \frac{3}{8}$$

$$\frac{3}{8} + u$$

$$.397$$

$$\pm .816 \quad 4 \cos(n 66.2^\circ) + 12 \cos(n 82.1^\circ)$$

$$66.2$$

$$1.61 + 1.67$$

$$82.1$$

$$132.5$$

$$-2.70 - 11.51$$

$$164.1$$

$$198.7$$

$$-3.79 - 4.88$$

$$246.7$$

$$264.8$$

$$-.34 + 10.18$$

$$328$$

$$331$$

$$+3.50 + 7.70$$

$$410$$

$$66.3^\circ$$

$$2.35 \text{ Fe} + 6.56 \text{ O}$$

$$16 \text{ Fe} - 26.42 \text{ O}$$

$$13.65 \text{ Fe} - 17.34 \text{ O}$$

$$8 \text{ Fe} + 19.68 \text{ O}$$

$$13.65 \text{ Fe} + 22.40 \text{ O}$$

$$379$$

$$488$$

$$867$$

$$1734$$

$$161$$

$$167$$

$$328$$

$$6.56$$

$$1151$$

$$270$$

$$1321$$

$$26.42$$

$$1018$$

$$34$$

$$984$$

$$1968$$

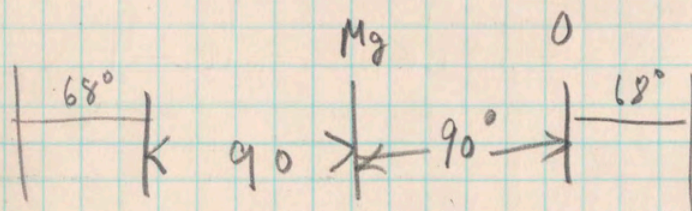
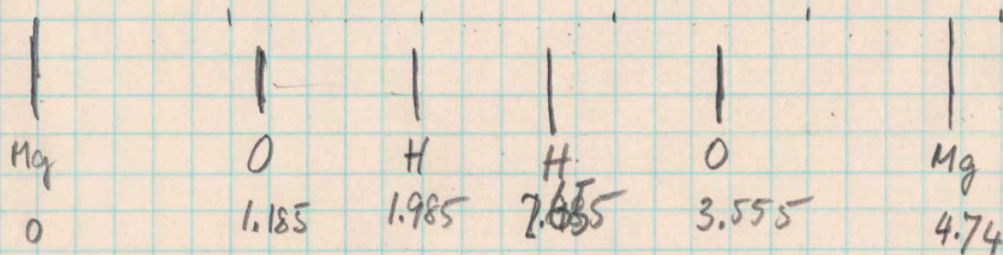
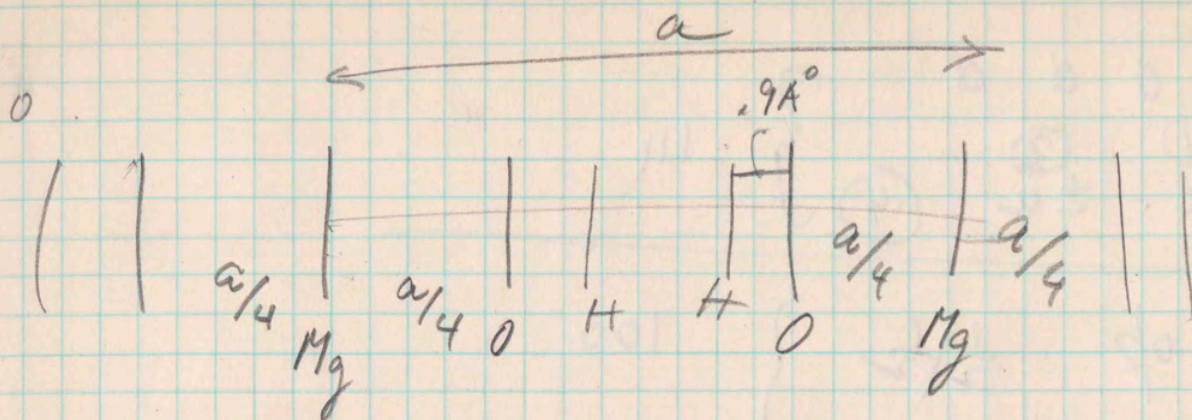
$$35$$

$$77$$

$$112$$

$$\begin{array}{r} .397 \\ 3 \\ \hline 1.191 \\ .375 \\ \hline .816 \\ .816 \\ \hline .184 \end{array}$$

$$\begin{array}{r} .375 \\ 397 \\ \hline .772 \\ .772 \\ \hline .228 \end{array}$$



$$Mg + 20 \cos(90^\circ) + 2H \cos(158^\circ)$$

	$Mg = 2$	$0 = 2$	$H = -1.2$	$Mg = 2$ $H = -1.2$
Mg	$-1.85H$	4.2	8400 2580	3.1
$Mg - 20 + 1.44H$		-3.7	670	-2.9
$Mg - .81H$		3.0	77	2.5
$Mg + 20 + .06H$		5.9	553	6.0
$Mg + .68H$		1.2	-	1.6

$$\begin{array}{cccc}
 0 & a & a & a \\
 \textcircled{1} & & \textcircled{2} & \\
 \pm 3u & & \pm u & \textcircled{4}
 \end{array}
 \left. \vphantom{\begin{array}{cccc} 0 & a & a & a \\ \textcircled{1} & & \textcircled{2} & \\ \pm 3u & & \pm u & \textcircled{4} \end{array}} \right\} 11$$

$$\begin{array}{cc}
 op. & \frac{1}{2} \times \frac{1}{2} \\
 \pm u & \frac{1}{2} \pm u
 \end{array}
 \left. \vphantom{\begin{array}{cc} op. & \frac{1}{2} \times \frac{1}{2} \\ \pm u & \frac{1}{2} \pm u \end{array}} \right\} 100$$

