

KG

11365

799

RADIOMETRIC
PROGRAM

Book 1

EMERSON

KG 11365, 799

Book 1.

Harvard College Observatory

Radiometric Program

1936-7

Return to D313

1936

at Cambridge, 10" telescope
in yard. 72" focus.

Nov 24, 1936. ¹

1. Cell was exhausted for 5 hours at D.I.T. on Nov 21, 1936 and was sealed off at McLeod pressure of about 10^{-6} mm. The Calcium had been twice heated. The experiments showed that when the cell was connected to gauge but not to pumps, heating the calcium to a dull red heat raised the pressure to 2×10^{-4} mm but when cold pressure was 10^{-5} mm, despite the large volume and the heating, accidentally, of some connecting tube.
2. The thermocouple resistance at 20°C is 330 ohms. The system vibrates with a time of decay to half amplitude of 3.8 seconds. (Nov 23, 1936). [See p. 13]
3. The galvanometer is in series parallel with resistance of nearly 250 ohms. Bad vibration due to traffic & thermal changes, latter principally in glass tube containing quartz fiber. Glass tube shielded with copper-cloth & shield, improved steadiness of zero. at $T=4$ sec, zero quite steady (~ 1 mm), at $T=8$ sec, zero unstable by ~ 5 mm to 1 cm (from mean).

2 KG 11365.799 $T = \text{galv. period (damped)}$.

4. ~~object on~~ Terrestrial object
on a sun-lit day give deflections
of the order of 20 cm (scale at 70 cm).
when $T = 6 \text{ sec}$. about $\frac{1}{2} \text{ cm/sec}$?
A 40 watt bulb in front of tube
change deflection by about 1.5 cm,
 $T = 6 \text{ sec}$.

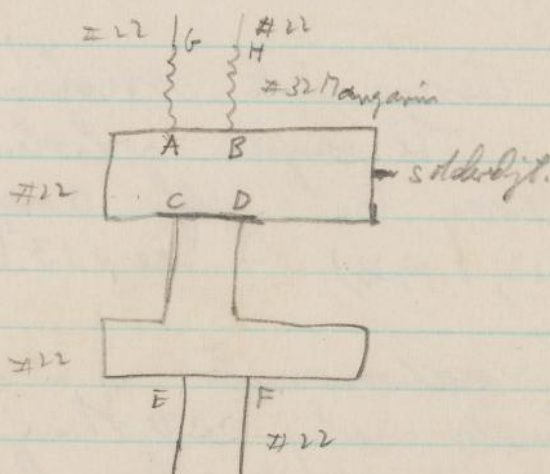
Nov 27, 1936 at 2:30 AM, galvanometer steady, $T \approx 6 \text{ sec}$
m.e. $\approx 0.1 \text{ mm}$

Test of galvanometer sensitivity

Nov 27, 1936.

measured; manganin: .149/cm (± 32)
copper #22 $4.86 \times 10^{-4} \text{ cm/cm}$
temp: 0.0°C

(all joint soldered)



all joints
reexamined

Oct 24, 1938

A-B resist-
ance

AB changed

to 5.0, Oct. 24, 1938.

voltage increased 2% from before.

8.9
9.5
9.2

GA	49.2
BH	48
AB	4.9
CD	5.25
EF	5.05
AC	41.6
BD	45.8
CE	46.9
DF	45.8

$$\text{Resistance } CD \downarrow = 46.9 + 5.05 + 45.8 = 97.75 \text{ cm.}$$

$$\begin{array}{r} 46.9 \\ 5.05 \\ \hline 45.80 \\ 97.75 \end{array}$$

$$CD - = 5.25 \text{ cm}$$

$$cd \downarrow^D = \frac{5.25 \times 97.75}{103} = 4.97 \text{ cm}$$

$$\begin{array}{r} 4.97 \\ 41.6 \\ \hline 45.80 \\ 92.37 \end{array}$$

$$AB \downarrow = 4.97 + 41.6 + 45.8 = 92.37 \text{ cm}$$

$$AB - = 4.9 \text{ cm}$$

$$AB \downarrow = \frac{4.9 \times 92.37}{97.27} = 4.65 \text{ cm}$$

$$\begin{aligned} G \&H &= 97.2 \times .149 + 4.65 \times 4.86 \times 10^{-4} \\ &= 14.5 + (.002) = 14.5 \Omega. \end{aligned}$$

$$\text{Current in } GA = \frac{V}{r + 14.5} \quad \text{where } V \text{ is applied } 57 \text{ F}$$

r is internal resistance

$$\text{Current in } AC = \frac{V}{r + 14.5} \frac{4.9}{97.27}$$

$$CE = \frac{V}{r + 14.5} \frac{4.9}{97.27} \frac{5.25}{103}$$

$$\begin{aligned} \text{Voltage } EF &= \frac{V}{1 + \frac{r}{14.5}} \frac{1}{14.5} \frac{4.9}{97.27} \frac{5.25}{103} 5.05 \times 4.86 \times 10^{-4} \\ &= \frac{V}{1 + \frac{r}{14.5}} \times 4.34 \times 10^{-7} \text{ volts.} \end{aligned}$$

$$1 \text{ dry cell} \approx 1.46 \text{ volts? (Leclanché)}$$

$$\begin{array}{r} 4.34 \\ 1.5 \\ \hline 4 \times 6.57 \times 10^{-7} \\ 1000 \\ \hline 2.16 \times 10^{-9} \text{ amp} \end{array}$$

4

11/28/36

6
51 9.5
9.0
50

rule at 71 cm.

(Chromometer)

Test of galvanometer sensitivity.

Period One dry cell on circuit pp 2-3.
 $V = 1.46$ volts.

Deflection in cm. Scale at 71 cm.

Gal. Res = 250 Ω (S.P.)
 damping screw
 all way back

Position of control magnets:
 one down, other up.

0.70 sec	
0.65 "	
0.60 "	0.10
0.60	0.09
0.65 "	0.09
0.63 "	0.09
0.625 "	0.0925 cm
0.650	0.925 mm
0.638 sec v	

Def in mm.

1.10	11.0 TES	9.52
1.00	11.3 RAC	7.8
1.00	1.7	
1.03 sec v	2.0	
	2.0	
	2.25	
	2.0	
	15.25	
	2.18 mm	

7/6 - 1.16

1.25

1.05

1.15

1.15 sec v

2.7

3.0

3.0

2.7

2.7

2.82 mm

7 1/2

16 1/2

14.1

2.82

2.3

2.28

2.30

2.29 sec v

10.0

10.0

10.5

10.5

10.

10.20 mm

not complete oscillations

9.0

11.0

8.0

9.0

10.0

8.5

7.0 sec

10.0

11.5

9.25

89 mm

100 mm

8.5 cm

14 35

11 21

11 32

11 20 1/2

13 33 1/2

13 20.5

10 30.5

9 21.5

35.2

26.3

11.5

33.0

22.5

30.5

10.5

8.0

120.5

100

$\begin{array}{r} 3.75 \\ 4.00 \\ 4.00 \\ \hline 3.92 \end{array}$

$\begin{array}{r} 27\frac{1}{2} \\ 24.3 \\ 28.3 \\ 24.9 \\ 28.2 \\ 25.0 \\ 28.1 \\ 24.5 \\ 28.1 \end{array}$

$\begin{array}{r} 27\frac{1}{2} \\ 33 \\ 3.2 \\ 4.0 \\ 3.4 \\ 3.3 \\ 3.2 \\ 3.1 \\ 3.6 \\ 3.6 \end{array}$
 27.4
 $3.42 = 34.2 \text{ mm}$

$\begin{array}{r} 3.25 \\ 2.75 \\ 2.75 \\ 3.00 \\ \hline 2.94 \end{array}$

$\begin{array}{r} 28.6 \\ 26.5 \\ 28.4 \\ 26.5 \\ 28.5 \\ 26.6 \end{array}$

$\begin{array}{r} 1-2+3-4+5 \\ -2+3-4+5-6 \end{array}$
 19.6 mm

$\begin{array}{r} 5.0 \\ 5.0 \\ 5.5 \\ 5.0 \\ 5.0 \\ \hline 5.1 \end{array}$

$\begin{array}{r} 31 \\ 26.2 \\ 31.2 \\ 26.0 \\ 30.3 \\ 25.4 \\ 30.7 \\ 26.2 \\ 30.5 \\ 25.4 \\ 30.0 \end{array}$

$\begin{array}{r} 148.0 \\ 48 \text{ mm} \end{array}$

$\frac{1}{2} \text{ m}$	T _{open}	mm at 71 meter	mm at 1 meter	T	1.4088 mm, 71m	mm, 1m	$\frac{1}{2} \text{ m}$
.31	.638	.925	1.30	9.25	109.5	154	.55
.34	1.03	2.18	3.07				
.33	1.15	2.82	3.97				
.36	2.29	10.2	14.4				
.31	2.94	19.6	27.6				
.32	3.92	34.25	48.2				
.38	5.10	48.0	67.6				

T on open circuit

Galv. Decrement

Screw all
the way out.

7

Nov 29, 1936

clamping app open circuit as in
timing test in calibration→ 31 28.8 zero (1.83)
→ 3031.2 28.8 zero (1.72)
30.2

$$\frac{2.2}{1.2} = 1.83$$

 $T_d = 1 \text{ sec.}$ 35 28.8 (1.77)
32.3.262
.235
.247
.22635 (1.68)
32.530 25.8 (2.47)
27.5.393 .439
.398 .347
.425 .415
.462
.516
.47736 (2.5)
30

27.5 26.0 (2.66)

$$\frac{12.7 + 17.5}{4.8 + 3.1} = 20$$

32 (2.9)
28.2
26.8 26.2 (3.3) $T_d = 2 \text{ sec}$ $T = 6 \text{ sec}$ 29.4 26.1 (3.0)
27.2
26.5 (2.75)r 43.5 r 44.8
r 25.8 r 27.3
r 30.6 r 30.429 (2.23)
27.4 26.1 (2.60)
26.613.6 32
1.322 1.132 1.318
1.505.663
.602
.602
.833
.352
.602
.54416 20.6 (4.6)
19.6 $T_d = 3 \text{ sec}$ 23.8 (4.0) -
21.7 (3.5) -
21.2 21.0(4.0) - 35 33 (6.6) -
(4.0) - 24 20.6 23 1/2 (2.85) -
(4.0) - 21.5 21 1/2 20.726.8
23.6
21.223.8 (5.0) -
21.6 21.1 (5.0) -
21.2.732
.699
.686
.685T = 4
→ 37.8 28.8 → 41.5 (8.6)
→ 29.9 (8.16) → 29.9 (9.92)35.0 (4.86) -
23.8 20.9 (4.82) -
21.5r 41 27.6 r 37.5 28.2
r 24.8 25.8
r 30.0 29.6 (8.85) -.912
.898
.996
.942

8

$$-\ddot{\theta} + \frac{4\pi^2}{T_c^2} \theta = 0$$

$$\frac{-\ddot{\theta} \pm i \sqrt{\frac{16\pi^2}{T_c^2}} \dot{\theta}}{2} = 0$$

$$\dot{\theta} = \frac{4\pi}{T_c} \theta$$

$$\theta = \theta_0 e^{-\frac{2\pi i}{T_c} t} \left[\cos \frac{2\pi t}{T} \sqrt{1 - \frac{T_c^2}{T^2}} \right]$$

$$T_d = \frac{T}{\sqrt{1 - T_c^2/T^2}}$$

$$T^2 = \frac{T_c^2 T_d^2}{T_c^2 + T_d^2}$$

$$T = \frac{T_d}{\sqrt{1 + \left(\frac{T_d}{T_c}\right)^2}}$$

(full swing)

$$\log_{10} \eta = \frac{2\pi T_d}{T_c} \times 4.2429$$

$$T_c = \frac{T_d}{\log_{10} \eta} \times 2.73$$

T_d	$\log_{10} \eta$	$T_d / \log_{10} \eta$
1	.242	4.13
2	.430	4.65
3	.636	4.72
4	.915	4.37
6	1.318	4.55
		4.48

$$T_c = 12.23$$

$$T_c = 12.0$$

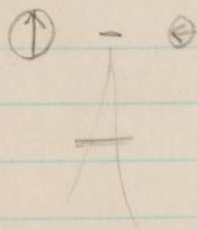
T_d	T	S	S/T^2	wt	S_{computed}
.638	.637	1.30	3.2	1	1.27
1.03	1.03	3.07	2.9	2	3.30
1.15	1.14	3.97	3.05	2	4.06
2.29	2.24	14.40	2.86	4	15.80
2.94	2.85	27.60	3.40	4	25.50
3.92	3.73	18.2	3.45	4	43.60
5.10	4.69	67.6	3.06	4	69.0
(9.25)	7.32	154	(2.86)	1	168.0
		av	3.14	22	

$$(Theoretical) S = 3.14 \frac{T_d^2}{1 + \frac{T_d^2}{144}} \frac{mm}{m} \times 10^{-7} \text{ units}$$

S. Parallel.

Theoretical

T_d	S mm/meter, 2.43×10^{-9} amperes. (6.08×10^{-7} volts)
1	3.12
2	12.20
3	26.6
4	45.2
5	66.9
6	90.4
7	114.8
8	139.0
9	163.0
10	185.0
11	
12	
13	
14	
15	
20	332

Critically damped ($T_c = 12$ sec) 452.at $T = 10$ sec, $T_d = 18$ sec.Damping ~~log ratio~~ ratio (half swings) = 112.

6.84×10^{-10}

12	6
185	9
1	6.5×10^{-10}
1	6.5×10^{-10}
4th mag	.21 μ V
1 mm	6.5×10^{-10} μ V
4th mag	32 mm
10.4	320.1 mm
6th mag	5 mm
Δ_6	10.2 ± 22
m	Δ_2
6	.02
2	.0002
3	.0005
4	.0022
5	.004
6	.010
7	.020
8	.050
9	.125
10	.31
	.75

1 mm 6.6×10^{-9}
 2.1×10^{-8}

Series Parallel

mm/meter $\mu 2.43 \times 10^{-9}$ amperes
150

x ← lowest

chemical curve
x's are observed points.

$$\frac{T_c = 12^s}{\text{Series}}$$

Damping
always
out.

100

80

60

40

20

10

0 1 2 3 4 5 6 7 8 9 10 seconds

$T_{damping}^{air}$

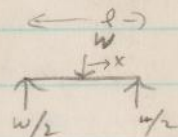
Nov 30, 1936

On ~~Friday~~ ^{Saturday} Nov 28, between 12 & 3 A 17,
the vacuum went bad. Heating restored half-period
to $\frac{1}{2}$ second ($e^{-\frac{\eta}{2}t}$) then back to no oscillation.
Leak in plug yeller. Tent of wax (A piece of W)

$$l = 9.65 \text{ cm}$$

$$\text{width} = 1.4 \text{ (a)}$$

$$\text{depth} = 0.6 \text{ (b)}$$



wt	deflection at center	
0	1.10	
2	1.11	
4	1.11	
6	1.12	
8	1.13	
10	1.14	
12	1.15	.05
4	1.12	
0	1.11	
12	1.15	
14	1.16	
16	1.17	
18	1.17	
20	1.18	
16	1.16	
20	1.18	
24	1.19	.09
28	1.20	
32	1.22	
36	1.25	.15
20	1.20	
32	1.23	
40	1.27	
44	1.30	
48	1.32	.22
52	1.36	
56	1.42	broken

$$(l/2 - x) \frac{w}{2} = M$$

$$\frac{d^2 y}{dx^2} = \left(\frac{lw}{4} - x \frac{w}{2} \right) \frac{1}{EI}$$

$$EI \frac{dy}{dx} = \frac{lw}{4} x - \frac{x^2 w}{2}$$

$$EI y = \frac{lw x^2}{8} - \frac{x^3 w}{6}$$

$$EI \Delta = \frac{3}{32} \frac{lw^3}{96}$$

$$\Delta = \frac{1}{48} \frac{l^3 w}{EI}$$

$$E = \frac{1}{48} \frac{l^3 w}{\Delta I}$$

$$I = \frac{ab^3}{12} = \frac{ab^3}{12}$$

$$E = \frac{1}{48} \frac{l^3 w}{ab^3 \Delta}$$

$$E = \frac{l^3}{4ab^3} \frac{w}{\Delta}$$

$$\frac{l^3}{4ab^3} = 7.4 \times 10^2$$

$$\frac{w}{\Delta} = \frac{3 \times 4549}{.22} = \frac{1.336 \times 10^6}{.22} = 6.06 \times 10^6$$

$$E = 4.49 \times 10^9$$

start

$$\frac{d^2 y}{dx^2} = \frac{lw}{4EI}$$

$$\Delta = \frac{1}{48} \frac{l^3 w}{EI}$$

$$\eta = \frac{l}{4} \frac{48 \Delta}{l^3}$$

$$\eta = \frac{12 \Delta}{l^2}$$

strain max

$$= \frac{6 \Delta b}{l^2}$$

$$= \frac{6 \times .32 \times .6}{(9.65)^2}$$

$$= (1.24 \times 10^{-2})$$

crack stress max = 5.56×10^7

$$= \cancel{5.56 \times 10^7} \cdot 55.6 \text{ kg/cm}^2 = 55.6 \times 2.2 \frac{\text{lb}}{\text{in}^2 / 2.54^2}$$

$$= \cancel{7.93 \times 10^7}$$

793 lb/in² max for wings.



$$\text{glu } 2 = .08 \times 10^{-4}$$

$$\text{wax } 2 = .6 \times 10^{-4}$$

$$5 \times 10^{-5} \times 60 = 3 \times 10^{-3}$$

stress is $\frac{1}{4}$ max.

or 200 lb/in²



12/2/36

Broken

~~Description of thermocouple - #2~~~~Resistance $\sim 330 \Omega$~~ ~~Sb-Bi-St diameters $\sim 5 \mu$~~ ~~Copper wire used in plug was cut from the shorter spool of #23 enamel-silk from Mr. Steinmetz of Anaconda Co.~~~~Receivers are tin disks painted with Higgins water-proof ink. Bi+St wires were soldered to these receivers with Bi-St solder, MP $\sim 110^\circ \text{C}$.~~

On Dec 12/4/36

freshly exhausted plug 2

2.8.5 cm at lower (bad) couple 2

27.2 cm

25.5 cm left upper

3.0 on flashlight bulb at end of white picket fence. (Standard galvanometer?)

12/4/36 Gal. at standard position (shortest period) as above. House light gave these deflections:

Poor junction 30.4 (30.7 cm max. but could not hold steady)

zero 27.5

good junction

23.8 Double deflection = 6.6 cm

Period = 1 sec

zero 26.0 cm

poor junction 32.3

good " 18.7

poor " 32.3

double deflection 13.6

$$\sec \epsilon = \sin \delta \sin \lambda + \cos \delta \cos \lambda \cos H A$$

$$= .6738 \sin \delta + .7388 \cos \delta \cos H A$$

12/4/36 Thermocouple #2 on plug #2.

Exhausted at MIT with a "stickney" vacuum
($< 10^{-6}$ mm) of 4 mm. Calcium tube was heated for
5 min. while on the pumps.

Resistance of couple = 285- Ω

Tin disks painted with Higgins Bi no 5 μ & 2.8-mm.
waterproof black ink. Sb $\sim$ 6 μ & 4 mm.
Bi-Sb solder used throughout.

Canella & Auzgal

10:30 PM

gab T = 4.4

4.4 mm

good	24.5	bad	25.3	
	24.8 (1)		25.2 (1)	24.8
	25.0		25.4 (1)	25.3
	24.9		25.3	

050846 24.40

sec = 1.04

	24.8	25.8	
	24.9 (1)	25.7 (1)	24.9
	24.8	26.0 (1)	25.8
	25.0	25.6	

gr	25.8	
	25.4 (6)	25.5
	25.4	
	25.3	

cm
.45 -12
.65 +8
.60 +3
1.70 123
3 .57 m⁸

± 1.05

10:45

043216 24.55

& Tauri

10:50 PM

good	25.0	bad
	24.8	24.85
	24.6	
	25.10	

Aldebaran

sec 1.13

system of units
reading
surface?

good bad
 25.5
 25.5 25.68
 25.6
 26.0
 25.8

25.20 25.68 .48
 25.55 25.92 .37
 26.04 26.15 .11
.96
.82

25.2
 25.7 25.55
 25.5
 25.8
 25.9
 26.2 26.15
 26.5
 26.0

26.5
 26.6 26.52
 26.7
 26.3

11. P17

2 origins 11 P, 17 ~~11.08~~

-1.05

052106 4^h10^m good bad

sec 21.30

26.8 26.4
 26.7 27.1
 26.6 26.9
 26.8 26.9

26.72 26.82
 (26.91) (27.17)

-0.09
 +0.07
 +0.26

27.1 27.6
 27.0 27.5
 27.1 27.4
 27.2 27.6

27.10 27.52
 (27.26)

+0.08

27.6
 27.4
 27.45
 27.20

27.41

11:08

bad nt

Setilgum
055107

2 Orionis
4^h24^m

11:14

rec = 1.31

27.1	27.6	28.98
26.9	27.5	(27.04) 27.56
26.8	27.45	27.10 (27.78)
27.1	27.7	(27.32) 27.99
27.2	28.2	27.54
27.1	28.1	
27.0	27.9	.52
27.1	27.85	.68
	27.9	.67
		<u>1.87</u>
27.3		<u>1.62</u>
27.5		
27.55		
27.8		
<u>27.5</u>		

11:18

050846 3^h40^m
4^h38^m

2 Aurigae

11:28

rec = 1.01

28.30
~~28.3~~
28.3

S. bad junction

		g	b
28.3	28.7	28.30	~~28.70~~
28.3	29.0		
28.2	28.75	(28.61)	28.79
28.4	28.70	28.92	(29.04)
28.8	29.3		29.30
29.0	29.2	(29.24)	
29.1	29.4	29.56	
28.8	29.3		

29.7
 29.5
 29.65
 29.4

18
 12
 06
 36
 .09

11:33

11:40 standard junction of galv T ~ 0.64 sec
 g b

1:40
 with gauge

T = 8.5"

g	b
31.0	38.9
30.9	
<u>39.8</u>	
	<u>45.0</u>
<u>42.2</u>	

1.50

g	b
23.3	25.0
<u>20.7</u>	<u>23.8</u>

out of focus

ready to

5 6

(3.2)	28.8	32.3	3.55
	28.7	32.6	3.75
			<u>4.50</u>
	27.5		11.80
			<u>3.93</u>

reform

25.3

	31.6	6.40	
25.1		6.10	
	30.8	<u>5.65</u>	<u>6.05</u>
25.2		18.15	

 α Canis Majoris~~28.8~~

18.2

19.1

21.6 (19.1)

2.5

21.77 19.1

2.6

21.8 (19.4)

2.9

19.7

2.50

T=8

$$-1.67 + \frac{5.60}{\sqrt{1.60}} = 2.77/\text{mm}$$

$$-1.27 + \frac{5.60}{\sqrt{1.60}} = 2.22$$

 α Canis Minoris

(Procyon)

.22+

= 2.44

16.5

(16.65)

17.2

0.55

16.8

(17.85)

1.05

(17.8)

18.5

0.90

18.8

2.300.77

scale to cm? (at 100 cm, av., 2.87)

Gal at standard position

$$\begin{array}{r} 27.1 \\ 26.5 \\ \hline 20.5 \end{array} - 6.6 \text{ cm.} \quad \text{OK.}$$

3:34 PM. Friday
Dec 4-5

at 12 sec, off scale at 15 cm, r.w. 43
(=28?) $\rightarrow$ = 18 cm on Betelgeuse 3:10 AM

Dec 4-5.

820^m ST

$$\begin{array}{r} 551 \\ 2129^m, 07 \\ \hline \end{array}$$

$$= 37^{\circ} 15'$$

$$1084 \checkmark$$

$$.58$$

$$.588$$

$$1.7 = \text{recat } 2$$

$$\begin{array}{l} -1.57 \\ +2^m \\ \hline 6^m \end{array} \quad \begin{array}{l} 2.6 \text{ cm/meter} \\ 1 \text{ cm.} \\ \hline 61'' \sim 1 \text{ cm.} \end{array}$$

$$30 \quad 1866$$

$$45 \quad 1107$$

$$8$$

$$174$$

$$552$$

$$3.8$$

$$1488$$

Moon off scale, T = 6 sec approx

Flashlight: 140 watts $T_d = .638$ 3 cm at 100 m?Betelgeuse: 354 km/sec. $T = 12?$ 18 cm

$$\frac{E}{B} = \frac{3 \times 354}{18} = 59. \quad b = \frac{1}{4 \times 10^8} = 7.94 \times 10^{-10} \text{ watt/cm}^2$$

$$B = 1.35 \times 10^{-10} \text{ watt/cm}^2$$

$$= 1.93 \times 10^{-10} \text{ cal/cm}^2 \text{ minute}$$

$$= 2.64 \times 10^{-10} \text{ outside atm.}$$

$$\text{ext} = 0.34$$

$$P \& N \quad 1.32 \times 10^{10}$$

$$18 \text{ cm} \quad 71 \text{ cm} \quad \text{Betelgeuse} \quad \text{ext} \cdot 7 \times 2 = .14$$

$$\text{or } 25.4 \text{ cm at 1 meter}$$

$$0.86 \text{ cm}$$

$$m = -1.67$$

$$m = +2.00$$

$$10''$$

$$0.98 \text{ cm}$$

$$1 \text{ meter}$$

$$m = +2.00 \text{ at zenith}$$

$$60''$$

$$0.88 \text{ cm}$$

$$1 \text{ meter}$$

$$m = +6.00$$

$$\text{r.w. } 100'', \text{ } p.04 \text{ cm.} \quad \text{we are } 22 \times \text{ as sensitive.}$$

$$\text{or } 23'' \text{ as } 200 \times 100''. \quad 10'' \quad .0245$$

$$1 \text{ meter} \quad m = +6.00 \text{ at } z = 0$$

Sec 7, 4.8 cm on ^{street} light.
 Sec 8 $\left\{ \begin{array}{l} 3.7 \text{ cm on street light} \\ 1.4 \text{ cm on flashlight} \end{array} \right.$

N
 0
 2

March 14

Bequette test

61" dome

in window

against

dome

$$\frac{150.0 - 75.0}{20} = \frac{150.4}{20} = 7.52$$

$$\frac{151.4}{20} = 7.57$$

$$\frac{153.5}{20} = 7.68$$

$$\frac{159.0}{20} = 7.95$$

$$\frac{145}{20} = 7.25$$

$$\frac{151.8}{20} = 7.59$$

$$\frac{147.4}{20} = 7.37$$

$$\frac{147.6}{20} = 7.38$$

$$\frac{152.2}{20} = 7.61$$

269.5 sh't N $\frac{2}{41}$ 360 E

267.3 sh't E

279.7 sh't S

277.0 sh't W

301.6 sh't SW

272.8 sh't NW

271.1 sh't N

269.4 " N $\frac{2}{41}$ 360 E

300.8 " SW

280.5 platform in way (no effect)

292.0

300.2

268.2

272.7

NE

SE

half way in (no effect)

In east window:

$$\frac{123.0}{20} = 6.15$$

N

del above. take case vertical

Telescope + 24°

4 h 20 m

$$\frac{123.4}{20} = 6.17$$

N

dist. center 2 radii of dome.

in South window of Administration Bldg.

191.8	N	0
(191.45) 191.5 191.4	E	-1.3
(191.82) 191.75 191.90	S	0
192.7 .25	W	1.4
191.8	~~N~~	~~0~~

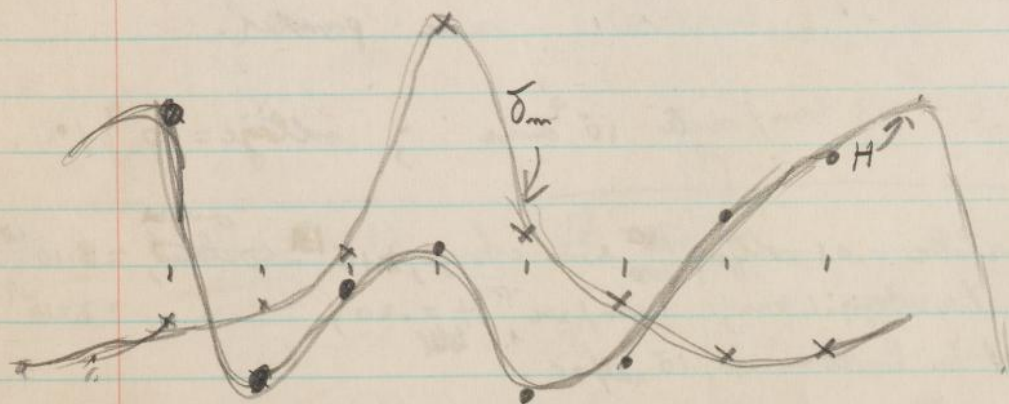
$$\frac{.35}{180} \pi = .006$$

(in window, vertical)

	^S T	H	$\Delta \text{dec}_{\text{m}}$	ΔH
N 271.1	7.25	0.146	~~-5.0~~	+0.014
NW 272.8	7.95	0.122	-3.3	-0.010
W 277.0	7.68	0.130	+0.9	-0.002
SW 300.2	7.59	0.134	+24.1	+0.002
S 279.7	7.97	0.120	+3.6	-0.012
SE 272.7	7.86	0.124	-3.4	-0.008
E 267.3	7.51	0.136	-8.8	+0.004
NE 268.2	7.375	0.141	-7.9	+0.009
	276.125	.132		

E window N 6^S.15 Telescope vertical
6^S.17 Telescope inclined

H
~~0.204~~
0.202



Cambridge Station Closed
on June 7, 1937.

June 1-7, 1937.

Torch
radius = $27'$
our radius = $36'$

Tests on Dome, galvanometer.

1. Galvanometer on window ledge; too unstable
2. at distance of 3 radii ^{from} of dome, period of ~ 8 sec (undamped, circuit open) galv. to N. of tunnel in admin. Bldg. on table near W wall, facing S, shift of 10 cm when dome is steadily rotated (extreme shift; shift oscillatory in period of dome). Same distance, on table near door (all in reading room) facing W, extreme shift 5 cm.

Dome's hypothesis - not all permanent magnetism

3. Inverse cube law checked.
4. Period damped by closed circuit

June 7) adjusted to ~ 12 sec; 20' old leads (twisted #23 wire in spaghetti, in woven paper sheath) attached & soldered by solder far end. When 10' heated by torch to about 150°C , deflection of 5 cm. (total - extreme left to extreme right). Direction of shift erratic, series parallel.

$$S = 93 \text{ mm/meter } 10^{-9} \text{ amp} ; \text{ voltage} = 10^{-9} / ^\circ\text{C}.$$

0.1 amp, 10/2,

electrostatic - .01 volt/pc ^{0.7} e.s. charge, 7×10^{-13} coulomb, $= 3 \cdot 10^{-10}$ volt
magnetic swing: 1 cm, 1 cm/sec, $H = .20$, $= 2 \times 10^{-9}$ volt
thermal in leads - 10^{-9} volt/°C.

$$\text{magnetic } x = a \sin \frac{2\pi}{T} t \quad \dot{x} = \frac{2\pi}{T} a$$

Magnetic ^{monitors stem} L in half turns/cm; each has area of $\frac{d}{n} \pm e \frac{d}{n}$ $d = \text{over all diameters wire}$. n length l , area $= \pm \frac{d}{n} \pm e d \sqrt{\frac{l}{n}}$.

$$(n = \#23, 100 \text{ m.}) \text{ total area} = \pm e \cdot .06 \sqrt{\frac{10^4}{3}} = \pm 6 \text{ cm}^2$$

$3\frac{1}{2}$ turns per inch, 56a charge in H₂O .001 gauss/second, voltage is $\pm 6 \times 10^{-11}$ which is trivial ($= 6 \times 10^{-3} \times 10^{-8}$).

July 29, 1937. Galvanometer installed. Scale ≈ 1 mV.
Oak Ridge. Wire connected; grounded; ends shorted on
61" telescope. $T = 10^5$ (open circuit). at 15 sec
intervals; (scale at 41", Aug 18, TES)

Twice term
is removed

$$x = \frac{2(7+73+75)+2}{12}$$

(Single deflection)

single

~~seconds~~

700
~~500~~

[illegible]

If linear term is removed in groups of 5 from 10^5 runs, m.e. of single reading is found to be ± 0.286

The expected is $\frac{\sqrt{I}}{2\pi} 2000 \sqrt{\frac{RT}{I}}$ mm/meter

$$= \frac{10}{2\pi} 2000 \sqrt{\frac{1.37 \times 10^{-16} \cdot 300}{6 \times 10^{-6}}}$$

$$= 0.264$$

T	T2	Dr	Exp
768	103	1286	.264
6.03	7	.185	.184

Constant & linear out.

$$a = \frac{1}{2}(y_2 + y_4) \pm E\sqrt{\frac{1}{2}}$$

$$b = \frac{2(y_5 - y_1) + (y_4 - y_2)}{10} \pm E\sqrt{\frac{1}{10}}$$

$$a - 2b + \Delta = y_1 \pm E, \text{ say}$$

$$a - b = y_2$$

$$a + 0 + \Delta = y_3$$

$$a + b = y_4$$

$$a + 2b + \Delta = y_5$$

$$\begin{array}{ccc} 5 & 0 & 3 \end{array} \quad \Sigma y$$

$$\begin{array}{ccc} 0 & 10 & 0 \end{array} \quad -2y_1 + y_2 + y_4 + 2y_5$$

$$\begin{array}{ccc} 3 & 0 & 3 \end{array} \quad y_1 + y_2 + y_5$$

$$\begin{array}{c} 2 \\ 1 \end{array}$$

$$y_2 + y_4$$

$$\frac{1}{2}(y_2 + y_4)$$

$$3 \quad y_1 - \frac{3}{2}y_2 + y_3 - \frac{3}{2}y_4 + y_5$$

$$\text{or } \Delta = \frac{2(y_1 + y_2 + y_5) - 3(y_2 + y_4)}{6} \pm E\sqrt{5\%}$$

Constant Linear & Quadratic out

$$a - 2b + 4c + \Delta = y_1 \pm E$$

$$a - b + c = y_2$$

$$a + 0 + 0 + \Delta = y_3$$

$$a + b + c = y_4$$

$$a + 2b + 4c + \Delta = y_5$$

$$\begin{array}{ccc} 2, 0, 2, 0 \end{array} \quad y_2 + y_4$$

$$\begin{array}{ccc} 0, 0, 6, 2 \end{array} \quad 4y_1 - y_2 - 4y_3 + y_4$$

$$\begin{array}{ccc} 0, 0, 10, 6 \end{array} \quad 2y_1 - 3y_2 + 2y_3 - 3y_4 + y_5$$

$$\begin{array}{ccc} 0, 0, 0, 8 \end{array} \quad y_1 - 4y_2 + 6y_3 - 4y_4 + y_5$$

$$\begin{array}{ccc} 5 & 0 & 10 & 3 \end{array} \quad \Sigma y$$

$$\begin{array}{ccc} 0 & 10 & 0 & 0 \end{array} \quad -2y_1 - y_2 + y_4 + 2y_5$$

$$\begin{array}{ccc} 10 & 0 & 34 & 8 \end{array} \quad 4y_1 + y_2 + y_4 + 4y_5$$

$$\begin{array}{ccc} 3 & 0 & 8 & 3 \end{array} \quad y_1 + y_3 + y_5$$

$$\Delta = \frac{y_1 - 4y_2 + 6y_3 - 4y_4 + y_5}{8} \pm \sqrt{\frac{35}{32}} E$$

$$8c = y_1 2y_3 + 35$$

$$c = \frac{y_1 2y_3 + 35}{8} \pm e \sqrt{\frac{8}{32}}$$

Solve for c in the 3 rows. We find

$.05 \pm .087$	$-.02 \pm .086$	$+.05 \pm .056$
0	$-.06$	$-.02$
$.05$	$+.08$	$+.02$
$.04$	$-.12$	$+.02$
$-.12$	$-.01$	$+.00$
0	$+.02$	$+.01$
$+.003 \pm .036$	$+.05$	$+.01 \pm .023$ which are not significant.
	$-.01 \pm .023$	

Since do not take out quadratic term.

Brownian motion. Take out linear & no Δ .

$$\begin{aligned} a - 2b &= y_1 \\ a - b &= y_2 \\ a &= y_3 \\ a + b &= y_4 \\ a + 6 &= y_5 \end{aligned}$$

$$\begin{array}{r} 5 \quad 0 \quad \Sigma y \\ 10 \quad -2y_1 - y_2 + y_4 + 2y_5 \end{array}$$

$$\begin{aligned} a &= \frac{1}{5} \Sigma y \\ b &= \frac{2(y_5 - y_1) + (y_4 - y_2)}{5} \end{aligned}$$

residuals: $T=10$

$.12$	$-.34$
$-.10$	$+.26$
$-.12$	$+.16$
$+.06$	$+.36$
$+.04$	$-.34$
$-.16$	
$+.28$	$-.34$
$-.08$	$+.62$
$-.04$	$-.22$
0	$+.04$
	$-.10$
$+.22$	
$-.22$	
$+.04$	
$-.30$	
$+.26$	
0	
$.12$	
$-.06$	
$-.24$	
$+.18$	

$$e = \pm .286, \text{ m.e.}$$

residuals: $T=7, 20^{\circ}$ interval.

$-.16$	$+.06$
$+.12$	$-.14$
$+.10$	
$+.04$	$+.09$
$.09$	$+.04$
$-.26$	
$-.30$	$.27$
$+.19$	$-.34$
$.18$	
$.06$	$-.08$
$.12$	$+.04$
$+.10$	
$-.04$	$.04$
$.12$	0
$-.12$	

$$e = \pm .195$$

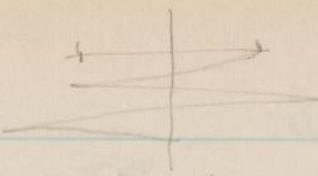
(exp. 185)

$T=7, 15$ intervals

$-.02$	$-.22$
$.18$	$.18$
$-.12$	
$-.10$	$-.11$
$.13$	$.02$
$.06$	
$-.04$	$.32$
$.08$	$-.16$
$-.20$	
$.04$	$.20$
$-.04$	$-.08$
$-.12$	
$-.08$	$.26$
$.10$	$-.16$
$-.12$	
$.02$	$.03$
$-.01$	0
$-.04$	

$$\pm .173$$

(arbit. 184)



$\star$	m_r	$\Delta(\text{mm})$	$m_r + 5/2 \log A$
Vega	0.10	74.2	
		83.2	
		66.8	
		54.7	
		62.2	
		113.0	5.23
		82.0	
X Cygni	(1.0 au) 1.6	46.7	
		51.3	5.27
		49.2	
β Androm	0.45	71.8	
		80.7	
		79.5	
		102.0	5.47
55 Peg	2.98	9.8	5.46
		7.9	
		7.4	
			~~21.43~~
			<u>5.36</u>
			limit 7.86

$$5.36_{6.1''} - 2.87_{10''} = 2.49$$

$$\text{diff. should be } 5 \log 6 = 3.89_{\text{op}} + 0.31_{\frac{10^5}{8^2}} = 4.20$$

a defect of 1.71

Coupler twisted (2.2
incidence)

old silver 1.5
larger coupler 1.5

$$4.95 \sim 1.71$$

Oat Ridge 6/4

Sunday ^{avg.} 14-4

Vega

11:45

V

L air

glass

241

169

246

170

244

243.7

169.5

(74.2)

12:00

225

165

224

139

237

162

212

124

229

163.5

208

63

12:15

391

(66.8)

44

131.5

230.3

214.7

(83.2)

~~167 168~~~~175~~~~202~~~~204~~~~179~~

glass cert 213

no glass 230

glass 208

glass no star 160

no glass no star 180

glass no star 155

light off 152

no star

no star

#1 glass
#2 glass

Vega image star away from the junction

12:40

air

197

149

203

147

208

202.7

148

(54.7)

Vega air image between eye & eye

12:43

212

143

204

150

210

146.5

208.7

(62.2)

12:50

Best focus

no glass

228

116

226

113

227

110

(113.10)

223

glass

12:55

193

109

190

109

191

109

190

82

1:20

X Cygni
airHA
= 250² W

~~145~~
165 120
150 110
170
161.7 115

(46.7)

air

146
135
140
140.3

~~93~~
85
89.0
(51.3)

1:42

1:38

glass

123 88

129 71

134 79.5
86

128.7

(49.2)

4:20 (1 mm)
334 259
335 260
325
4:25

B Androm

331B

259.5

(71.8)

55

(1.1 mm)

2587

2448

2492 2375

(2450) 4823

7529 2412

2510

2412

0.99.8 mm

4135

Reg

2540

2448

92 mm

Bardrom

2440

1680

2330

1360

2210

2327

1520

1520

(80.7)

4:45

2210

1495

2250

1420

2300

2253 1458

1458

(79.5)

4:50

55 *Lygni* Peg

1880

1782

1831

1739

1805

1839 1760

1760

(7.9)

5:00

1874

1815

5:1

1908

1835

1915

1825

5:05

1899

1825

B Androm

5:10

2220

1180

2170

1080

2030

2140

1120

1120

(102.0)

5:14

B Androm

71.8

AM 2
4:22 14°

4:30 54°

9.8

80.7

4:40 18°

79.5

4:48 19°

4:55 58°

7.8

5:02 60°

7.4

102.0

5:12 24°

330.5

83.50

8.37

9.96

8

8.3

82.65

747

795

777

480

B Androm

= 2.50

7.78 2.23

9.05 2.39

11.86 2.68

2.43

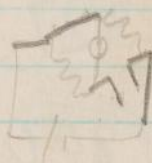
Aug 16 E Test of Galvanometer
 Couple.

N → L ↑ S

W

Couple + line, 270Ω } check
 270Ω

1 line to $\pm \frac{1}{4} \infty$
 2 line to $\pm \frac{1}{4} \infty$
 3. $\frac{1}{4} \infty$ to $\pm$ real



fresh battery

$$V = 1.46$$

$$r = .1$$

$$\frac{V}{1 + \frac{r}{R}} = 1.45$$

$$1 + \frac{r}{R} = \frac{1.46}{1.45} = 1.0069$$

$$\frac{r}{R} = 0.0069$$

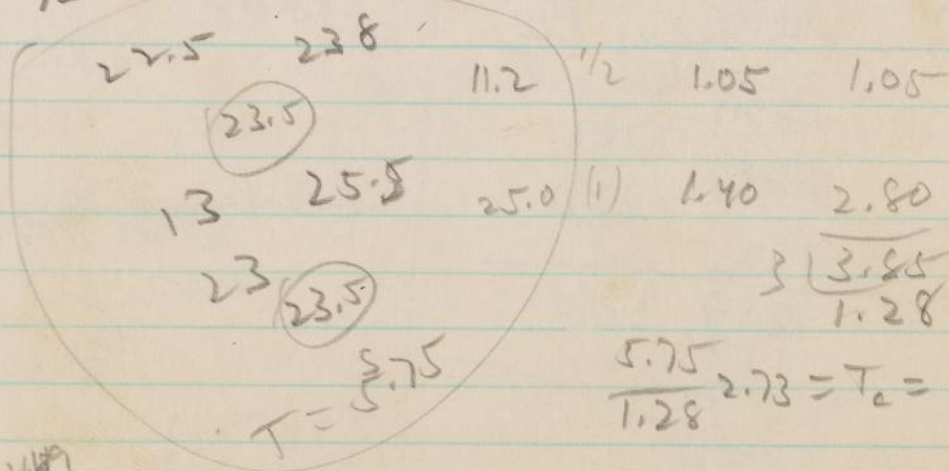
$$R = \frac{r}{0.0069} = \frac{0.1}{0.0069} = 14.5$$

$$= 6.3 \times 10^{-7}$$

with

T	Δ				
0.62	1.6	239.1	240.7		
0.93	3.0	258.9	262.0	259.1	262.1
2.30	18.4	228.2	246.5	228.0	246.2
3.60	43.	221	264	224	267
4.00	46.	214	260		
5.75	90				

scale at 41°



$$\frac{5.75}{1.28} 2.73 = T_c = 12.3$$

$$\begin{array}{r} 1.28 \overline{) 5.75} \\ \underline{5.12} \\ 630 \\ \underline{640} \end{array}$$

T_d	S (mm/m 6.3×10^{-7} volt)	S (theoretical) = $3.26 \frac{T_d L}{1 + T_d/144}$	$\frac{O-C}{C}$
0.62	1.54	1.25	0.23
0.93	2.88	2.79	0.03
2.30	17.7	16.50	0.07
3.60	41	39.00	0.05
4.00	44	47.1	-0.06
5.75	86	89	-0.03

$$S = 3.14 \frac{T_d^2}{1 + \frac{T_d}{144}} \frac{\text{mm}}{\text{m } 6.08 \times 10^{-7} \text{ volt}} \quad (\text{S.P.})$$

$$= 3.14 T^2 \frac{\text{mm}}{\text{m } 2.42 \times 10^{-9} \text{ amp}} \quad (\text{S.P.})$$

$$= 6.28 T^2 \frac{\text{mm}}{\text{m } 2.42 \times 10^{-9} \text{ amp}} \quad (\text{P.})$$

$$= 2590 T^2 \frac{\text{mm}}{\text{m } 10^{-6} \text{ amp}}$$

$$\therefore F = \frac{259000}{(1000)^{2/5}} = 16200$$

$$\frac{1000^{2/5}}{4} = 4$$

$$62^{2/5} = 52$$

Oct 11-12, 1937

p And. 29.75

29.45

29.80

29.45

29.75

29.77

29.45

= 3.2 mm

#2-glass
in place

28.50

27.94

28.44

27.85

28.30

28.41

27.89

5.2 mm

~~28.25~~

28.05

28.46

27.94

28.37

27.92

27.97

28.41 =

5.6 mm

o Ceti

25.60

26.05

13.3

25.45

25.92

25.28

25.44

25.98 =

5.4 mm

#2-glass

26.22

26.63

26.10

26.60

25.95

26.09

26.62 =

5.3 mm

#2-glass

26.20

26.00

26.25

25.90

26.15

26.20

25.95 =

2.5 mm

o ceta (cont)

~~#2-glass 25.83 26.09~~~~25.74 26.19~~~~25.88~~

slit not open

25.82 26.14 = 3.2 mm

~~#2-glass 25.85~~ 26.25

25.87 26.23

25.88

25.87 26.24 = 3.7 mm

#2-glass 25.33 25.70

25.40 25.61

25.30 25.63

25.34 = 3.1 mm

#3 - clear

Oct 16-17, 1937. 95 period. all calcium heated; only faint green discharge.

B androm. #1, no glass (0.45 = m. P & N) 170

298.0 266.9

294.0 257.5

291.5 262.2

294.5 32.3 mm

#2, glass, long mm

342

221

332

140

235 180.5

909

303

122.5

no glass same part

160

270

177

310

175

29

170.7

147.7

95 period o ceta 12 P 17

222

171

215

159

212

165

216.3

✓ anetha

252.5

(1.24)

241.0

269.5

217.0

252.0

236.8

260.7

217.0

208.5

236.8

187.8

223.0

207.0

208.5

184.5

187.8

12110

191.0

25.0

12/23 0 Ceti 12:23

306
252
295 242
282
294.3 247
(47.3) ✓

2 Ceti (0.72) 12:35

1880
173.0
218. 195.0 (27.5) ✓
228.5
211.5 184 12:40

226.0
194.0

229.0 196.0
229.5
228.2 195
(33.2) ✓
m v

12:48

0.19
0.48 } 0.34

0 Ceti (51.3) (49.3) 41° P 9 N

2 Ceti (27.5) (30.3) 39° 0.72 12 2.82

2 Ari (23.9) (24.4) 19° 1.24 K1 2.23

1st ret $\Delta = 0^{m}.18$
0.00

-0.52
0.05

(-0.07) $\pm .28$ each m.

in groups of five $\frac{1}{6}(2(1)-3(2)+2(3)-3(4)+2(5))$

2nd ret -0.07

-0.16

-0.03

0.02

$\pm .09$ each

3rd ret .20

.30

.02

-0.25

.20

(.09) $\pm .22$

4th ret

.10

.48

.33

.10

$\pm .30$ each

Reduction for $\Delta \rightarrow$

Test for Effect of Headphones

Wednesday, Dec 15-16, 1937

sh

Temp 28° F. Moon full. Sky hazy.

Galvanometer connected to thermocouples. The following readings are taken every 15^s. Period 13^s.
Cover on galvanometer.

1st Set: Headphones on floor. First reading, 2:20, G. C. T.

126.2	125.5	124.8	124.0	123.8	123.2	122.4
122.3	121.8	120.8	120.5	120.6	119.7	119.7
118.7	118.2	118.2	118.7	117.9	117.4	116.9

2nd Set: Headphones worn on head, holding as still as possible
First reading: ~~2:27~~ 2:28

115.2	114.9	114.8	114.7	114.2	114.7	115.2	114.7
115.0	115.4	115.2	115.7	115.9	115.9	116.2	115.9
115.7	115.9	116.2	116.1	116.8	116.7	116.8	116.2

3rd set: Headphones worn on head, moving head to see reading & to record, somewhat more than necessary. Phones plugged into circuit
First reading: 2:35

116.9	117.2	116.9	116.4	117.2	117.2	117.2
117.6	117.8	118.6	118.2	118.6	118.0	118.1
118.9	—	118.9	119.4	119.2	119.7	119.8
120.1	119.3	120.2	120.3	119.7	120.0	119.6

4th set: Same as 1st set. (Bumped lamp, & adjusted it slightly)
First reading 2:45

135.4	135.2	135.2	135.2	135.3	135.8	135.2	135.6
135.3	135.8	136.0	135.6	135.7	135.8	136.4	136.3
136.1	136.7	136.3	135.9	136.1	135.8	135.6	135.7

formulae

$$a - 2b = \gamma_1$$

$$a - b = \gamma_2$$

$$a = \gamma_3$$

$$a + b = \gamma_4$$

$$a + 2b = \gamma_5$$

$$\begin{array}{r} 5 \ 0 \end{array} \quad \Sigma \gamma$$

$$10 \quad -2\gamma_1 - \gamma_2 + \gamma_4 + 2\gamma_5$$

$$a = \frac{1}{5} \Sigma \gamma$$

$$b = \frac{1}{10} (-2\gamma_1 - \gamma_2 + \gamma_4 + 2\gamma_5)$$

$$\left\{ \begin{array}{l} \gamma_1 - a + 2b \\ \gamma_2 - a + b \\ \gamma_3 - a \\ \gamma_4 - a - b \\ \gamma_5 - a - 2b \end{array} \right\}$$

individual residuals

1st set	a	124.86	r_1	r_2	r_3	r_4	r_5
	124.86	-.63	.108	.101	-.06	-.23	+.20
$e = .31$	122.10	-.54	.02	-.24	.20	.24	-.22
	119.84	-.45	-.24	.31	-.14	.31	-.24
	118.08	-.19	-.26	-.07	.62	.01	-.30
2nd set	114.76	-.22	0	-.08	.04	.16	-.12
	115.00	.12	-.06	.32	-.30	-.12	.16
$e = .19$	115.78	.17	-.24	.09	.12	-.05	.08
	115.96	.09	.12	-.17	-.06	.15	-.04
3rd set	116.92	-.02	-.06	.26	-.02	-.50	.32
	117.68	.34	.20	-.14	-.08	-.22	.24
$e = .35$	118.36	.09	.02	.33	-.36	-.35	+.36
$\pm .06$	119.40	.21	-.08	.21	-.20	.09	-.02
	119.92	.02	.22	-.60	.28	.36	-.26
4th set		-.02	.10	-.08	-.06	-.04	.08
		.01	.29	-.33	.06	-.25	.24
$e = .28$		.10	.30	-.20	-.20	-.20	.30
		-.06	-.08	-.22	.44	.10	-.24

meteor at 4:08 sidereal time
 vertically down in NW
 Jan 15, 1938
 Temp 14° F. Period 8.0 sec. at 1:05 G.C.T.
 334.2 272.2 329.6 207.2 325.9 209.3
 318.7 202.2 324.0 198.7 315.0
 Voltage applied to alternate readings. See page 2.
 Some revolved thru 360° & no change in galvan.
 zero point more than few mm.
 Small change of zero point with heady bones.
 266.8 0 248.0 287.7 170.2 293.0
 169.2 287.2
 New point 7.0 sec. at 1:38

Thursday Jun 27, 1938

1 cell on voltage divider - period $\sim 6^s$
 $T = 30^\circ F$ ~~19~~

(12^h+) GCT Voltage on + off. slit west
 2:39 off 19.7 - on 31.4 - 20.0 - 31.7 - 20.1 (4) cm.

slit north
 2:43 20.8 - 32.7 - 21.2 - 32.9 - 21.5

slit east
 2:45 22.3 - 33.9 - 22.5 - 34.0 - 22.8

slit south
 2:49 23.5 - 34.8 - 23.8 - 35.3 - 24.1

Change ϕ by holding wrench near gal.
 2:53 30.0 - 41.5 - 30.3 - 41.7 - 30.4

3:00 deflected other direction with wrench.

↳ 20.6 - 33.7 - 23.1 - 36.4 - 25.5

3:02 21.4 - 34.5 - 24.7 - 36.9 - 26.5

Reversed current to galvanometer + wrench
 3:07 13.5 - 3.5 - 18.0 - 7.3 - 20.7

no wrench
 3:08 28.0 - 16.4 - 28.0 - 16.3 - 28.1

no wrench
 4:19 34.2 23.0 33.5 22.9 33.5

7 sec period
 continued on next page

Thermocouples, gal. & voltage in series
in telescope.

- 1) Moved telescope to NW. Zero moved 4 cm to higher numbers.

Voltage on + off

4:30 - 38.0 - 30.7 - 37.8 - 30.7 - 38.1

New period ~ 7.5 sec.

Slit east

4:56 15.8 - 4.8 - 15.4 - 4.5 - 15.2 - zero - 15.2

Moved Telescope & ~~time~~

5:02 24.5 - 14.3 - 24.6 - 14.5 - 24.9

Moved Telescope - slit S.E.

5:06 37.8 - 27.9 - 37.5 - 27.9 - 37.8

Moved Telescope

5:10 26.5 - 16.5 - 26.7 - 16.8 - 26.9

Moved Telescope

5:14 11.4 - 0.5 - 10.8 - 0.4 - 10.5

5:17 27.0 - 17.3 - 26.9 - 17.4 - 26.5

GCT	GA	Scale	Circumference	GCT	GA	Scale	Circumference
14:39	69.7	19.9 (-35)	Sat W	16:30	43.6	38.0	Coupler in view
14:43	69.8	21.2 (-2.1)	Slit N	16:56 - 12	64.9	15.5	New period slit E
14:45	68.5	22.5 (-9)	Slit E	17:02 - 6	61.6	24.7	2 Telescope moved
14:49	67.5	23.8 (-4)	Slit S	17:06 - 2	58.8	37.7	3 Slit SE
14:53	68.2	30.2 (6.8)	Ward	17:10 + 2	60.3	26.7	4
15:00	71.9	23.1 (-3)	Ward	17:14 + 6	62.7	10.9	5
15:02	69.0	24.2 (1.8)	Ward	17:17 + 9	56.7	26.8	6
15:07	72.0	17.4 (-6.0)	Ward no current		60.8		
15:08	70.1	28.0 (4.0)	No Ward	17:08	GA corrected $(x - x_0) \times +.33$		
15:19	64.7	33.7	No Ward	1	64.9	15.5	
				2	63.6	24.7	
				3	62.1	37.7	
				4	64.9	26.7	
				5	68.6	10.9	
				6	63.6	26.8	
					64.6	23.7	

	time	scale	resid.	
0	-15	-3.5	1.3	.4
4	-17	-2.2	1.1	.5
6	-9	-0.9	-.4	-.6
10	-5	4.0	-1.7	-.7
14	-1	6.8	-1.3	.4
21	6	-.3	1.8	1.7
23	8	+0.8	-1.3	-1.1
28	13	-6.0	1.3	-.2
29	14	+4.6	-.7	.5

$$at + bs = \text{resid}$$

from early
measures

$$\Delta' = a + bt + c(\text{Scale})$$

$$\frac{-.253}{68.4} = \frac{-.0037 \pm .0012}{\text{cm}}$$

$$\begin{aligned} 918 & \quad 49.00 \quad -10.7 \\ 138.02 & \quad -34.85 \\ \hline & \rightarrow 135.40 \quad -34.28 \end{aligned}$$

$$\begin{aligned} s &= -.253 \pm .084 \\ r &= +.0018 \end{aligned} \quad \frac{5.81}{9-3} = .97$$

$$\begin{aligned} 918 & \quad -12.8 \quad 27.22 \\ 14.75 & \quad -34.85 \end{aligned}$$

$$\begin{aligned} 14.57 & \quad -34.47 \\ \text{resid} & \quad -2.36 \\ \text{scale} & \end{aligned}$$

$$\text{correction to } \Delta = \frac{2.36}{68.4}$$

$$\frac{.0116}{10.7} + 49.0$$

$$14.63 \quad -34.28$$

$$-2.34$$

$$\frac{2.34}{68.4} = 0.0342$$

From late me runs p 39.

time residual scale

-12 +0.3 -8.2

-6 -1.0 +1.0

-2 -2.5 14.0

+2 +0.3 -13.0 x

6 4.0 -12.8

9 -1.0 +3.1

+305 -0.0754 +23.0 +9.5 ✓

24.43 -98.66 ✓

22.70 -94.38

residual
scale = -4.16corrected values
not as good (?)
as original
ones

$$\frac{4.16}{64.6} = 0.0644$$

T r S check

-12 4.1 -8.2 -16.1

-6 0.8 +1.0 -4.2

-2 2.0 14.0 10.0

+2 -0.5 3.0 4.5

+6 1.9 -12.8 -4.9

+9 -4.1 3.1 8.0

-2508 -0.0704 -8.197

305 -76.5 21.5 -25.0 ✓

42.12 -99.35 -133.73 ✓

446.69 318.84 ✓

485.11 ✓

-4.0977 -3.0977

22.93 -93.96 -71.03 ✓

445.18 351.24 ✓

280.18 ✓

60.16 60.18 ✓

60.15 ✓

$$\frac{60}{6-3} = 20 = c^2$$

$$S = -4.10 \pm .93$$

$$\frac{-4.10 \pm .93}{60.8}$$

$$= -.0674$$

this is absurd, too large.

Resolve using "corrected" values
over which the scale is
corrected.

S	
-3.5	1.3
-2.2	1.1
-0.8	-1.4
4.0	-1.7
6.8	-1.3
-3	1.8
+1.8	-1.3
-6.0	+1.3
+4.6	-1.7
-34.85	

from late measure

$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
-12	-8.2	4.1	-1.5
-6	+1.0	0.8	-1.4
-2	+14.0	-2.0	.5
+2	+3.0	-0.5	.6
+6	-12.8	+1.9	.6
+9	+3.1	-4.1	-1.3

$$r + 12.115 + 1.235 \checkmark$$

$$\frac{3.07}{6-3} = 1.02 \checkmark$$

$$\frac{1.02}{445} = .048 \checkmark$$

$$\begin{array}{r} 305 \checkmark \\ 215 \checkmark \\ 446.69 \checkmark - 99.35 \checkmark \end{array}$$

$$\frac{-2.11 \pm .048}{60.8} = -.0035 \pm .0008 \checkmark$$

$$\Rightarrow 445.17 - 93.96 <$$

$$S - .211 < \pm .048$$

$$x - .235 \checkmark$$

$$\begin{array}{r} -.0035 \\ -.0037 \\ \hline -.0036 \end{array}$$

$$(\text{corrected}) \Delta = \Delta + .0036 \text{ scale } \Delta = \Delta (1 + .0036 \text{ scale})$$

$$\text{Corr to } \log \Delta = + \frac{5}{2} \log (1 + .0036 S)$$

S (mm) Correction (σ) to $\frac{1}{2} \log A$

S (mm)	Correction (σ) to $\frac{1}{2} \log A$	S (mm)	σ
0	.000		
1	.004		
2	.008		
3	.012	0	-0.095
4	.015	10	-0.091
5	.019	20	-0.087
6	.023	30	-0.084
7	.027	40	-0.080
8	.030	50	-0.076
9	.034	60	-0.072
10	.038	70	-0.068
11	.042	80	-0.065
12	.046	90	-0.061
13	.049	100	-0.057
14	.053	110	-0.053
15	.057	120	-0.049
16	.061	130	-0.046
17	.065	140	-0.042
18	.068	150	-0.038
19	.072	160	-0.034
20	.076	170	-0.030
21	.080	180	-0.027
22	.084	190	-0.023
23	.087	200	-0.019
24	.091	210	-0.015
25	.095	220	-0.011
		230	-0.008
		240	-0.004
		250	-0.000
		250	+0.095
		490	+0.091
		480	+0.087
		470	+0.084
		460	+0.080
		450	+0.076
		440	+0.072
		430	+0.068
		420	+0.065
		410	+0.061
		400	+0.057
		390	+0.053
		380	+0.049
		370	+0.046
		360	+0.042
		350	+0.038
		340	+0.034
		330	+0.030
		320	+0.027
		310	+0.023
		300	+0.019
		290	+0.015
		280	+0.011
		270	+0.008
		260	+0.004
		250	+0.000

10.12.38 $10^8 \Omega$ $\pm$ to copper tube at Oak Ridge,
 $2\frac{1}{2} \times 10^8 \Omega$ leads to copper tube
 lead to lead, $> 500 \times 10^6 \Omega$

10.13.38 @ 4S.8, 44^m deflection on testing coil.
Should be 62.

$$\begin{array}{r} 62/44 \quad (7090) \\ 434 \end{array}$$

10.14.38 @ 4S.1, 37^m on test coil & check battery. Should
 be $47^m \times .92 = 43.2$. (8690)

10/16-17/38 - 7⁵ period. Gal. thermocouple, test coil in series
 $\Delta = 65^m m$ (64.8) Gal. + test coil, $\Delta = 159^m m$. (150^{2nd} mm)
 6 trials after above test gave 7.6 for period.

10/24/38 Resistance of gal. coils in series-parallel = 245 Ω

P.	Ends					
2.8	334	> 299	(.68)	385	(.62)	329
2.8	315			263		290
2.9				323	(.634)	311
3.05	328	> 302	(.674)	294	(.574)	301
2.9	314			309		306
2.9						
2.9	292		(.51)	324		
2.89	304				(.61)	

W & dip²

3.9	222	433	232	362	221	178
4.0						
3.6	273		254	274	254	289
4.0				261	256	246
3.7				259		263
3.8	1.38					
4.0	.668					
4.0	2.048					
4.0	1.024					
3.5	Nb.					
				.85	.29	.82
				.85	.441	.81
				.91		
						(.84)

Handwritten notes and calculations:

4.6
4.8
4.6
4.8
3.6
4.6
3.9
4.8
4.6
4.4
4.8
4.8
4.8
4.7
4.0

426
26
4
318
304
262
299
244
322
296
304

250
320
299
305
463
253
319
298
305

log w
1.03 321
1.94 30
1.16 4
1.04 49
1.09 4
1.00 441
0.99 40
1.96 4

w log w
64 .96
7 1.02

30 1.03 30.9
3 .94 2.8
5 1.04 5.2
44 1.00 44.0
4 .99 4.0

6	.96	5.8
1	1.02	1.0
93	1.01	93.7

6.0	356	108	357	132
6.0	305	302	314	350
5.8	316			301
6.4	78			313
6.0	360			
6.2	299			
6.0	314			
<u>6.06</u>				

$$\begin{array}{r}
 9.4 \\
 10.0 \\
 10.0 \\
 10.0 \\
 9.8 \\
 \hline
 9.84
 \end{array}
 \begin{array}{r}
 442 \\
 231 \\
 246 \\
 \hline
 462 \\
 227 \\
 244
 \end{array}
 \begin{array}{r}
 428 \\
 228 \\
 243 \\
 464 \\
 228 \\
 243
 \end{array}
 \begin{array}{r}
 226 \\
 244 \\
 \hline
 \begin{array}{r}
 4 \quad 2.30 \quad 9.20 \\
 6 \quad 2.28 \quad 13.68 \\
 4 \quad 2.25 \quad 9.00 \\
 6 \quad 2.39 \quad 14.34 \\
 \hline
 20 \quad \underline{\underline{2.31}} \quad \underline{\underline{46.22}}
 \end{array}
 \end{array}$$

7.2
 6.8
 6.8
 6.8
 6.8

 6.88

432
 264
 294
 288

409
 267
 294
 288

426
 262
 295
 288

442
 263
 297
 289

W	Agg	
3	1.50	4.50
2	1.39	4.17
2	1.44	2.88
3	1.44	4.32
11	<u>1.44</u>	15.87

T_d	$\log_{10} \gamma$	$T_d / \log_{10} \gamma$	
2.89	.62	4.66	+ .07
3.88	.84	4.62	+ .03
4.70	1.01	4.65	+ .06
6.06	1.32	4.59	.00
6.88	1.44	4.78	+ .19
9.84	2.31	4.25	- .34
		<u>4.59</u>	

$$\underline{T_c = 12^{\circ}.5}$$

$$f = 1.005 \quad \text{check.}$$

$$(\text{bold } f = 1.026)$$

$$f = \frac{\text{damping couple or unit } \times \text{ velocity } (L)}{\text{moment of inertia. } (I)}$$

is it unlikely that either L or I has changed.

Nov 11-12, 1938 RMS, RMS.

Recorded on #1 sheet after 10/11.

Test of gal. sensitivity

Period No. of cells in series.

$\frac{1}{2} \Delta$

2.0, 1.9, 2.0, 1.8, 1.9 = 1.92 + (0-1-0-2-0-3-0)

- (0-1-0-2-0-3-0)
+ (0-1-0-2-0-3-0)

NG - poor terminal

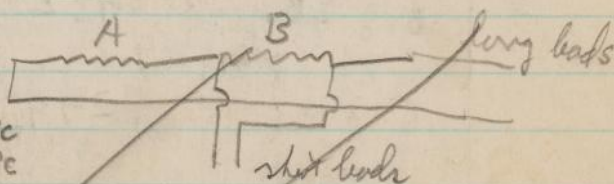
3.1, 3.0, 3.1, 3.0, 3.1 = 3.06 + (0-1-0-2-0-3-0)

No deflection noted - break in test coil?

Nov 12 New test coil.

A, non metallic, $1.064 \times 10^6 \Omega @ 17^{\circ}C$
1.051
1.008 $20^{\circ}C$
 $34^{\circ}C$

B, #24 wire 0.4550Ω



Temp dependence
too high.

Nov 14 New test coil

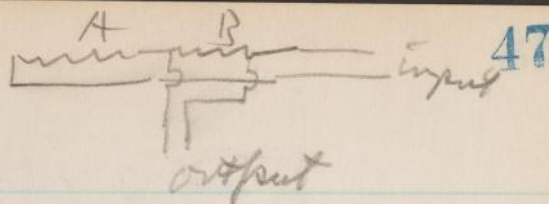
$$A = 100,607 \Omega @ 20^\circ C$$

corrected 1×10^{-5}

$$B = 0.050 \Omega \text{ of } \# 24 \text{ Cu wire } 583 \text{ mm long}$$

(Measured, .050②; computed $\frac{.0628 \times 583}{732} = .050$)

since 732 mm had res. of 0.0628② Ω .



$\therefore$ if E is input voltage, output is $\frac{E B}{A}$

$$= 5 \times 10^{-7} E.$$

One day all, 1.46 volts, 7.3×10^{-7} volts output.

11/16/38 Measured resist. B of new test coil

$$B = 0.0486 \pm 0.0003 \Omega \quad (\pm .61\%)$$

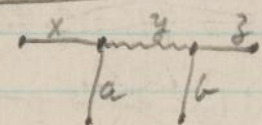
Factor is $\frac{B}{A} = 4.83 \times 10^{-7}$ (p.e.)

11/18/38 Measured B . $B = 0.04920 \pm .00034$ (m.p.) Ω T.E.S.

If .0003 is p.e., diff. of measures is $(60 \pm 56 \text{ m.e.}) \times 10^{-5}$, which is not significantly different from zero. For a final average, the mean of the determination is 0.04894 ± 0.0003 p.e. (Ω)

$\therefore$ Factor is $\frac{B}{A} = 4.86 \times 10^{-7}$

$\pm .03 \text{ p.e.}$

Details: 

$a+b+y =$	.12586, .12590*	.12586	residual $\times 10^5$
$a+x =$	.07912, .07905	.07908	0
$b+x+y =$	.12645, .12635	.12640	-20
$b+z =$	.04034, .04029	.04032	0
$a+y+z =$	.09105, .09095	.09100	-20
$x+y+z =$	.09235, .09229	.09232	+18

*.12583

by least squares,

a	.03907
b	.03739
x	.04001
y	.04920 $\pm .00034$ m.e.
z	.00293

Test of gal. for linearity

1) Period = ⁽¹⁾

$$V_A =$$

"0" at center

2) Period = ⁽²⁾

$$V_A =$$

"0" at center

3) Period = ⁽³⁾

$$V_A =$$

"0" at center

$$11/25/38 \quad 23^\circ F$$

Direct or left

4.9

5.1

5.6

6.0

5.5

5.6

0 center as schedule but
repeat reverse
B, B+A, B, B+A, B

Space

as schedule

5.0

4.6

5.0

5.2

0 at

~~0 A, 0 B, 3B+A, 3B, 2B+A, 2B, 3B, 3B+A, 3B, 4B, 4B+A, 4B, 5B, 5B+A, 5B~~

Space

0

0 left

~~0, A, 3B, 3B+A, 3B, 5B, 5B+A, 5B, 7B, 7B+A, 7B, 4B, 4B+A, 4B, 0, A, B~~

Space

Direct

5.0

5.0

7.0

6.8

6.5

6.6

6.6

6.6

0 center

~~0 A, 0 A, 0 A~~

Space

~~4~~ Ocenter

PAPAO direct

4.0

4.1

4.2

~~(4.5)~~

4.1

Space

up to 6B Present 1st then move on
in schedule

3.2

3.2

3.2

~~0, A, 0, B, B+A, B, 2B, 2B+A, 2B, 3B, 3B+A, 3B, 4B, 4B+A, 4B, 5B, 5B+A, 5B, 6B, 6B+A, 6B, 7B, 7B+A, 7B~~
 up to 7B
 reverse

0, A, 0 then to 7B, 7B+A, 7B
 space

2.12

1.9

Σ 1

Σ 2

2.05

2.10

1.2

1.2

1.26

1.20

OAO NO

space

OAOAO

$$V_A = 1.53$$

$$T = 19^\circ F$$

$$\times [1 - 0.00004 (T - 75^\circ F)]$$

Reductions

Spec chart beginning of A
 Dist from left to

paper width = 502.7 mm.

	mm	A
(1) 269	-78.23 ✓	
(2) 188	-86.3 ✓	
(3) 272	+72.1 ✓	
(4) 340	+74.4 ✓	
(5) 343	+74.2 ✓	

502.7

3⁵, 2 sec autostart Δ From left

	Δ	
234	-27.0 ✓	(207, +27.0)
207	-27.4 ✓	(180, +27.4)
180	-27.9 ✓	(152, +27.9)
152	-29.1 ✓	(123, +29.1)
123	-29.4 ✓	(94, +29.4)
93	-30.3 ✓	(63, +30.3)
233	+27.5 ✓	
258	+27.0 ✓	
282	+27.2 ✓	
305	+27.4 ✓	
328	+27.6 ✓	
350	+28.7 ✓	
373	+29.7 ✓	
398	30.1	

Scale distance
1 meter

T_d	Δ	T	Δ/T	$T = \frac{T_d}{\sqrt{1 + \frac{T_d^2}{12.5^2}}}$
✓ 15.22	4.4 ✓	1.21	3.02	
✓ 2.07	12.5 ✓	2.04	3.01	
✓ 3.20	27.0 ✓	3.09	2.83	
✓ 4.10	43.9 ✓	3.89	2.89	
✓ 5.45	72.1 ✓	5.00	2.88	
✓ 6.68	106.2 ✓	5.88	3.06	
			2.95	

Sensitivity:

$$\text{Voltage is } 1.53 \times 4.86 \times 10^{-7} = 7.44 \times 10^{-7}$$

$$\text{Current is } 2.98 \times 10^{-9}$$

$$\text{Series current for same } \Delta \text{ is } 1.49 \times 10^{-9}$$

$$\text{at } 10^5 = T, 1000 \Omega, \Delta \text{ for } 1 \mu\text{a is}$$

$$\frac{295000}{1.49}$$

$$\text{at } T = 10^5, 1 \Omega, \Delta \text{ for } 1 \mu\text{a is}$$

$$\frac{295000}{1.49 (1000)^{1/2}} = 12,500 = F.$$

See p6.

45.95 zero it.

mm from left to start of Δ

	Δ
467 ✓	-61.3 ✓
408 ✓	-62.1 ✓
346 ✓	-63.5 ✓
279 ✓	-63.1 ✓
204 ✓	-71.4 ✓
139 ✓	-81.7 ✓

hence $\Delta S = .999 - .001175 I + .003811 S^2 + .00004425^3 - .0000109 S^4$

I

S

etc.

-5	-5.4500				
-4	-4.3288				
-3	-3.2580				
-2	-2.2100				
-1	-1.1900				
0	-0.1833	10067	-75		
1	+1.8159	9992	104	+89	
2	1.8165	1.0006	90	76	-13
3	2.8261	1.0096	90	78	2
4	3.8525	1.0264	168	80	2
5	4.9037	1.0512	248	77	-3
6	5.9874	1.0837	325	77	0
7	7.1113	1.1239	402	74	-3
8	8.2828	1.1715	476	50	-24
9	9.5069	1.2241	526		

0	-1833	19998			
2	18165	20360	362	627	
4	38525	21349	989	616	-11
6	59874	22954	1605		
8	82828				

S	I
-1833	0
1.8165	2
3.8525	4
5.9874	6
8.2828	8

I S $\frac{dS}{dI}$

0	1.0006			
0	1.0006	-.003	.00324	
0	-0.1833	1.0013	-.0036	.00324
4	3.8525	1.0373	.0089	.00324
8	8.2828	1.1981	.0363	.00324

I	S
0	-1833
0	-1833
0	-1833
2	18165
4	38525
6	59874
8	82828

$$\frac{dS}{dI} = 1.0006 - .003S + .00324S^2$$

min at $0.47 = S$ (25.6)

$$\frac{dS}{dI} = .9999 + .00325S$$

5 mm from 25.6
or middle of page

Write left edge page by -1 , rt by $+1$ (x);
for small ΔS , $\Delta = \Delta_{\text{anti}} (1 + .277x^2)$

if all x's are equally likely,

$$\bar{E} = .0092$$

$$\sigma_E = .277\sqrt{\frac{4}{45}} = .0082$$

if x's between $-\frac{1}{2}$ and $+\frac{1}{2}$,

$$\bar{E} = .0023 \pm .0020$$

$S = .1662$, or 25.7 mm from left edge paper.

$$\frac{dS}{dI} = .9999 + .2774x^2$$

$$\overline{x^4} = \frac{1}{5}$$

$$\overline{x^2} = \frac{1}{9}$$

charge unit of I , & zero of x .

$$\frac{dx}{dI} = 1 + .2774x^2$$

$$\frac{dI}{dx} = 1 - .043x - .174x^2$$

$$\frac{I}{x} = K - .0215x^2 - .058x^2$$

If string is 1 mm ($x = .004$)

then scale error is (at center)

mag	Δm
∞	0
4	0
3	0.0005
1	0.005
0	0.018
-1	0.080

and at $x = 1/2$

mag	$\frac{dI}{dx}$	ΔI	Δm
∞	0	.935	0
3	.925	.932	0.003
1	.916	.916	.020
0	.882	.882	.057
-1	.768	.768	.180

Analysis of S.S. 4

S/100	S/10
102	1.04
151	3.65
272	7.40
340	11.56
343	11.76

from left edge, mm	ΔS	S from center	x	Δx
102	86.3	-149	-.594	.344
191	78.2	-60	-.239	.312
272	72.1	21	.084	.287
340	74.4	89	.355	.296
343	74.2	92	.367	.296

$$S = a + b\left(\frac{S}{100}\right) + c\left(\frac{S}{100}\right)^2$$

	$\frac{S}{100}$	$\frac{S}{100}^2$	S	$\frac{S}{100}$	$\frac{S}{100}^2$	S
1	1.04	1.08	102	1.04	1.08	102
1	3.65	13.32	151	3.65	13.32	151
1	7.40	54.76	272	7.40	54.76	272
1	11.56	133.43	340	11.56	133.43	340
1	11.76	138.29	343	11.76	138.29	343
5	0	0	205	0	0	205
			90.32			86.6
			2.05			66.8

$$\Delta = 77 + .04 = 19.7\left(\frac{S}{100} - 2.5\right) + 3.26\left(\frac{S}{100} - 7.08\right)^2 = 103.2 - .197S + .000326S^2$$

I + unit

S

-2
0
0
1
2
3
+

2500	75.8	-2.09	.58
250	74.3	-1.51	.58
324.3	73.6	-.35	.58
397.9	73.6	+1.40	.58
474.3	76.4	4	

$$S = 250. + 75.8I - 2.09I^2 + .58I^3$$

change unit I,

$$X = \textcircled{15} + .3032I - .00836I^2 + .00232I^3$$

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change unit I; $I = I'/.3032$

$$X = I - .09096I^2 + .0833I^3$$

$$\frac{dX}{dI} = 1 - .19192I + .25I^2$$

is close enough.

I x $\frac{dX}{dI}$

$$\text{Let } S = 250 + bI + cI^2 + dI^3 \quad \left(\begin{array}{l} I=0 \\ S=250 \end{array} \right)$$

assume $\frac{dS}{dI}$ is min at center, despite measures, which may be bad. Then $0 = 2c + 6dI$; $c=0$.

$$\text{ii } S = 250 + bI + dI^3$$

$$\Delta S = (b + 3dI^2) \Delta I + 3dI(\Delta I)^2 + d(\Delta I)^3$$

Let $\Delta I = 1$ for better "A"

$$\text{Better, let } I = aS + cS^3$$

(since $\frac{d^2I}{dS^2} = 0$ & $\frac{d^3I}{dS^3} = 0$)

where $S = 0$ at center of paper.

$$\Delta I = (a + 3cS^2) \Delta S + 3cS(aS)^2 + c(\Delta S)^3$$

$$\text{Let } \Delta I = 1$$

$$\frac{\Delta I}{\Delta S} = a + c(3S^2 + 3S(aS) + (aS)^2)$$

use x instead of S (replace S by x in formula, merely)

The a & c are changed, which does not matter.

a	c	$\frac{\Delta z}{\Delta S}$	c
1	.1564 ✓	2.91 ✓	3.27
1	.045 ✓	3.21 ✓	
1	.176 ✓	3.48 ✓	
1	.781 ✓	3.37 ✓	
1	.878 ✓	3.36 ✓	
	<u>-.4765</u>		
5	2.384	6.35	
	1.630182	7.75498	
	<u>.493498</u>		
		-1.0007	
		$c = -.00142$	
		$a = 3.2706$	

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Salvante, W. 2 Dec 7, 1938

Period	Δ	$k = \frac{V}{\Delta}$	$2.5 \log k$
0 unconnected	0		
0 connected 3356	0		
1 1.54 3471	114	135	.327
2 3.03 3578	220	138	.356
3 4.50 3684	325	138	.356
Center 0 3360	0		
4 5.98 3790	430	139	.362
5 7.43 3895	534	139	.362
6 8.91 4000	638	140	.365
0 — 3362	0		
2.5 0 — 1466	0		
1 1.54 1645	179	872	.351
$V=8.54$ 2 3.04 1816	349	871	.350
3 4.52 1983	545	878	.358
Left 0 — 1469	0		
4 6.00 2147	677	886	.367
5 7.48 2311	840	891	.374
6 8.97 2473	1001	895	.378
0 — 1473	0		
V 8.54 2427	954	895	.378
V 8.55 2466	993	861	.336
$V+1$ 10.12 2636	1162	872	.351
$V+2$ 11.61 2796	1322	878	.358
$V+3$ 13.09 2954	1479	885	.367
0 1475	0		
$V+4$ 14.58 3108	1632	893	.376
$V=8.60$ $V+5$ 16.07 3266	1789	898	.381
$V+6$ 17.56 3421	1944	904	.391
0 1478	0		
V 8.60 2454	978	879	.357
0 1475			

Dec 7

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Period 3.2

Zero at left Δ V/Δ

0	—	1516	0		
1	1.55	1787	271	572	.894
2	3.04	2043	527	577	.901
3	4.53	2290	771	589	.924
0	—	1519	0		
4	6.01	2531	1011	594	.934
5	7.48	2772	1250	598	.941
6	8.97	3007	1484	605	.955
0	—	1524	0		
V	8.61	2981	1455	592	.931
V+1	10.16	3243	1715	592	.931
V+2	11.64	3483	1953	595	.935
V+3	13.12	3711	2179	603	.953
0	—	1535	0		
V+4	14.59	3933	2397	608	.958
V+5	16.05	4166	2629	611	.965
V+6	17.52	4396	2858	614	.970
V	8.54	2982	1443	591	.929
0	—	1539	0		
6	8.97	3012	1472	609	.961
5	7.48	2783	1242	603	.952
4	6.01	2548	1006	597	.937

Dec 7

Period = 4^s.4Center $\sqrt{10}$

Center to Right	0	—	3349			
	1	1.55	3781	430	360	.391
	2	3.04	4190	835	364	.402
	3	4.53	4600	1241	365	.404
	0	—	3362			
	5	7.48	5403	2036	368	.414
	4	6.01	5012	1640	366	.407
	6	8.97	5819	2442	366	.407
	0	—	3383			
	0	—	3367			

Period ditto

Center to
Left

	0	—	3352			
	1	1.55	2916	434	357	.379
	2	3.03	2480	868	349	.356
	0	—	3345			
	3	4.53	2025	1316	345	.344
	4	6.01	1533	1804	333	.305
	5	7.48	—			
	0	—	3327			
	4	6.01	1530	1793	335	.314
	3	4.53	2004	1315	344	.342
	2	3.04	2462	853	356	.376

P=5.6

Center to
left

	0	—	3330			
	1	1.55	2584	734	211	.0811
	2	3.04	1773	1533	198	.745
	0	—	3295			
	3	4.53	—			
	0	—	3284			
	3	4.53	—			

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V/A

2	3.04	1725	1661	183	.659
1	1.55	2536	752	206	.782
0	—	3288	—		

Period ditto

0	—	3342			
1	1.55	4051	703	221	.861
2	3.03	4735	1381	219	.852
0	—	3361			
3	4.53	5404	2038	223	.865
2	3.04	4753	1382	220	.856
0	—	3376			
1	1.55	4069	697	222	.862
0	—	3368			
0		3361			

P=7.2

Center to

Right

0	—	3487			
1	1.56	4620	1123	139	.361
X	m.g	—			
2	3.01	5725	2196	137	.335
1	1.55	4692	1150	135	.327
0	—	3556			
2	3.03	5721	2163	140	.365
1	1.55	4691	1131	137	.335
0	—	3561			
2	3.03	5732	2169	140	.365
1	1.55	4698	1133	137	.335

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Dec 7

P ditto
Center to
left

0	—	3481			
1	1.55	2232	1233	126	.247
0	—	3450			
1	1.55	2228	1218	127	.250
0	—	3442			
0		3463			

#	V _{obs}	δ	α	V _{comp}	m Δ
Tuesday, Dec 20, 1938					
1	0	1818			
2	0.18	1841	22		0.20
3	0.39	1860	40		37
4	0.67	1894	73		67
5	1.00	1928	105		96
6	1.38	1971	148		1.36
7	0.00	1823			
8	1.80	2017	194		1.78
9	2.52	2095	271		2.49
10	0.00	1825			
11	3.69	2221	397		3.65
12	5.08	2368	545		5.01
13	6.48	2516	694		6.38
14	8.01	2677	856		7.87
15	0.00	1820			
16	10.00	2881	1064		9.78
17	9.50	1.97	$R = \begin{cases} 4.83 \\ 4.82 \\ 4.86 \end{cases}$	$\left. \begin{matrix} 4.83 \\ 4.82 \\ 4.86 \end{matrix} \right\} 4.84$	
18	8.50	1.75			
19					

Tues Dec 20

#	V _{obs}	Δ	Δ	V _{comp}	m Δ	V - m Δ	$\frac{V - m \Delta}{m}$
17	0.00	1813					
18	2.00 k	2894	1084	9.69	9.96		
19	2.50 k	3158	1351	12.11	12.42		
20	3.00 k	3405	1604	14.53	14.74		
21	0.00	1796					
22	3.49 k	3636	1843	16.90	16.94		
23	4.00 k	3929	2139	19.37	19.66		
24	4.50 k	4160	2373	21.79	21.81		
25	0.00	1785					
26	4.99 k	4385	2603	24.17	23.92		
27	5.46 k	4656	2877	26.44	26.44		
28	6.00 k	4953	3177	29.06	29.20		
29	6.50 k	5199	3426	31.48	31.48		
30	0.00	1770					
31	7.02 k	5475	3708	34.00	34.08		
32	7.50 k	—					
33	2.01 k	—					

Period

1.3

1	0.00	1337	
2	.22	1346	09
3	.41	1351	14
4	.78	1364	27
5	1.00	1337	
6	1.03	1375	38
7	1.44	1389	52
8	1.81	1401	64
9	2.52	1426	89
10	0.00	1337	
11	3.60	1475	138
12	5.02	1514	177

from #27
 $m = \frac{V}{\Delta} = \frac{26.44}{2877}$
 0.009190

$\frac{1}{m} = 108.8$

Dec 20, 1938

13	6.47	1562	225	
14	8.00	1616	280	
15	0.00	1336		
16	10.00	1682	348	
	R:	{ 10.00, 2.07	{ 4.83	} 4.85
		{ 1.90, 9.19	{ 4.84	
		{ 1.60, 7.80	{ 4.87	
17	0.00	1333		
18	2.00 R	1685	353	9.64
19	2.50 R	1766	435	12.11
20	3.00 R	1853	523	14.53
21	0.00	1328	114	
22	3.50 R	1942	614	16.95
23	4.00 R	2018	690	19.37
24	4.50 R	2100	772	21.79
25	5.00 R	2189	861	24.22
26	0.00	1328		
27	5.49 R	2260	932	26.59
28	6.00 R	2345	1018	29.06
29	6.50 R	2444	1118	31.48
30	0.00 R	1325		
31	7.00 R	2529	1200	33.90
32	7.59 R	2624	1291	36.76
33	0.00	1336		

Temp = 38 F Dec 20, 1938

 $P = 3.1^s$ one terminal grounded

1	0.00	1795	
2	.12	1819	23
3	.28	1845	47
4	.50	1890	90
5	0.00	1802	
6	.70	1922	118
7	.93	1966	160
8	1.22	2017	209
9	1.50	2067	257
10	0.00	1812	
11	1.99	2146	333
12	2.71	2270	456
13	3.08	2332	517
14	3.70	2433	617
15	0.00	1817	
16	4.18	2512	695
17	5.15	2670	852
18	6.08	2822	1004
19	7.09	2985	1166
20	0.00	1820	
21	8.11	3144	1325
22	9.99	3435	1617

$$R = \begin{Bmatrix} 9.99 & 2.08 \\ 8.71 & 1.80 \\ 7.99 & 1.64 \end{Bmatrix} \quad R = \begin{Bmatrix} 4.80 \\ 4.84 \\ 4.87 \end{Bmatrix} \quad 4.84$$

23 0.00 1816

24 2.00 R 3447 1629 9.69

25 3.00 R 3841 2021 12.15

25 2.50 4243 2421 14.53

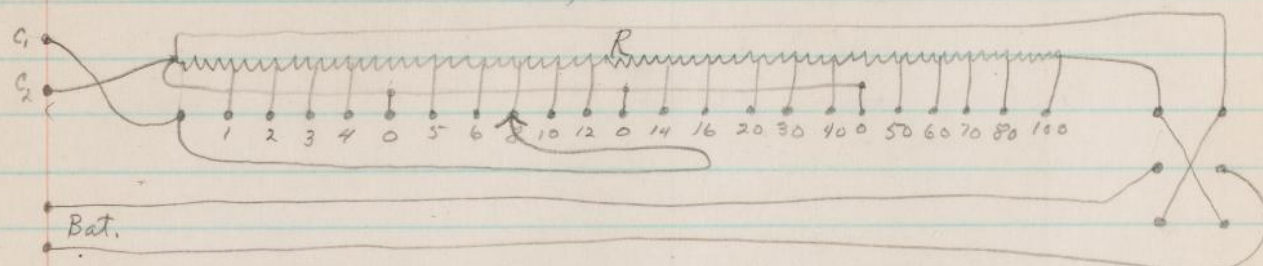
Dec 20, 1938

27	3.50	R 4623	2801	16.95
28	4.00	R 5007	3181	19.37
29	4.20	R 5172	3345	20.34
30	0.00	1829		
31	4.40	R 5305	3476	21.31
32	4.60	R 5471	3641	22.28
33	0.00	R 1831		

Edge of paper: 0561

1/11/39

Voltage divider - to be used with test coil p 47.
Do not use over 200 volts, i.e. 10 watts on divider



#	Resistance (C, C ₂)	Ratio $\left[\frac{C, C_2}{R} \right] \times 10^2$	$\left[\frac{V_t}{V} = \frac{C, C_2}{R} \frac{A}{A + R \left(\frac{C, C_2}{R} - \frac{C, C_2^2}{R^2} \right)} \right] \times 10^2$
1	48.332	0.978	0.978
2	98.72	1.999	1.997
3	148.36	3.004	2.999
4	198.45	4.018	4.010
5	247.55	5.012	5.000
6	297.15	6.016	5.999
8	400.27	8.104	8.075
10	500.75	10.139	10.094
12	598.95	12.127	12.064
14	699.92	14.171	14.088
16	800.14	16.200	16.094
20	1004.2	20.332	20.173
30	1502.2	30.415	30.104
40	1978.5	40.059	39.592
50	2473.0	50.071	49.464
60	2966.5	60.063	59.363
70	3422.0	69.285	68.577
80	3913.0	79.226	78.608
100	4939.0	100.000	100.000

$V =$ Bat. voltage. I.C.T. VI, 316. $\frac{dV}{dT} \doteq 0.01 \text{ volt}/10^\circ\text{F}$

$V_t =$ voltage across C, C₂, $A = 100,607 \Omega$ (see p. 47)

Constants for Reduction of Observations

At Oak Ridge, $(\sec z)^{-1} = 0.67563 \sin \delta + 0.73724 \cos \delta \cos HA$
 $= A + B \cos HA$

Star	α	$\sin \delta$	$\cos \delta$	A	B
Capella	5	.7181 ¹	.6959 ¹	.4852	.5130
γ Cas	0	.8695 ¹	.4939 ¹	.5875	.3641
α UMa	11	.8838 ¹	.4679 ¹	.5771	.3450
α Per	3	.7615 ¹	.6481 ¹	.5145	.4778
β UMa	10	.8358 ¹	.5490 ¹	.5647	.4047
z UMa	11	.8499	.5270	.5742	.3885
S UMa	12	.8780 ¹	.4787 ⁴²	.5932	~~4373~~ ³⁵²⁷
U U Mi	14	.9212	.3891	.6224	.2869
S U Mi	15	.9810	.1942	.6628	.1432
T Cep	21	.9285	.3714	.6273	.2738
S Cep	21	.9792	.2028	.6616	.1495
RV Cyg	21	.8090	.5878	.5466	.4333
δ Per	3	73 ⁸⁵ ~~44~~	67 ⁴³ ~~82~~	49 ⁹⁰ ~~65~~	50 ⁴⁹ ~~00~~ ⁷¹
ϵ Aur	4	.6909	.7230	.4668	.5330
β Cas	0	.8554	~~8554~~ ⁵¹⁸⁰	.5779	.3819
i UMa	8	.7466	.6652	.5044	.4904
κ UMa	8	.7361	.6769	.4973	.4990
ψ UMa	11	.7046	.7096	.4760	.5231
γ UMa	11	.8090	.5878	.5466	.4333
ϵ UMa	12	.8320	.5548	.5621	.4090
η UMa	13	.7615	.6481	.5145	.4778
γ U Mi	15	.9511	.3090	.6426	.2278
η Dra	16	.8796	.4756	.5943	.3506
β Dra	17	.7912	.6115	.5346	.4508
γ Dra	17	.7826	.6225	.5287	.4589
θ UMa	9	.7869	.6170	.5316	.4548

1938phae.proj..806E