Robert Millikan (top center) on the steps of Ryerson Laboratory, U. of Chicago, 1908. Other colleagues (L-R): A. A. Michelson, Carl Kinsey, Henry G. Gale

ROBERT A. MILLIKAN
Oil Drop Experiment Notebooks

NOTEBOOK TWO:
March-April 1912

PART 2 OF 3
From page 30 to page 59

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Abstract

Robert A. Millikan (1868-1953) began his experiments to measure the charge on the electron, e, in 1907. The experiments were performed in Ryerson Laboratory at the University of Chicago, where Millikan was professor of physics. For this work, and for work on the photoelectric effect, Millikan was awarded the Nobel Prize in physics in 1923.

Millikan gives his own account of the electron charge determination in his published autobiography in the chapter titled "My Oil-Drop Venture (e)" (Robert A. Millikan, *The Autobiography of Robert A. Millikan*, New York, 1950). With the aid of graduate students Louis Begeman, Harvey Fletcher, and J. Y. Lee, Millikan devised the method of measuring the rate of fall of a single electrically charged oil drop under the forces of gravity and electricity. From 1909 until the spring of 1912, Millikan reports, he spent every available moment in the laboratory on his oil-drop experiment. His first comprehensive, though to some extent preliminary, results were published in September 1910 in the journal *Science* as "The Isolation of an Ion, a Precision Measurement of Its Charge, and the Correction of Stokes' Law," *Science* 32: 436-448. He soon became embroiled in a controversy with the Viennese physicist Felix Ehrenhaft, who claimed to have found much smaller electric charges. Millikan went back to work on a new

set of experiments. By the spring of 1912 he had collected the data for what he termed "the final, absolute determination of the numerical value of the electron" (*Autobiography*, p. 84). Results were published in August 1913 in "On the Elementary Electrical Charge and the Avogadro Constant," *Physical Review* 2: 109-43. This last, definitive set of experiments were recorded in the only two lab notebooks which Millikan preserved among his papers. These two notebooks are presented here in facsimile. They cover the period from October 1911 through April 1912 and contain what Millikan himself considered his conclusive, historic work on this problem.

For an analysis of Millikan's notebooks and a defense of his experimental method, see the article by David Goodstein, "In Defense of Robert Andrews Millikan," published in *American Scientist* 89/1 (Jan-Feb. 2001): 54. http://www.americanscientist.org/issues/num2/2001/1/in-defense-of-robert-andrews-millikan/1

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http://resolver.caltech.edu/CaltechLN:LN_Millikan_R_2

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29 Thursday Mar. 28th 1912 $\theta = 22.83$ / 22.13

$p = \frac{6409}{5527}$ 882 $\frac{6407}{5525}$ 882

Second Obs. at 4:30 PM. Volts at 4:05 PM.

840.0 + 12.7
840.5 + 12.7
1680.5 + 25.4
= 1705.9

Last Obs → Add for this obs → 838.0 / 12.9

2556.8

[826.0 / 14.5] may not use –

G		F	
31.848	(54.4 / 108.8)	108.606	$\frac{1}{108.0}$ .009259 } .008116
32.076	54.4	108.0 —	
31.990	(28.7 / 57.4)	57.436	$\frac{1}{57.55}$ = .017375
31.882	28.5	57.6 —	57.763 = .01731
31.856	(28.7 / 58.1)	57.894	$\frac{1}{58.01}$ = .01724 } .008250
32.124		39.180	$\frac{1}{39.24}$ = .02548 omit because …
31.866	(39.4)	39.466	39.443 .02536
32.000		39.444	$\frac{1}{39.50}$ = .02532 } .024345 / 3 = .008115
31.904		129.0 — 1st div.	$\frac{1}{102.4}$ = .000975
		130.0 — 2nd div.	
		129.0 — 3rd div.	
		128.0 — 4th div.	} .008034
	56.0	111.0 —	$\frac{1}{111}$ = .009009
32.078	56.6	111.8 —	$\frac{1}{111.4}$ = .008977
31.794			

4 | 265
.008067

.5%

11 | 351.418
31.947
.32
31.98 = .03127 × 1021
= .031427
log = −2.5042
½ l = −1.2521

5:07 PM.

$v_1 + v_2$ = .00828 × 1021
= .008250
log = −3.9165
−1.2521
−3.19776
−6.36636 V = 2556
3.40756
−10.95880

.03127
.008977
5 | .040247
.008049

.03127
975
4 | .032245
.008061

3127
2536
7 | .5663
.008090

3127
973?
6 | .4858
.008097

3127
9259
5 | .40529
.008105

8049
8061
8090
8097
8105
5 | .402
.008080

9095
11
q = 9084

$e^{2/3}$
−10.9583
2
3 | −19.9166
−7.9722
93.80 = $e^{2/3}$

ak
−10.46136
3.40756
−7.86692
−3.9165
−5.95242
−5.9526 = log ak
−4.1387
−1.8149 = log k
1.851 = log $\frac{1}{k}$
1.5313 = $\frac{1}{k}$ … 99
log 5313 = −1.7252
2.9155
−4.6098

−1.7253
−1.7702
−1.9551

A = .9018
b = .0006453

a
−16.4209
3.40756
−2.5042
−14.33266
−3.9165
3 | −12.41616
−4.13872 .0001376 = a
0.94575
−3.08497
2.91553

l
−4.8547
.9458
−5.9089
−4.1387
−1.7702
.5892 = $\frac{l}{a}$

823.2 = $\frac{1}{pa}$

No 60

Beauty. … of May 22

Thursday Mar. 28, 1912

31 Obs at 5:28 P.M. Volts at. 5:07 P.M.

θ = 22.53

P = 6448 / 5478 / 9.70 ... 5448 / 5478 / 9.70

839.0+12.8
839.5+12.6
838.5+12.8
2517.0+38.4

preceding Obs → 2555.9 ← also this Obs

Best yet

Recently ...

G		F
12.836		11.960
12.994		11.938
12.892		10.704
12.914		29.350
12.930		29.280
12.902		29.108
12.838	(32.0)	32.866
12.808	(32.6)	33.068
12.920	(33.0)	32.894
12.886	(33.0)	32.892
12.908		29.704
12.902		32.950
12.916	45.2	90.2 —
12.850	(90.4)	90.260
12.854	(39.0 / 67.0)	66.762
12.912	(38.6 / 66.8)	66.650
12.908	70.6	139.8 —
12.870	71.2	139.4 —
12.882	(67.0)	66.942

$\frac{1}{11.949}$ = .08367

$\frac{.04956}{13}$ Volt at 6:08 = .003812

$\frac{1}{29.279}$ = .03415

.00378

$\frac{1}{32.930}$ = .03034

$\frac{.01929}{5}$ = .003858

$\frac{1}{90.230}$ = .01108 ; $\frac{.003860}{1}$ = .003860

$\frac{1}{66.706}$ = .01498 ; $\frac{.007797}{2}$ = .003898

$\frac{1}{139.6}$ = .007163 ; $\frac{.007757}{2}$ = .003878

$\frac{1}{66.94}$ = .01495

4 | 1169.22 → 12.891

$\frac{1}{12.89}$ = .07758 × 1.021 = .07921 = v_1

6:08 P.M.

Log = −2.8988

Log = −1.4494

836.0+12.8
836.5+13.8
833.0+13.9
2505.5+40.1
2545.6

differences: 3812, 3858, 3860, 3898, 3878 ; 5 | 19306 → 3861

Differences

7758 / 1496 / 4 | 9254 / 3854 ; 7758 / 7163 / 4 | 14743 (?) / 3852

7758 / 1499 / 4 | 9257 / 3857 ; 7758 / 1108 / 2 | 8866 / 3855

7758 / 3034 / 4 | 10792 / 3854 ; 7758 / 3415 / 3 | 11173 / 3858

7758 / 8367 / 42 | 16125 / 3839

3854, 3852, 3855, 3855, 3852, 3859

mean = .003854 × 1.021

= $v_1 + v_2$ = .003935

Log = −3.5949
−1.4494
3.1983
6.2426
3.4062
10.8361
.6557
e = 4.53

a: −16.4209, 3.4065, −2.3988, −14.7323, −5.5454, 3 | −11.1389, −4.3781, 0.9868, −3.36886, 2.63684, .0602, 2.6362

b: −4.5547, 0.9868, −5.5679, −4.39497(?), −1.4982 ; .3082 = b/a ; 3089

.0002392 = a ; 3388

430.1 = $\frac{1}{p\alpha}$; 4338

$e^{2/3}$: −.18352, 3 | 1.46788, 7.8906

$e^{2/3}$ 77.98 (3) 77.48(?)

6848

79-21

Thursday Mar. 28, 1912 θ = 22.90 $\theta = \frac{54.54}{64.65}$ 10.11

4th Obs at 6:23 P.M.

Volts at 6:08 P.M.

836.0 + 13.6
836.5 + 13.6
833.0 + 13.9
2505.5 + 40.1 = 2545.6

G		F
24.302		8.564
24.286		8.550
24.260		16.818
24.316		15.388
24.202	(21.7 / 42.0)	41.832
24.186	(21.0 / 42.0)	41.796
24.376	(55.6)	55.6
24.304	(28.0 / 55.4)	55.354
24.378		82.6
24.210	(41.2 / 82.6)	82.520
24.142	(41.6 / 82.8)	83.772
24.176		41.898
24.162	(41.6)	41.420

13) 330.6
24.254
12
24.27

6.48 P.M.

$\frac{1}{24.27}$ = .04120 × 1.021

= v_1 = .042065

Log = −2.6239

$\frac{1}{v_1}$ = −1.31195

$\frac{1}{16.82}$ = .05945

$\frac{1}{15.39}$ = .06498 } .0553 .05922 / .0412 .05866

41.814

.0239

} .0591

$\frac{1}{55.53}$ = .01802

} .0593

$\frac{1}{82.6}$ = .01208

} .1158 .05905

$\frac{1}{41.72}$ = .02397

Volts at 6:49 P.M.

835.0 + 13.6
830.5 + 14.1
830.0 + 14.2
2495.5 + 41.9 = 2537.4

5922
5866
591
593
5945
5)2957(3
.005915 = dif

$v_1 + v_2$ = .005917 × 1.021
= .006041

Log = −3.7811
−1.31195
−3.19776
−6.29081
3.40575
−10.88566
10
−10.8849

e_1 = .7672

$e^{2/3}$
.8849
2.47698
−1.9233
$e^{2/3}$ = .8382

.05917

a
−16.42043
3.40575
−2.6239
−14.45057
−3.7811
3)−12.66947
−4.22316
1.0−488
−3.22804
2.77196

b
−4.6547
1.0043
−5.6488
−4.2233
−1.6266

4.333 = $\frac{b}{a}$

.0006272 = a

5915 = $\frac{1}{pa}$

ak
−10.46136
3.4065
−7.86786
−3.5944
−4.27296
−4.3767
−1.89626
13
−1.89634 = log k
.10261 = $\frac{1}{k}$
.62694 = $\frac{1}{k}$

Log .2644 = −1.4305
2.6362
−4.7943

b = .0006227

−1.4305
−1.4410
−1.9395

A = .8700

ak
−10.46136
3.40575
−7.86711
−3.7811
−4.08601
−4.22376
−1.86285
10
−1.86295 = log k
.13705 = $\frac{1}{k}$
1.37095 = $\frac{1}{k}$

Log .77180 =
−1.56980
2.77196
−4.79785

−1.56940
−1.8266
−1.9428

A = .8766 b = .0006271

Publish
Beautiful

must compare with
Sheldon's figures

Worked out May 23.

No 55

Friday Mar. 29th 1912

First obs. at 10:40 A.M.

$\theta = 23.16$ $p = \frac{65.81}{53.30}{12.61}$

12.603 at 23

Volt at 10:23 A.M. 824.5 + 14.7
804.0 + 15.9
798.0 + 16.2
811.5 + 16.0
5 = 3990.8
2426.5 + 46.8 = 2473.3

	G		F		
(17.0) 33.6	33.432	(58.6)	28.494	1/38.559 = .03449	
(16.6) 33.4	33.346	(44.4) 68.8	28.624		
16.4 33.0	33.172		20.806	.01302/2 = .006501	
			20.819 / 2083 = .04601		
(16.6) 33.2	33.310		20.832	.01951/3 = .006503	
(16.6) 33.6	33.380		35.032 / 35.058 = .02850		.006490
(16.6) 33.3	33.306	(14.2) (28.3)	28.548	1/28.57 = .03499	.026019, .006505
33.4	33.346				
(16.5) 33.4	33.328	(56.3) 111.9	111.244	1/111.47 = .008971	.006471
17.0 33.4	33.684	200.0	For four divisions only	1/400 = .002500	.006436
	33.484	(56.6) 112.0	111.706	1/111.93 = .008936	6)2406
10	13788				.006485 mean dp
	33.3788				
	40				
	33.42				

$v_1 v_2 = .006467 \times 1021 = .006623^2$

1/33.42 = .029922 × 1021 / 1:18 A.M.
= V_1 = .03055

$\log = -2.48501$
$\frac{1}{n} = -1.24255$
3

a			
			$\log = -3.82107$
-16.42092			-1.24255
3.38946			-3.10776
-3.48501			-6.26133
-14.29539			3.38946 $V = 2452$
-3.82107			-10.87187
-12.47432			00030 Term
-4.15810	.3945 = $\frac{\beta}{a}$	$e_1 = 7.4502$	-10.87217
1.10098	.001439 = a		$e^2/3$
-3.25858			3)19.74434
2.79142	651.35 = $\frac{1}{\beta a}$		-291478
			$e^2/3 = 82.89$

ak		
-10.46126		
3.38946		
-7.85082		
-3.82107		
-4.02975		
00030 Term		
-4.02957		
-4.15810		
-1.87147	$= \log A$	
.12853	$= n\frac{1}{k}$	
1.3443	$= (1 - \frac{1}{k})$	
log 1.3443 = -1.52870	-1.6370	
-2.74149	-1.5961	
-4.7956	-1.9409	
$b = .006246$	$A = .8728$	

Beauty finished
Thomas after 23

no 53

38) Friday Mar 29, 1912

$t = \frac{23.18}{23.19}$ $p = \frac{6627 \\ 5272}{13.55}$

Second Obs. at 11:37 A.M. Voltat. 11:20 am

One of the best

cont. bright

G		F
13.838		10.698
13.906		17.168
13.868		17.242
13.872	(14.4 / 28.8)	28.924
14.012	(14.6 / 29.0)	28.968
13.870	(14.2 / 28.2)	28.900
13.900	(24.6 / 48.2)	48.392
13.932	(25.0 / 49.2)	48.660
13.888	(24.0–46.4)	48.272
13.930	(25.0–48.6)	48.470
13.842	(62.8)	62.480
14.068	(31.4–62.4)	(?) 62.042
13.914	(31.4–62.6)	62.560
13.870		150.4
13.934	63.0 1st div. / 64.0 2nd div.	
15) 58644	127.0 × 4 =	508.0
13909		

$\frac{1}{1391}$ .07169 × 1021 = .7334 12:00 M.

Log = −2.8657

$\frac{1}{2.1}$ = −1.4329

$\frac{1}{17.205}$ = .05812

}.02356 / 5

$\frac{1}{28.931}$ = .03433

}.01393 / 3

$\frac{1}{48.4485}$ = .02060

}.00459 / 1 = .459

$\frac{1}{62.360}$ = .01604

}.00935 / 2 = .004680

$\frac{1}{150.4}$ = .006649

}.4680 / 1

$\frac{1}{508}$ = .001969

.004712

= .004643

.4680 / 4) 2630

mean of best 4 det's = .004648

$v_1 + v_2$ = .004635 × 1021

= .004729

Log 3.6748

−1.4329

3.1963

−6.3060

3.5125

0.7935

6.286 / 5

e_1 = 6.286

e_1 = 6.214

$e^{2/3}$

Voltat 12:00 M.

823.5 + 14.6

799.5 + 16.2

769.0 + 17.4

810.0 + 15.5

3201.0 + 63.8 = 3264.8

822.0 + 14.8

792.5 + 16.5

762.5 + 17.6

809.5 + 15.6

3186.5 + 64.5

64.5

3251.0

V = 3254

23920 / 482 / 24402

7169 / 197 / 16) 7386 / .004616

4643 / 4540 / 145 / 464 / 3891 / 4648

7169 / 665 / 17) 7834 / .004620

7169 / 1599 / 19) 8768 / .004625

7169 / 2084 / 20) 9253 / .004627

7169 / 3456 / 23) 10645 / .004628

7169 / 5812 / 25) 13001 / 4657

4657 / 4616 / 4620 / 4625 / 4627 / 4628 / 5) 173 / .004633

a: −16.4240 / 3.5125 / −2.8657 / 4)−14.8052 / −3.6738 / 3)11.1314 / −4.3771 / 1.1319 / −3.5090 / 2.4410

l: −4.8547 / 1.1314 / −5.7233 / −4.3771 / −1.3457 / .2165 = b/a

.002383 = a / 2370 / 309.7 = $\frac{1}{pa}$ / 310.6 = $\frac{1}{pa}$ / 311.6

$e^{2/3}$ 10.7930 / 2 / 3)−1.4556 / −7.8620 / $e^{2/3}$ = 72.80 / $e^{2/3}$ = 72.88

7434 / 3)5868 / −7.8623 / $e^{2/3}$ = 72.83

1243 / 3748 / 1346 / 20 / 5084 / 4935

31) Saturday Mar 30th 1912 θ = 22.81 p = 5210 / 6678 / 14.68 — 5212 / 6679 / 14.66

Volts at 4:45 PM:
840.0 + 12.7
846.5 + 12.2
846.5 + 12.2
825.0 + 14.5
3358.0 + 51.6
51.6
3409.6

First Observation at 5:03 P.M.

(50)

G		F
25.856	(25.8)	
25.946		10.884
25.890		10.342
25.816		38.604
25.876		53.450
25.818		24.906
25.934		30.248
25.956		30.016
25.876		18.282
26.064		16.216
26.018		24.860
25.907		21.062
25.860		30.126
25.930		20.884
25.994	(21.2)	21.130
		21.174
25.814	(86.4)	85.922
26.012		84.780 for 3 div
		(85.4)
	114.3	257.0
25.904	(86.6)	86.368
25.802	(86.8)	86.406
25.918		

5:45 PM.

11/ 284.88
25.9093
26
25.935

$\frac{1}{25.935} = .03856$
$v_1 = .03999$ 3997
$l_{v_1} = -2.5925$
$l_{v_1} = -1.2976$

$\frac{1}{10.884} = .09673$
$\frac{1}{38.66} = .02587$
$\frac{1}{53.55} = .01867$
$\frac{1}{24.92} = .04013$
$\frac{1}{30.16} = .03315$
$\frac{1}{18.28} = .05470$
$\frac{1}{16.216} = .06167$
$\frac{1}{24.87} = .04021$
$\frac{1}{21.9} = .04746$
$\frac{1}{30.16} = .03315$
$\frac{1}{21.07} = .04746$
$\frac{1}{86.14} = .01161$
$\frac{1}{226.6} = .004412$
$\frac{1}{86.55} = .01156$

$\frac{.07086}{10} = .007086$
$\frac{.007145}{1} = .007145$
$\frac{.01455}{2} = .007152$
$\frac{.02155}{3} = .007163$
$\frac{.01431}{2} = .007155$
$\frac{.01431}{2} = .007155$
$\frac{.03585}{5} = .007170$
.007148
= .007148
4/ 1442
007160 = v_1

71.0621, 7161.59, 7157.54, 7156.12, 7174.72, 7176.74, 7161.59, 7163.61, 7173.68, 7179.71, 7170.88, 7170.67, 7165.59, 7179.71
14/ 1001
.007161

.03856 / .01156 / 3/.05012 / .07174
.03856 / 4413 / 6).04252 / .007159
3856 / 1161 / 7/.5017 / .007167
3856 / 4746 / 12/.8602 / .007168
3856 / 3315 / 10/.7171 / .007171
3856 / 4021 / 11/.7879 / .007161

3856 / 9673 / 19/.13529 / .007121
3856 / 4413 / .007159
3856 / 3875 / .007154
3856 / 4013 / 11/.78869 / .007152
.007172
3856 / 0470 / 9/.6326 / .007174
3856 / 6107 / 14/.10027 / .007169

$v_1 + v_2 = .007164 \times 1021$
$v_1 + v_2 = .007314$ 7311
$l_{v_2} = -3.86480$
-1.29760
3.39776
-6.35933
3.53160
-10.82773
00039
-10.82734

$e_1 = 6.719$
3/ 14.65468
4.8849
$e_1^{2/3} = 76.71$

a
-16.47097
3.53154
-2.59539
-14.54785
-3.86418
3/ -18.68367
-4.22789
1.1665
-3.39439
2.60561

l
-4.8599
1.1665
-5.6862
-4.3339
-1.4609

2.886 = $\frac{l}{a}$
.00016402a
4033 = $\frac{1}{pa}$

Brady publish. Worked up Aug 23

Saturday Mar. 30, 1912
Second Observation at 6:11 PM

θ = 22.81

p = 67.04 − 51.69 = 15.35

Volts at 5:47 PM.

837.5 + 13.0
842.5 + 13.5
842.0 + 13.5

2522.0 + 39.7 = 2561.7

821.0 + 14.8 ← not used
3343.0 + 52.8
57.8
3395.8

G		F	
32.366	(32.4) (32.1)	20.330	
32.398	(32.4)		
32.217	(32.2)	23.140	
32.342	(32.4)	23.230	(23.2)
32.358	(32.4)	80.786	(81.0)
32.438	40.6	81.416	
		18.113	
32.412	(16.2) (32.2)	18.144	
32.236		54.490	(54.6)
32.424		81.486	

9) 3191
32.356
42 chronometer

$\frac{1}{20.33}$ = .04914

$\frac{1}{23.185}$ = .04313

.03082 / 5 = .006164

$\frac{1}{81.260}$ = .01231

.04286 / 7 = .006123

$\frac{1}{18.1285}$ = .05517

.03685 / 6 = .006142

$\frac{1}{54.60}$ = .01832

.00608 / 1 = .006080

$\frac{1}{81.66}$ = .01224

mean .006134

Volts at 6:37 PM

836.5 + 13.6
841.0 + 13.2
839.5 + 13.3
2517.0 + 40.1
40.1
2557.1

.030857
.01224
7) .043094
.006156

30857
1832
6) 49274
.006159

$\frac{1}{32.406}$ = .030864 × 1.021 = v_1 = .031506

Log = −2.49833
$\frac{1}{2}$ = −1.24915
24915

6:35 PM

.6159
.6150
.6144
.6169
.6165
5) 287
.006157 × 1.021 = $v_1 + v_2$ = .006286

30854
4313
12) 73984
6165

30864
1231
7) 43164
6166

30850
55170
14) 86024
6143

Log = −3.79840
−1.24915
3.19776 V = 2559
−6.24523
3.4080
10.8378
.1864
10.6514

q
−4.8547
1.1864
−5.6683
−4.1763
−1.4920

a
.164209
3.4080
−3.4183
−14.32772
−3.7954
3) 12.5286
−4.1769
1.1864
−3.3127
2.6373

.3087 = $\frac{l}{a}$
.3104

.0001504 = a
1504

431.4 = $\frac{l}{pa}$
4335

e_1 = 6888

e_1 = 6888

$e^{2/3}$ = 77.86

found sig 3

$e^{2/3}$

−10.83364 6369
3.19674 6383 6739
−7.63723 7.8915
77.86
78.04 = $e^{2/3}$
77.86

Fine illustration of case in which v. o. from diff. is the mean by 2%

Publish

Result would be 3% low … mean of …

would be 2% lower if … mean … but

19

Monday Apr. 1st 1912

First Observation at 5.07 P.M.

θ = 22.98

Volts at 4:50 P.M.

$p = \frac{6782}{5086}$ 1296 6781 5086 1695

831.0 + 14.0
832.0 + 15.8
830.5 + 14.0
821.0 + 14.7
3314.5 + 58.5 = 3370.5

G		F
50.6		
50.364	(22.3) (44.2)	43.998
50.442	(44.8)	44.446
50.416	(30.4)	30.254
50.770	(30.3)	30.326
50.178		22.904
50.456	(30.2)	30.396
50.460	(84.3)	83.716
50.118	102.6 – 1st keep division	
4) 3204	106.8 – 2nd "	
50.40	97.2 – 3rd "	
18	89.8 – 4th "	
5058	101.0 – 5th "	
	497.4	
	99.5	
	7960	

$\frac{1}{44.510}$ = .02245 }.010515

$\frac{1}{30.290}$ = .03298 }.01067

$\frac{1}{22.91}$ = .04365 }.01079

$\frac{1}{30.43}$ = .03288 }.01047

$\frac{1}{83.88}$ = .01192 } 0

$\frac{1}{496}$ = .001256

$\frac{1}{50.58}$ = .01980

5.49 P.M.

.01980 .01252 3).03150 .01053

1960 1192 3)3172 .01057

1960 3286 5)5260 .01053

1960 4365 6)6345 .01058

1960 3294 5)5278 .01055

1960 2245 4)4228 .01056

1053
1057
1053
1058
1055
1057
6)6333
.010555

.010664
3)1649
.01055

$v_1 + v_2$ = .010555 × 1.021

$v_1 + v_2$ = .010775

Log = –2.03242
–1.15285
–3.18776
–6.38303
3.5251
–10.85873 V = 3351

e_1 = 7210

3)4.7163
–.90529

$e_1^{2/3}$ = 8040

V_1 = .01980 × 1.021

V_1 = .020216

Log = –2.30570

$\frac{1}{2}$ " = –1.15285

a
–16.42092
3.5251
–2.3057
–14.2517
–2.03242
3)–12.21930
–4.07310
1.2242
–3.30290
2.69760

l
–4.4547
1.2242
–5.6255
–4.0731
–1.5524

.3566 = $\frac{l}{a}$

.0001188 = a

498.5 = $\frac{1}{pa}$

ab
–10.46136
3.5251
–7.98646
–2.03242
–5.95404 = log a^2
–4.07310
–1.88094 = log k
.11906 = $\frac{a}{k}$
1.3155 = $\frac{1}{k}$

log .3155 = –1.4440 –1.4440
–2.6080 –1.5524
–4.8030 –1.9466

e_1 6353, A = .8842

2054

Good one. probably better than any yet. twice as big 2.3.

ab
–10.46136
3.5257
–7.98206
–3.4722
–4.18986 = log ab
4.3015
–1.88836 = log k
.09164 = $\frac{a}{k}$
12.350 = $\frac{1}{k}$
log 1.2350
–1.2788
2.5613
–4.8898

–1.3133

log .006451

Correction

4/ Monday Apr. 1st 1912 A=

p = 6796 − 5069 = 1727; 6798 − 5069 = 1729

Second Observation at PM.

Volts at 5:50 P.M.

828.0 + 14.3
821.0 + 14.7
812.0 + 15.6
820.0 + 14.8
3281.0 + 59.4 = 3340.4

Good one

(29.6)	29.666	(41.8)	41.630
(29.8)	29.664		

} about 10 min. wasted, because switch sparked.

Volts 6.50 P.M.

826.0 + 14.5
808.0 + 16.1
790.0 + 18.0
816.0 + 15.1
3240.0 + 63.7 = 3303.7

			9.896	
	29.794		18.452	1/18.45 = .05420
(29.8)	29.790	(58.6) (56.7)	57.152	} .03658/5 = .07316
(29.8)	29.886	(57.0)	56.314	
(30.0)	29.864	(58.6) (57.0)	56.658	
(29.7)	29.768	(56.8)	56.776	1/56.74 = .01763 } .01430/2 = .00715
(29.9)	29.738	(57.2)	56.794	
	29.686		31.316	1/31.32 = .03193 } .02168/3 = .007227
		(49.2) (97.9)	97.592	1/97.59 = .01025 } mean = .01021
(30.0)	29.806	(50.2) (98.6)	98.322	1/98.32 = .01017 } .07360
			89.0 — 1+2 Div.	1/357 = .002810
			89.2 — 3+4 div.	

10) 7.862
29.776
131

.03356

6.49

.03354

29.791

1/29.81 = .03355 × 1021 = .03426

log = −2.53492
1/2 = −1.26756

Div.
7316
7150
7227
7360
4)11053
7263

.03350
.00281
5).03366
.00727

33580
1021
6)43780
7293

33580
1763
7)51780
.07312

7278
7293
7312
3)1883
7292 × 1021

mean of 7292 and 7263 = 7277
×1021 = 7,432 = .07430

33580
54,20
13)8775
7313

V = 3317

a
−16.4296
3.5207
−2.5350
−14.4766
−3.8722
3)−13.6444
−4.2065
1.2372
−3.4337
2.5613

l
−4.8547
1.2372
−5.6175
−2.3235
−1.4180

.2096 = l/a
26086
1548 = a
1590

3704 = 1/pa
394.2
372.0 obtained
394 corrected

log = −3.87400
−1.26736
−3.14776
−6.33612
3.5207
−10.8154

e_1 = 6.566

reduces to 6.566 on acct of Thermometer corr.

$e^{2/3}$
−10.8166
2
3)19.6332
−7.8777

$e^{2/3}$ = 75.45
= 75.37

16

18 4.6304
7.8768

e_1 = 6.574
$e^{2/3}$ = 7530

(31)

Saturday Apr. 6, 1912
First Observation
at 4:35 PM

θ = 22.47

p = 9307 − 2070 = 7237; 12.09 − 2.08 = 10.01

Volts at 4:20 PM.

839.5 + 13.3
841.0 + 13.2
842.0 + 13.1
825.0 + 14.6
843.0 + 13.1
842.0 + 13.1
5032.5 + 80.4 = 5112.9

G		F
10.346		~~37.108~~
10.126		54.206 →
10.410		60.274 } ½ distance
		120.6 } whole " →
		26.006
10.504		26.364
10.398		26.162
10.384	13.2	26.072 →
10.390	(37.6) (75.8)	75.808 →
10.400	(62.0)	62.620 } ½ dis
10.414		123.0 } →
	(43.4)	43.462
10.460	(43.6)	43.444
10.390	(33.3) (43.4)	43.540
10.366	31.6	43.628 →
10.408	(66.0) (128.8)	128.606 →
10.334	(36.4)	36.266 →
10.434	(22.6) (44.2)	44.248
10.450	(44.1)	43.888 →
10.432	(40.0) (78.6)	78.258
10.432	(78.8)	78.672 →

5:15 PM

Temp. had been changing. Probably an error of 1% in temp. connection. Doubt working nothing else

Took apparatus apart + changed atomizer inserting new oil density of which was diff. as shown in last pages

Saturday Apr. 6, 1912

Second Observation.

at

θ=

p=

Volts at 5:17 PM.

837.5 + 13.4
836.0 + 13.6
837.0 + 13.4
823.0 + 14.7
837.0 + 13.4
837.0 + 13.4

5003.5 + 81.9 = 5085.4

Monday Apr. 8, 1912

$\theta = \langle 22.99 \\ 23.01 \rangle$ $\rho = 9318 - 2050 = 7268$

First Observation 4:25 P.M.

Volts at 4:10 P.M.

839.5 + 13.3
837.5 + 13.5
840.5 + 13.2
826.5 + 14.5
839.0 + 13.3
839.5 + 13.3
5024.5 + 81.1 = 5105.6

G	F	
12.826		
12.864		
12.740		
12.814		
12.776		
12.770	13.754	13.775
12.860	13.796	
12.728	22.436	
12.830	19.770	19.816
	(9.8) 19.862	
12.800	(11.3 22.4) 22.296	22.304
12.816	(11.3 22.2) 22.312	
12.836		

1½ mm. below center of

Cant get a diffraction

⅓ of a small division, in 60 seconds

4:37 P.M.

39 Monday, Apr. 8, 1912
Second Observation
at 4:50

$\theta = 23.08$ $p = \frac{93.45 \; 20.20}{73.25}$

Volts at 4:38 P.M.

838.5 + 12.6
833.0 + 13.6
836.5 + 13.0
825.0 + 14.5
832.0 + 13.6
839.0 + 12.6
5004.0 + 80.5 = 5084.5
Ave. volts = .5073

Middle of Plates is now 10.689

G		F
10 640		19 154
10 724		17 866
10 640		34 958
10 772	(156-27.0)	26 972
10 666	(12.3-26.5)	26 822
10 638	(42.6-84.5)	84. 648
10 594	(42.6-84.6)	84. 144
10 718	(29.7-59.0)	58. 828
10 596	(29.4-59.3)	59. 084
10 640		
10 584	(—-37.0)	36. 890
10 624	(16.6-37.0)	36. 822
10 558	(23.6-45.3)	45 446
10 644	(23.8-45.3)	45 382
10 690	(29.2-56.9)	58 758
10 618	(42.4-83.6)	83 668
10 706	(72.6-)	146 4—
10 816	(72.2-144.4)	145.832
10 650	(29.0-58.0)	58 562
	(29.6-58.8)	58. 636
10 690	(37.2)	36. 934

20) 13268
10.6634

5.40 P.M.

$\frac{1}{26.897} = .03717$
$\frac{.02534}{5} = .005068$
$\frac{1}{84.396} = .01183$
.005105
$\frac{1}{58.95} = .016935$
$\frac{.010135}{2} = .00509$
$\frac{1}{36.85} = .02710$
.00512
$\frac{1}{45.42} = .02202$
$\frac{.01017}{2} = .005060$
.00500
$\frac{1}{56.84} = .01698$
.00506
$\frac{1}{83.67} = .01192$
.005076
$\frac{1}{146.1} = .006844$
$\frac{.01010}{2} = .005046$
$\frac{1}{58.7} = .01704$
$\frac{.01006}{2} = .005085$
$\frac{1}{36.98} = .02705$

differences

.005064	.5068
.005115	.5105
5090	.5090
5120	.5060
5000	.5060
5060	.5076
5096	.5096
5000	.5045
9) 4537	
.005071	.005070

.01195
.09378
2) .10573
.005036

.03717
.09378
20) .13095
.005037

.006868
.09378
20) .100648
.00503

.01185
.09378
20) .10563
.005030

.01706
.09378
22) .11084
.005038

.01695
.09378
22) .11073
.005034

.02704
.09378
24) .12082
.005036

.03714
.09378
24) .13092
.005038

.02202
.09378
23) .11580 .005035

.01702
.09378
20) .10080
.005040

$\frac{1}{10.6634} = .09378 \times 1.021$
$= .09578$ 04

Log. = 3.9813
$\frac{1}{2}$ " = 2.9907

a = 3.931
2.924

$\frac{1}{2}$ Log. e_1 = $\bar{1}$.49078
Log 1.021 = $\bar{3}$.71400
$\bar{3}$.19380
$\bar{6}$.40233
3.70520
10.69750

$v_1 = .5073$

a -16.4700
+ 3.7053
- 2.9813
-13.1075
- 3.7100
3) 13.3975
- 4.4695
1.8648
- 2.3299
+1.6701

-4.6547
-6.9849
-2.3283
4.67

4.9810 × 10^{-10}
1.5

log. e = .69734

4.9885
e = 4.988
log e^{3} = 7.7981
$e^{3} = 6.282$

5035
5032
5038
5036
5040
5035
5038
5034
5030
5037
3554
.50355
.011
.965
.0050483
.005154 = $v_1 + v_2$
log = 3.7121

79. All larger drops

39) Monday, Apr. 8, 1912

$t = 23.06$

$p = \frac{93.50}{20.03} = 73.47$ (93.50 − 20.03 = 73.47)

Third Observation at 5:55 P.M.

Volts at 5:41 P.M.

837.0 + 13.0
829.5 + 14.3
831.0 + 14.0
823.0 + 14.6
828.5 + 14.3
831.5 + 14.1
4980.5 + 84.3 = 5065.4

~~Good Volts. = 5054~~

G		F	
18 402			
18 556			
18 350		14 966	
18 470		14 870	
18 412	(18.7−37.4)	37 376	
18 318	(37.6)	37 594	
18 388	(18.4−37.3)	37 368	
18 376	(25.0−50.1)	50 228	
18 406	(37.6−76.3)	76 154	
18 392	(	155. 6	
18 492			

11) 14562 = 18.405

6:12 P.M.

$\frac{1}{14.918} = .06703$
$\frac{1}{37.446} = .02667$
$\frac{1}{50.23} = .01989$
$\frac{1}{76.16} = .01313$
$\frac{1}{155.6} = .006428$

.04036 / 6 = .006727
.006980
.006780
.006682
mean = .006742

Volts at 6:13

836.0 + 13.6
826.0 + 14.5
830.0 + 14.2
823.0 + 14.7
824.0 + 14.7
830.0 + 14.2
4969.0 + 85.9 = 5054.9

.5431 × 64: 9) 6074 = .006749
5431 × 1313: 10) 6744 = 6744
5431 × 1464: 11) 7420 = 6746
5431 × 2658: 12) 8098 = 6748
5431 × 8703: 18) 12134 (6752

6749
6742
6748
6752
5) 7737 = 6746

$\frac{1}{5431} = .5431 \times 10^{-1} = v_1 = .05545$

Log = −2.7429

$v_2 = -1.8720$

$v_1 + v_2 = .006746 \times 1021$

= .0068896

Log = −3.8382

a	l
−16.4270	−48547
− 2.7429	1.6641
3.7042	−29886
−14.8751	−4.3456
− 3.8382	−26930 = $\frac{c}{a}$
3) 11.0369	.04395 = $\frac{c}{a}$
−4.3456	.0002216 a
1.6641	2.7 × .2206 = a
−3.2117	
1.7883	

−3.8382
−1.3770
3.1483
−6.4085
7042
1.7043

$v = 5060$

$e_1 = 5061$
$e_2 = 5062$
$e_0 = 5.054$

$e^{2/3}$
−10.7044
2
3) 14.4088
−7.8029
63.50
$e^{2/3} = 63.43$

~~5476~~ = $\frac{1}{pa}$
6141
6159 = $\frac{1}{pa}$
69

16a

Brady
Perfect. Then Good. Unused. No Publish

49) Tuesday, Apr. 9, 1912

First Observation at:

$\theta = 23.46$

p =
9363 / 1994 — 73.69
9363 / 1992 — 73.71

Volt. at 4:0_ P.M.

839.0 + 13.8
842.0 + 13.5
842.0 + 13.3
823.5 + 14.9
843.5 + 13.3
843.0 + 13.45
5033.0 + 97.2 = 5113.4

Volt. at 5:49 P.M.

837.0 + 13.0
838.0 + 13.9
840.5 + 13.7
822.0 + 14.8
839.0 + 13.3
840.5 + 13.7
5017.0 + 78.8 = 5095.9

G		F	
		54.0	5 small div. (from 1½ to 2)
		57.4	from 2 to 2½
		57.0	from 2½ to 3
		56.2	from 3 to 3½
		54.6	from 3½ to 4
		50.2	from 4 to 4½
9.826		50.2	from 4½ to 5
9.934	(47.9)	47.652	
9.880	(48.0)	47.536	
9.832	(31.9)	32.278	
9.914	(32.6)	32.462	
9.938	(32.8)	32.472	
10.044	(33.0)	32.180	
9.954	(16.2 – 32.0)	32.270	
9.854	(16.2 – 32.2)	32.248	
9.966	(16.2 – 32.3)	32.274	
9.918	(19.0 – 38.2)	38.140	
9.878	(19.2 – 38.1)	38.098	
9.844	(19.2 – 38.3)	38.108	
9.996	(24. – 47.3)	47.080	
9.900	(24 – 47.7)	46.836	
9.854	(23.6 – 47.3)	47.164	
9.874	(31.2 – 61.0)	60.986	
9.898	(31.2 –)	60.902	
9.836	(44 – 87)	86.950	
9.890	(78.6 – 151.9)	152.363	(133.318 = 7 div.)
9.996		27.654	
		18.138	

$\frac{1}{80.00} = .001250$

$\frac{.019725}{4} = .004931$

$\frac{1}{47.594} = .02097$

$\frac{.009945}{2} = .004972$

$\frac{1}{32.31} = .03095$

$\frac{.0970}{2} = .004850$

$\frac{1}{38.115} = .02620$ } .00494

$\frac{1}{47.03} = .02122$ } .00484

$\frac{1}{60.94} = .01638$ } .00490

$\frac{1}{86.95} = .01148$ } = .004899

$\frac{1}{152.4} = .006561$ } $\frac{.02965}{6} = .004931$

$\frac{1}{27.65} = .03619$

mean $\frac{1}{v_1} = .004893 \times 1021 =$

$.004996$

Log = −3.6986
−1.50667
3.1963
6.40353
3.7076
10.69593
4966

Defi

.004941 4931
4968 4874
4895 490
4850 484
4910 485
4921 4970
4899 4931
4899 4900
4931
4921
10 | 49095
.0049095

1009.8
668
22 / .10755
.004889
1009.8
1152
23 / .11245
4890
1009.8
1641
24 / .11739
.004892
1009.8
2126
25 / .12224
4890
1009.8
2624
26 / .12719
4894
4890
4892
4890
4890
4887
4879
4880
9 / .04397
.004887
4891

1009.8
3095
27 / .13190
4885

1009.8
3015
28 / .14865
.004579

1009.8
423
21 / .10220
.004870

$v = 5408$ $e^{2/3}$

−10.6472
3 / 12.3940
−7.7980
6280

5:48

$\frac{1}{9.901} = .1010 \times 1021 = .10312 = V$

Log = −1.01334
2/11 = −1.50667

(15 a)

$e_1 = 4.971 = e_1 \; 4.977$

$4.488 = \frac{1}{\lambda}$
$44.62 = \frac{1}{\lambda}$

9.9080 / 9.906

(4)

Wednesday Apr. 10th 1912 θ = 22.96

$p = \frac{9366}{1993} \frac{9366}{1990}$ 7367 7376

First Observation at 3:55

Volts at 3:38 P.M.

839.5 + 13.3
839.0 + 13.3
841.5 + 13.2
824.0 + 14.1
837.5 + 13.5
839.5 + 13.3
5021.0 + 81.3
= 5102.3

	G	F	
(10.2–21.0)	20.868		
–20.8)	20.804		
(16.6–20.0)	20.944	(13.2–26.1)	25.806
(10.3–20.8)	20.788	(16.0–31.6)	31.995
(10.2–20.8)	20.888	(15.6–31.4)	31.654
(10.3–20.6)	20.860	(21.2–41.5)	41.152
(10.2–20.6)	20.740	(21.0–40.9)	40.926
(21.0–41.2)	20.944		
	8)16856		
	20.857		

$\frac{1}{25.81} = .03875$

$\frac{1}{31.82} = .03143$ } .0700

$\frac{1}{41.04} = .02437$

$\frac{1}{20.857} = .04795 \times 1.021 = .048956 = v_1$

log = –2.6898

4:15 P.M. log 1/7 = –1.3449

.04795
3.143
16) .07938
.007216
.007232
7232
7216
7225
5)121
.007224 × 1.021

4795
2437
19)7232
.007232

4795
3875
1)8670
7225

$= v_1 + v_2 = .007376$

log = –3.8679
–1.3449
3.1483
–6.4111
3.7070
–10.7041

v = 5093

5059

a
–16.4270
3.7070
–2.6898
4)14.8238
–3.8674
3)12.9559
–4.3186
1.8679
–2.1865
1.8135

l
–4.8547
1.8679
–6.9868
–4.3186
–2.6682

$.04658 = \frac{l}{a}$

$.00002082 = a$

$6508 = \frac{1}{pa}$

$e^{2/3}$
7041
2
3)–14.4082
7.8027
6349

Cut check
Two methods of getting un-
Hence can't use

47/ Wed. Apr. 10, 1912

θ = 23.01

p = 9376 / 1979 / 7396

Second Observation at 4:37 P.M.

Volts at 4:17

839.0 + 12.9
835.0 + 13.2
832.5 + 13.8
823.0 + 14.6
834.0 + 13.8
839.0 + 13.8
5003.5 + 81.0 = 5084.5

	G		F	
		(203-395)	38.384	1/38.33 = .02609
(7.9-15.4)	15.142	(38.0-76.0)	75.796	1/75.8 = .01319
	15.172	(25.6-51.9)	51.614	1/51.6 = .01938
(7.6-15.2)	15.248	(37.6-76.0)	75.752	
(15.3)	15.184	(37.4-75.8)	75.650	1/75.67 = .01323
	15.290	(37.6-75.4)	75.298	
	15.210	(69.0)	139.8	1/139.8 = .007153
	15.164		123.4 — 1st div.	
			116.2 — 2nd "	
			107.2 — 3rd "	1/878 = .001139
			102.2 — 4th "	
			100.0 — 5th "	
			549.0	
	15.136	(19.3-38.8)	38.980	1/38.98 = .02565
	15.166	(-51.6)	51.440	
(?)	~~15.392~~	(25.6-51.5)	51.380	1/51.39 = .01942
	15.184	(25.6-51.4)	51.350	
	15.198	(37.6-75.0)	74.918	1/74.92 = .01332
	15.202	(70.4-	139.2	1/139.2 = .007184
	15.188			
	2896 / 392 / 13)2504 / 15.193	no uniform field shape	117.0-1st div.	
			112.6-2nd	1/898.4 = .001114
			112.0-3rd	
			112.0-4th	
			104.0-5th	
			112.0-6th	
			112.0-7th	
			117.4-8th	
			898.4	

.01290 / 2 = .00645
.006140
.006130
.006099
.006014
.02487 / 4 = .006120 [?]
.006190
.006100
.006136
.006070

Diffs
~~.0060~~
.006059
6034
6110
6100
6136
6020
~~.6057~~
6)487
.006081
~~.006081~~

6085
6094
6088
6087
6080
5)429
.006084

new = 6088

.06582
.01114
11).06939
.006085

6582
7164
11)73004
6084

.06582
.01942
4)08524
6088

6582
114
11)6696
.006087

6582
1021
13)[?]
.006080

6084 × 1021

= $v_1 + v_2$ = .006218

$\frac{1}{15.193}$ = .06582 × 1021

v_1 = .56720

Log = -2.8274

$\frac{1}{2}$ " = -1.4137

5:35 P.M.

a	l
-16.4270	-4.8547
3.7047	1.8640
-3.8274	-6.9857
-14.9591	-4.3885
-3.7935	-2.5972
3)11.1656	.03955 = l/a
-4.3885	~~3466~~ = l/a 3973
.0002446 = a	
-4.3885 / .0002456 = a	
1.8640	
~~[illegible]~~	
-3.2575	
-1.7425	

Log = -3.7932
-1.4137
3.1983
6.4052
2.7049
10.7005

V = 5066

e_1 = 5048
e_1 = 5015

$e^{2/3}$
-10.7005
2
3)19.3[?]010
-7.8033
15
6387 = $e^{2/3}$
6312 = $e^{2/3}$

5528 = $\frac{l}{pa}$
55.28 = $\frac{1}{pa}$

5% low

Publish Grade[?]

14a

#2 Wed. Apr. 10, 1912
Third Observation
at 5:50 P.M.

$\theta = 23.05$ $p = \frac{934.8}{19.68}$ $\frac{934.8}{19.47}$
74.15

Voltsat 5.38 P.M. - 834.5 + 13.30
829.5 + 14.3
823.0 + 14.6
821.0 + 14.7
827.0 + 14.4
834.0 + 13.8
4970.0 + 85.1
= 5055.1

G		F
17.306		19.180
17.278		19.278
17.182	(75.6-15.6)	150.768
		(13.076) for Hydrocarbons
		6.00 P.M.

4/ Wed. Apr. 10, 1912 ✓

Fourth Observation at 6:17 P.M.

$\theta = 23.08$

$p = \frac{9391}{1859} = 7532$

Volts at 6:02 P.M.

G		F
(← -35.2) 35.080		17.605
35.140	(← 18.0)	17.688
(17.3-35.2) 35.154	(← 17.8)	17.602
(← -35.3) 35.198	(53.4-106.4)	105.796
35.260	(13.2-26.3)	26.312
(17.6-35.4) 35.386	(-21.0)	20.980
(17.6-35.3) 35.276	(17.8-34.9)	35.132
35.268		26.216
(17.6-35.2) 35.330	(53.4-104.8)	104.642
35.414	(26.4-52.6)	52.426
35.174	(26.6-52.6)	52.258
35.358	(52.2-	105.10
14) 30.84		
35.253		

Balanced speed no motion for in 80 seconds.

$\frac{1}{35.253} = .02834 \times 10^{-1}$

$v_1 = .028435$

Log = -2.4613

$\frac{1}{2} \ldots = -1.2307$

$\frac{1}{17.63} = .05672$; $\frac{.04784}{5} = .09459$

$\frac{1}{105.8} = .009452$; $\frac{.2856}{3} = .09508$

$\frac{1}{26.31} = .03990$; .09468

$\frac{1}{20.98} = .04768$; $\frac{.1920}{2} = .09600$

$\frac{1}{35.13} = .02843$; .0967

$\frac{1}{26.22} = .03814$; $\frac{.02856}{3} = .09520$

$\frac{1}{104.6} = .009562$; .09590

$\frac{1}{52.34} = .01909$; .09568

= .09600 .09546

9524

$\frac{5069}{1059}$

6:50

834.5+13.8
827.5+14.4
822.5+14.8
831.0+14.8
819.0+14.9
820.5+14.2 / 5041.5
4955.0+86.8 = [illegible]

831.5+14.1
819.0+14.9
812.5+15.4
820.5+14.9
808.5+15.6
820.5+14.9
4912.5+89.8 = 5002.3

.09459		9452
.09508		9444
.09520		9474
.09590		9500
.09566		9465
.09516		9444
		9470
		9447
		9466
.02834	2 8344	9461
9524	1007	
41037 8.66	3 4747	43791
.09466	9494	9478

wt last column 2 to 1 & others 1

Get weighted mean = .09479

$.09485 \times 10^{-1} =$

$v_1 + v_2 = .09684$

Log = -3.9863 9858
-1.2310 2307
3.1963
-6.4136
3.7005
-10.7151
5.189
$e_1 = 5.191$
$e_1 = 5.176$
$e_1 = 5.166$

$v = 5018$

$v_1 + v_2 = .9461 \times 10^{-1}$ = .4660

a	l
-16.4270	-4.8547
3.7003	1.8711
-2.4619	-6.9836
-14.5894	-4.4093.5
-3.9860	-2.7843
3) -12.6034	
-4.20915	
1.8711	
-2, 07025	
1.92975	

$.0606 = \frac{l}{a}$

$.6069 = \frac{al}{a}$

$.0001589 = a$

$.0001581$

$8508 = \frac{1}{pa}$

$e^{2/3}$

-10.7153 7140

$3) 19.4306$ 14280

7.8102 78093

6442 = e

6436 = e

$e^{2/3} = 64.60$

This is largest drop but ... 2 ways of getting $v_1 + v_2$ but Ammeter came out

(3a)

Thursday Apr. 11th 1912.

First Obs at 4:28 4:13 P.M.

θ = 23.64, 23.73

p = 74.08, 74.10, 74.68

837.0 + 13.5
842.5 + 13.1
841.0 + 13.2
821.5 + 14.8
842.0 + 13.2
841.5 + 13.2
5025.5 + 81.0 = 5106.5

G watch	G chronograph	F watch	F chronograph
	18.638		
	18.686		
	18.680	17.8	17.756
	18.730	18.0	17.778
	18.686		45.978
	18.726	46.1	45.870
	18.772	45.9	45.716
	18.740	233-46.0	45.758
	18.724	95.0	94.654 — 1st div.
			88.2 — 2nd "
			88.2 — 3rd "
			83.4 — 4th "
			80.0 — 5th "
			85.3 — 6th "
			85.3 — 7th "
			90.6 — 8th "
			695.6
	~~18.854~~	27.8	27.950
	18.720	59.0-118.6	118.388
	18.816	227-45.2	45.030
	18.816		45.274
	18.716	17.0-	34.564
	18.804	27.6-44.9	44.836
	18.746	59.0-117.7	117.198
	18.746	45.2	44.784
	18.790		
17	17536		
	18.737		

Note time

No evidence of convection at all here. Drop doesn't move. Only to right or left in a low field. must be some glass chip.

$\frac{1}{17.778}$ = .05628 } $\frac{.03454}{5}$ = .006908

$\frac{1}{46.0}$ = .02174, .02178

$\frac{1}{45.81}$ = .021826 } $\frac{.020385}{3}$ = .006795

$\frac{1}{694}$ = .001441 } $\frac{.03429}{5}$ = .006860

$\frac{1}{27.98}$ = .03574 } $\frac{.02730}{4}$ = .006825

103.590 for 7 div. $\frac{1}{118.5}$ = .008439 } $\frac{.01373}{2}$ = .006866

$\frac{1}{45.10}$ = .02217, .02439

.06549

$\frac{1}{34.60}$ = .02890

$\frac{1}{44.90}$ = .02227 } $\frac{.01375}{2}$ = .006876

.008516 } $\frac{.01377}{2}$ = .006884

$\frac{1}{117.9}$

$\frac{1}{44.85}$ = .02295

7/.6019, .006860

$v_1 + v_2$ = .006860 × 1.021 = .007005

log = –2.8454, –1.36815, –3.19776, –6.41131 √ = 5.103, 3.7079, 7034

$\frac{1}{18.74}$ = .05337 × 1.021

= v_1 = .05449

log = –2.7363

log v_1 = –1.36815

a: –16.42146, 3.7079, –2.7363, –14.88556, –3.8454, 3)–11.03326, –4.34009 .00219 = a, 1.8727, –2.21239, 1.7491

b: –.48547, 1.8733, –6.9815, –2.3401, –3.6414, .043297 b/a, 480

e_1 = 5.051

e_1 = 5.065

$e^{2/3}$: 7046, 2, 1.4092, 7.8031

63.54 × e_1

$\frac{33}{61.44}$ = $\frac{1}{p a}$

.05337, .05628, 14).10965, .006832

5337, 2174, 4)7515, 6532

.05337, 1441, 8)054811, .006851

5337, 3574, 13)8911, .006855

5337, 844, 9)6181, .006868

5337, 2217, 11)7554, .006867

6851, 6832, 6851, 6855, 6868, 6867, 6856, 6876, 6874, 10)613, 6861

5337, 2890, 12)8227, 6856

5337, 2227, 11)7564, 6876

5337, 8516, 9)61886, 6876

5337, 2230, 11)7567, 6879

(12a)

Perfect Rubish

Thursday Apr. 11, 1912
Second Observation
at 5:33 P.M.

$A = \frac{23.76}{\text{[illegible]}}$ (5:14)

$\beta = \frac{94.70}{19.35}$ / 76.85

836.5 + 13.6
841.5 + 13.2
840.0 + 13.2
820.0 + 14.9
841.0 + 13.2
840.0 + 13.2
5019.0 + 81.3 = 5100.3

G	F		
	254-508	51.537	(?)
26.418	250-510	50.960	50.756
26.606	260-508	50.532	
26.580	434-872	87.066	
26.568			
4 | 2172		5:45 P.M.	
26.543			

47) Thursday Apr. 11, 1912
Third Observation
6:06 PM

$\theta = 23.79$ $p = \frac{9436}{1918}{7518}$

5:47 PM.

11.958		16.286
11.880		16.382
11.966		~~16.676~~
11.878	29.4	29.092
11.964	18.0	17.678
11.918	16.4	16.346
11.928	17.2–34.4	34.496
11.946	22.2	22.202
11.926	39.0–77.6	77.446
12.020	78.0	77.594
12.072	14.6–29.4	29.020
11.942	37.4–54.6	54.388
12.000		

17348
955
~~11.9799~~
11.950 = .08368 × 1021 =

6:23

$\frac{1}{16.34} = .06120$ } $\frac{.02686}{5} = .005372$
$\frac{1}{29.09} = .03439$ } $\frac{.02684}{5} = .005368$ [5.35]
$\frac{1}{16.34} = .06118$ } $\frac{.03227}{6} = .005378$
$\frac{1}{34.53} = .02896$
$\frac{1}{22.20} = .04505$ } $\frac{.03216}{6} = .005360$
$\frac{1}{77.53} = .012894$ } $\frac{.02546}{4} = .005386$
$\frac{1}{29.05} = .03442$ } $\frac{.1608}{3} = .005357$
$\frac{1}{54.59} = .01835$

6|.32206
.005369

836.0 + 13.6
839.5 + 12.7
840.0 + 12.7
820.0 + 14.96
840.5 + 12.76
840.0 + 12.76
5016.0 / 78.5 = 5094.5

835.0 + 13.2
838.0 + 12.9
837.5 + 13.0
820.0 + 14.8
838.0 + 12.9
840.0 + 12.9
5008.5 + 79.7 = 5088.2

.08368 / 1835 → 19|.10203 → .005370
8368 / 3442 → 22|11810 → .005368
8368 / 12894 → 18|9655 → .005364
8368 / 2896 → 21|11264 → .005364
8368 / 3434 → 22|11802 → .005366

mean = 5367

$v_1 + v_2 = .005367 \times 1021 = .005480$

Log = −3.7388
−1.46585
3.1983
−6.40295
3.7088
10.69596

v = 5090

$v_1 = 0.8544$
Log = −2.9317
λ_a = −1.46585

$e_1 = 4.9669$
18
$e_1 = 4.9847$
$e_1 = 4.988$

a
−16.4270
3.7070
−3.9317
−13.6657
−3.7388
3|11.3269
−9.4403
1.8756 = .07569 = a
.3757 = a
−2.3179
1.6852
4.810 = $1/\lambda a$
48.44 = $1/\lambda a$

−4.8544
1.87465
−6.9802
−4.4403
−2.5369
.3984
.03442 = l/a
3466 = l/a
3466

$e^{2/3}$
6973
10.6974
3|14.3948 (14.3846)
7.7988
7.7982
62.85 = $e^{2/3}$
62.82 = $e^{2/3}$

Pollock
Perfect medium
simple ple

(11 a)

45) Thursday Apr. 11th 1912   A = 23.81 / 23.85   p = 9924 / 1816 / 75.24

Fourth Observation at 6:58   7:25 PM

834.0 + 13.4
836.0 + 13.4
832.0 + 14.0
819.0 + 14.9
833.0 + 13.6
834.0 + 13.4
4988.0 + 82.4
5071.0

G		F	
18.908		14.348	14.350 — $\frac{1}{}$ = .06964
18.948		14.352	$\frac{.04759}{7}$ = .006790
18.958			
18.950			
18.904	22.4-44.8	45.070	$\frac{1}{45.14}$ = .02215 ; .006905
18.988	17.3-34.6	34.338	$\frac{1}{34.384}$ = .02904
18.896	17.9-34.2	34.432	34.46 ; .006766
(?) 19.094	17.3-34.4	34.334	
18.936	22.6-44.8	44.864	$\frac{1}{44.94}$ = .02225 ; .006805
18.980	17.6-34.6	34.430	.02405 ; 1825
19.030		74.2 — 1	$\frac{.02722}{4}$ = .6807
		67.8 — 2	
		66.6 — 3	
		64.8 — 4	$\frac{1}{548}$ = .01825
Reef Shake		65.0 — 5	
		68.0 — 6	$\frac{.02742}{4}$ = .006858
		71.8 — 7	
		71.5 — 8	
		544.9	$\frac{1}{54.18}$ = .01926 ; .007046
18.872	17.2-34.5	34.143	
18.808	22.0-44.4	44.654	$\frac{1}{44.567}$ = .02240
18.910	22.6-44.7	44.520	64 ; .006890
18.946	22.6-44.6	44.526	
18.936	63.7	64.480	$\frac{1}{64.41}$ = .01558 ; .006766
18.950	57.3-114.6	114.404	$\frac{1}{114.1}$ = .00874 ; .006851
19.030	57.0-113.6	113.452	
19.018	64.2	63.934	$\frac{1}{68.65}$ = .01515 ; $\frac{.02705}{4}$ = .006808
19.116	11.6-23.0	23.260	
	10.2-20.2	20.212	$\frac{1}{23.30}$ = .04292
1/9 178 / 18.959	11.2-23.4	23.350	

Refilled

Refilled ... another ...

$\frac{1}{18.96}$ = .05274 × 1021 =

v, 535385

log v, 2.37372

... = -1.3656

7.24 PM

Dfs.
6848
6651
6756
6858
6847
6790
6817

5274 / 4492 / 14 | 9566 / 6832

5274 / 1564.5 / 10 | 6838 / 6835

5274 / 6784 / 9 | 6858 / 6834

5274 / 2240 / 11 | 7514 / 6831

5274 / 24054 / 12 | 81294 / 6816

5274 / 18.5 / 8 | 5456.5 / 6820

5274 / 2220 / 11 | 7494 / 6813

5274 / 6965 / 18 | 12241 / 6801

6837 / 6838 / 6836 / 6851 / 6850 / 6820 / 6829 / 6831 / 8 | 182 / 6823

$v_1 t_{g_1}$ = 6823 × 1021 = .06966

log = 3.8430 / -1.3656 / 2.1983 / 86408 / 3.7057 / ...

5036 / e_1 = 5046 / e_1 = 5049

v = 5074 ; $e^{2/3}$; -4.7032 ; -14.4044 ; -2.8022 ; e_1 = 6340 / 6337

a : -16.4240 / 3.7057 / -2.7312 / -14.8639 / -3.8430 / -11.0209 / -4.3408 / 1.8764

l : -4.8347 / 1.8264 / -6.7783 / -4.3401 / -2.6382

.04347 / 4888 = l/a

... = a

1.7835

6103 / 6074 = l/pa

47) Thursday Apr. 11, 1917
Third Observation
6:06 PM

θ = 23.79   p = 74.6 / 74.8 / 75.0

5:47 PM.

11.958		16.286
11.880		16.382
11.966		~~16.676~~
11.878	29.4	29.092
11.964	18.0	17.628
11.916	16.4	16.346
11.928	17.2-34.4	34.496
11.946	22.2	22.202
11.926	39.8-77.6	77.446
12.020	78.0	77.594
12.072	14.6-29.4	29.020
11.942	27.4-54.6	54.388
12.000		

17348
951
~~11.9944~~
11.950 = .08368 × 1.021 =

v_1 = .08544

Log = -2.9317
$\frac{1}{2}$ log = -1.46585

6:23

1/16.34 = .06120
1/29.09 = .03434
1/16.34 = .06118
1/34.53 = .02896
1/22.20 = .04505
1/77.53 = .01289
1/29.05 = .03442
1/54.59 = .01835

.02686/5 = .005372
.02684/5 = .005368 6.35
.03227/6 = .005378
.03216/6 = .005360
.02156/4 = .005386
.01607/3 = .005357
6)32206
.005369

$v_1 + v_2$ = .005367 × 1.021 = .005480

Log = -3.7368
-1.46585
3.1983
-6.40295
3.7067
10.69596
e_1 = 4.9669
18
e_1 = 4.9847
e_1 = 4.981

$v = 5090$

836.0 + 13.1
839.5 + 12.7
840.0 + 12.7
820.0 + 14.6
840.5 + 12.6
840.0 + 12.6
5016.0 / 78.5 = 5094.5

835.0 + 13.2
838.0 + 12.9
837.5 + 13.0
820.0 + 14.8
838.0 + 12.9
840.0 + 12.9
5008.5 + 79.7 = 5088.2

.08368
1835
19).10203
.005370

8368
3442
22)11810
.005368

8368
12894
18)9658
.005364

8368
2896
21)11264
.005364

8368
3434
22)11802
.005366

mean = 5367

a
-16.4270
3.7070
-3.9317
-13.0657
-3.7368
3)13.3269
-9.4403
1.8756 = a
.7797 = a

-2.3179
1.6852
4.810 = 1/pa
48.44 = 1/pa

-4.8544
1.87965
-6.9802
-4.4403
-2.5384
.3994
.03442 = b/a
3466 b/a

$e^{2/3}$
6973
10.6974
3)13.3046
2.7982
7.7988
62.85 = $e^{2/3}$
62.82 = $e^{2/3}$

Publish
Pref. reading
sample

(11a)

48) Thursday Apr. 11th 1912

Fourth Observation at 6:38

$t = 23.81$, 23.85

$p = 7434$, 1410, 75.24

7.25 PM

834.0 + 13.4
836.0 + 13.4
832.0 + 14.0
819.0 + 14.4
833.0 + 13.6
834.0 + 13.4
4988.0 + 82.4
5071.0

G		F
18.908		
18.948		14.348
18.958		14.352
18.950		
18.904	22.4 - 44.8	45.070
18.988	17.3 - 34.6	34.338
18.896	17.9 - 34.2	34.432
(?) 19.094	17.3 - 34.4	34.334
18.936	22.6 - 44.8	44.864
18.980	17.6 - 34.6	34.430
19.030		74.2 - 1
		67.8 - 2
		66.6 - 3
		64.8 - 4
		65.0 - 5
		68.0 - 6
		71.8 - 7
		71.5 - 8
		544.9
18.872	17.2 - 34.5	34.143
18.808	22.0 - 44.4	44.654
18.910	22.6 - 44.7	44.520
18.946	22.6 - 44.6	44.526
18.936	63.2	64.1380
18.950	57.3 - 114.6	114.404
19.030	57.0 - 113.6	113.452
19.018	64.2	63.934
19.116	11.6 - 23.0	23.260
17.9178	10.2 - 20.2	20.212
18.959	11.8 - 23.4	23.320

Ruff shape

$\frac{1}{14.350} = .06964$ — $\frac{.04759}{7} = .006790$

$\frac{1}{45.04} = .02215$ — .006905

$\frac{1}{34.384} = .02905$ (34.46) — .006766

$\frac{1}{44.94} = .02225$ — .006805

.024054, 1825

$\frac{.027229}{4} = .006807$

$\frac{1}{544} = .001835$

$\frac{.027472}{4} = .006858$

$\frac{1}{54.18} = .02426$ — .007046

$\frac{1}{44.567}$ (64) $= .02240$ — .006870

$\frac{1}{64.41} = .01550$ — .006766

$\frac{1}{114.9} = .008744$ — .006851

$\frac{1}{63.85} = .015615$ — $\frac{.027305}{4} = .006808$

$\frac{1}{23.30} = .04292$

Difs
6848
6651
6766
6858
6807
6790
6817

5274, 4268, 14 | 9542, 6832

5274, 1565, 10 | 6835, 6835

5274, 1764, 9 | 6158, 6837

5274, 2240, 11 | 7514, 6835

5274, 29054, 12 | 81794, 6816

5274, 1825, 8 | 54565, 6820

5274, 2220, 11 | 7494, 6813

5274, 1966, 14 | 15242, 6801

6832, 6835, 6834, 6838, 6820, 6820, 6833, 6821, 8 | 7462, 6828

$v_1 \cdot 702 = 6829 \times 1.021 = .006966$

Rubbish

Perfect candle ... for

$\frac{1}{1896} = .05274 \times 1.021 =$

v_1 585385
$\log v_1$ 57312
$= -1.3656$

7.24 PM

a: -16.4290, 3.7057, -2.7312, -14.8639, -3.8430, 4) -11.0208, -4.3408, 1.8764

ℓ: -4.8347, 1.8764, -6.9783, -4.3401, 2.6382

.4347 ... 4368 = ℓ / a

.002188 = a, 1.7835

6103, $60.24 = \frac{\ell}{pa}$

$\log = 3.8430$, -1.3656, 3.1983, 264069, 3.7057, -10.7012, 5036, 10, $e_1 = 5.048$, $e_1 = 5.048$

$v = 5036$, $e^{2/3}$, -10.7037, 2, 8.14044, -7.8014, $e^{2/3} = 6340$, 6337

(10 a.)

Friday Apr. 12, 1912

First Obs. at 9:45 PM.

θ = 22.97 / 23.02

9.36 P.M.

P = 94.89 / 19.15 / 75.74

832.0 + 13.9 + 13.8
837.0 + 13.6 + 13.0
898.0 + 13.2 + 12.9
818.5 + 15.0 + 15.0
838.0 + 12.8 + 12.9
837.5 + 12.3 + 13.0
5001.0 + 606

= 5001.6

New corrections for voltmeter readings

G		F
16.024		19.684
15.974	13.2–26.2	26.352
15.886		19.694
15.950	40.3–78.4	78.4
15.984	26.0–52.4	52.404
15.948	–39.2	39.142
15.946	19.4–39.0	39.050
16.078	26.1–52.0	52.080
15.964	38.6–77.0	77.084
16.006	22.3	22.498
15.996	26.2	26.162
15.968	26.0	26.064
15.982	39.0–76.9	76.550
16.030	38.4–76.4	76.860
16.040		

1)239 776 / 15.985

$\frac{1}{15.985}$ = .06244 × 1.021

= v_1 = .06375

Log = –2.8044

½ " = –1.4022

10:22 P.M.

$\frac{1}{26.39}$ = .03792 } .03512 = .006280
$\frac{1}{19.69}$ = .05081 } .03400 = .006333
$\frac{1}{78.1}$ = .01280
$\frac{1}{52.5}$ = .01905 } .00624 = .006240
$\frac{1}{39.16}$ = .02555 } too small diff.
$\frac{1}{52.18}$ = .01917 } = .00622 = .006220
$\frac{1}{77.22}$ = .01295 } .03149 / 2 = .006298
$\frac{1}{22.50}$ = .04444 } .02530 = .006325
$\frac{1}{26.14}$ = .03825 } .02521 / 4 = .006303
$\frac{1}{76.705}$ = .01304

7)43999 / .006285

.03792 / 6244 / 16)10036 / .006291 — 5080 / 6244 / 18)11324 / .006291

01280 / 6244 / 12)7524 / 6270 — 1905 / 6244 / 13)8149 / 6269

2555 / 6244 / 14)8799 / .006285 — 1917 / 6244 / 13)8161 / 6278

6291, 6291, 6270, 6269, 6285, 6278, 6283, 6267, 6294, 6290 — 10)628 / .006284

1295 / 6244 / 12)7539 / 6283 — 4444 / 6244 / 17)10688 / 6267 — 3825 / 6244 / 16)10069 / 6294

1304 / 6244 / 12)7548 / 6290

$v_1 + v_2$ = .006284 × 1.021 = .006416

Log = –3.8073
–1.4022
3.1483
6.4078
3.7059
10.7019

e_1 = 5.034

e_1 = 5.028

$e^{2/3}$

10.7019 × 2 = 3)–19.4038 / –7.8013

63.29 = $e^{2/3}$

63.24 = $e^{2/3}$

3% low

a	l
–16.4670	–4.8547
3.7059	1.8758
–2.8044	–6.9789
–14.9373	–4.3767
–3.8073	–2.6022
3)–11.1300	
–4.3767	
1.8758	
–2.2525	
.7475	

.02380 = a

.04001 = $\frac{l}{a}$

.02373 = a

.04013 = $\frac{l}{a}$

55.91 = $\frac{1}{pa}$

56.15 = $\frac{1}{pa}$

$(1 + .849 \frac{l}{a})$ = 1.03397

Log = 014508 × 3 = 2)043524 / .02176

7019
02176
68014 (sic)

e = 4.768

Brainy in every particular

58/ Friday Apr. 12, 1912 $\theta = 23.09$ $p = \frac{94.37 \; 19.03}{75.28}$

Second Observation at 10:35 - 10:25 PM

832.0 + 13.8
836.0 + 13.1
838.0 + 12.9
817.5 + 15.0
837.5 + 13.0
837.0 + 13.0
4998.0 + 80.8 = 5078.8

This and 5 are among the very best

G		F
18.606		
18.732		
18.784		14.654
18.700		13.198
18.730	18.0	17.968
18.652	23.4 - 46.3	46.172
18.656	17.8	17.896
18.730		17.818
18.762	23.6 - 46.8	46.328
18.760	46.2	46.258
18.708	23.6 - 46.4	46.266
18.658	67.2	67.473
18.668	34.0 - 67.4	67.148
18.826	67.0	67.148
18.710		17.896
18.802		15.868
18.778		15.854
18.790		96.6 - (1)
		97.4 - (2)
		94.0 - (3)
		92.0 - (4)
		93.3 - (5)
		89.0 - (6)
		85.6 - (7)
		86.8 - (8)
		85.0 - (9)
		84.4 - (10)
		82.2 - (11)
		75.0 - (12)
18.846		
18.804	11.6 - 22.4	23.376
18.662	33.4 - 65.6	23.504
18.704		65.416
	119.4	118.970
22) 160.68		
18.730	$\frac{1}{18.73}$ .05339	x 1021 = v_1 = .25451

12.00 Midnight

831.0 + 14.1
835.0 + 13.2
836.5 + 13.1
816.5 + 15.1
836.5 + 13.1
836.0 + 13.1
4991.5 + 81.7
81.7
5073.2

$\frac{1}{4634}$ .02163
.3437 = .006874
$\frac{1}{17.857}$ = .05600
.03443 = .006886
.4636 .02157
.00680 = .00680
$\frac{1}{67.29}$ = .01484
.04104 = .006840
= .05588 .04421 = .006887
$\frac{1}{15.86}$ = .06300
= .06168 = .006853
$\frac{1}{15.0}$ = .001370
.04129 = .006882
within $1\frac{1}{2}$ of small division from lower plate
.02740 = .006850
.006871
= .008369
.006784
= .01605
(1) div

Diff. .6874 .6886 .6800 .6840 .6887 .6853 .6882 .6850 .6871 .6784 → .006851

votes in ... .6820 .6833 .6815 .6823 .6831 .6850 .6845 .6861 .6865 .6864 .6874 .6844

1%

$v_1 v_2 = .6844 \times 1021$ = .006988

$\left(1 + \frac{.644 \, b}{a}\right)$ = 1.03676
Log = .01568
3
2) .04704
.02352
$\frac{1}{2}$ .02352
.68188
e = 4.807
= 7301

G	F
	77.4 - (1) div
	76.0 (2)
	79.6 (3)
	77.8 (4)
	76.6 (5)
	77.4 (6)
	77.6 (7)
	80.4 (8)
18.830	622.8
	80.6 (1) div
	75.0 (2) div

5 minutes after the last set of long times

11:59 PM

Log = -3.8444
-1.3682
3.1987
-6.4109
-3.7054
-1.07043

-16.4209 -4.6547
3.7054 1.8767
-2.7365 .6.9780
-14.8689 -4.3415
-3.8444 -2.6365
3-11.0245 .04330
-4.2415 .0001.1605
1.6767 2185
-2.2182
6.7818

6050 = $\frac{1}{pa}$
6068
6078

.04343 $\frac{e^{1}}{a}$ = 5066
e = 5064
7045
7.6030
$e_1^{2/3}$ = 63.62
63.6353

8a

-2.7365
-1.3682

51)

Saturday Apr. 13, 1912 $\theta = 22.76$ $p = \frac{94.43}{1903} \, 75.40$

First Observation at 3:40 P.M. Volts at 3:15 P.M.

G	F	
39.510	31.4 − 62.1	61.970
39.816	19.2 − 37.4	37.536
39.978	14.6	27.154
39.876	14.0 − 27.4	37.146
39.836		21.0 (1)
		21.6 (2)
		23.3 (3)
		20.5 (4)
		21.2 (5)
		23.0 (6)
		20.4 (7)
		19.0 (8)
		169.0 −

$\frac{1}{62.09} = .01610$

$\frac{1}{37.59} = .02661$ } $\frac{.02663}{.12} = .01031$

$\frac{1}{27.180} = .03673$

} $\frac{.030913}{3}$ .010273

mean .01029

$\frac{1}{169} = .005917$

(6) → chronograph gives 129.696 for six distances − 173.0

857.0 + 13.0
843.0 + 121.4
841.0 + 121.6
821.0 + 14.8
841.5 + 121.6
840.5 + 12.7
5034.0 + 78.1
78.1
5102.1

.02502
.01610
4)04112
.01028

2502
2661
5)5163
.01033

.02503
.03673
6)06176
.010293

2503
5917
3)30937
.01031
1029
1033
1028
4)4121
.010294

$V_1 + V_2 = .010294$
× 1021
$V_1 + V_2 = .01051$
Log = −2.0216
−1.20386
3.1963
−6.42364
3.7074
−10.71624

39.994
~~40.456~~
5)19500
39.90
6

$\frac{1}{39.96} = .02502 \times 1021 =$

V_1 = .02545

Log = −2.4072

$\frac{1}{2}$ = −1.20364

4:00 P.M.

a
−16.4270
3.7074
−2.4075
−14.5419
−2.0216
3)−12.5203
−4.1734
1.8774
−2.0508
1.9492

l
−4.8347
1.8774
−6.9773
4.1734
−2.8039

.5202
6
$e_1 = 5.196$
$e_1 = 5.190$

.06367 = $\frac{l}{a}$
.06388 = $\frac{l}{a}$

.0001491 = a
.0001485 = a

8896 = $\frac{1}{pa}$
88.95 = $\frac{1}{pa}$

$e^{2/3}$
10.7157
2
3)−19.4314
−7.8105

6464 = $e^{2/3}$
6459 = $e^{2/3}$

.2% low

$\left(1 + .844 \frac{l}{a}\right) = 1.05406$

Log = .022866
3
4.068598
.0343

7157
.0343
.6814

e = 4.802

7a

54 Saturday Apr. 13, 1912
Second Observation at

$\theta = 2283$ Volts at 4:00 P.M.

$p = \frac{9443}{75.54}$

835.5 + 13.1
842.0 + 12.5
840.0 + 12.7
820.0 + 14.9
840.0 + 12.7
840.0 + 12.7
5018.5 + 78.6
-78.6
5097.1

G		F
25.980		14.756
26.216		14.796
26.198	18.6 - 37.2	36.984
26.102	18.6 -	
(12.4) (26.3) 26.090	47.6 - 94.2	94.054
(13.0) (26.2) 26.062	11.5 - 23.0	23.062
(26.2) 26.192	46.4 - 91.6	91.764
25.988	18.0 - 36.4	36.610
26.200		46.3 (1)
		47.3 (2)
		46.0 (3)
		46.4 (4)
		46.4 (5)
		45.2 (6)
		47.4 (7)
		45.0 (8)
		370.0

9)235.028
26.114
26.12

~~26.36~~ (Long)
~~26.10~~
~~26.16~~

$\frac{1}{14.78} = .06766$
$\frac{1}{37.15} = .02692$
$\frac{1}{94.25} = .01061$
$\frac{1}{23.06} = .04337$
$\frac{1}{91.95} = .01087$
$\frac{1}{36.66} = .02728$

$\frac{.04074}{5} = .008148$
$\frac{.1631}{2} = .008155$
$\frac{.3266}{4} = .008165$
$\frac{.03250}{4} = .008125$
$\frac{.01641}{2} = .008205$

$\frac{.02442}{3} = .008140$
6)48938
Mean of .008156

$\frac{1}{370} = .002703$

3823
6766
13)10589
.008149

3829
2692
8)6519
.008149

3827
1061
6)4888
8147

3827
4337
10)8164
8164

3827
1087
6)4914
.008190

3827
2728
8)6555
8194

3823
2703
5)4097
8194

8140
8147
8149
8164
8190
8194
8194
7)478
8168

$v_1 + v_2 = .008168 \times 10.21$
$= .008339$
Log = -3.9212
$\frac{1}{2}$ 11 -1.29575
-3.1963
-6.41525
2.7070
-10.70825

v_2 .00189

$\frac{1}{26.12} = .03827 \times 10.21$
$= v_1 = .039073$
Log = -2.5915
$\frac{1}{2}$ 11 = -1.29575

4:48 P.M.

5.108
4
$e_1 = 5.104$
$e_1 = 5.098$

$e^{2/3}$
7074
2
3)-1.94148
7.8049

63.82 = $e^{2/3}$
~~[illegible] = $e^{2/3}$~~

3.9 % low

$1 + .544 \frac{l}{a} = 1.04398$
Log = .01865
3
.05595
.06767

7070
.02767
.67993

e = 4.785

a	l
-16.4270	-4.8547
3.7070	1.8761
-2.5915	-6.9766
-14.7255	-4.2682
-3.9209	-2.7084
3)-12.8046	
-4.2682	
1.8781	
-2.1463	

.05110 = $\frac{l}{a}$
.0001854 .05134 = $\frac{l}{a}$
.0001844 .04
71.40 = l/a 71.48 l/a

(6a)

(5a)

Saturday Apr. 13, 1913 $\theta = 22.82$ $p = \frac{9450}{1888}$ 75.62 7566

Third Obs. at 5:05

Publish Volts at 4:50 P.M.

(Best one yet for all purposes)

834.5 + 13.4
840.5 + 12.6
839.0 + 12.8
819.0 + 14.8
829.5 + 19.8
839.0 + 12.8
5011.5 + 79.2 = 5090.7

G	F	
11.848	39.9–80.2	80.708
11.890	11.2–22.4	22.366
11.908	–22.0	22.390
11.904	11.2–22.4	22.368
11.882	70.6–140.9	105.474 (forb dis)
		(140.565)
11.906	39.9–78.6	79.600
11.838		34.798
11.816		34.762
11.776 (?)	34.4	34.846
11.840	14.8–	29.286
11.904	14.6–29.3	29.236
11.870	69.5–137.4	137.308
11.957	17.6–34.9	34.638
11.860		
11.846		22.104
11.917		22.268
11.910		500
		63.3 (2)
		62.6 (3)
		63.6 (4)
		61.8 (5)
		61.6 (6)
		61.4 (7)
11.918		374.8
	21.6	442.1
		19.704
11.870		19.668
11.888		
11.894	77.4– (?)	77.630
11.878	38.9–77.6	77.806
11.880	21.0–42.6	43.302
(3) 11.890		
11.888		

$\frac{1}{80.7} = .01236 + .08419 = .09655 \div 18$ — 5366

$\}\frac{.03234}{6} = .005390$

$\frac{1}{22.37} = .04470 + .08419 \div 24$ — 5371

$\}\frac{.037584}{7} = .005858$

$\frac{1}{140.8} = .007102 + .08419 \div 17$ — 5375

$\}\ .005348 = .005348$

$\frac{1}{79.74} = .01254 + .08419 \div 18$ — 5374

$\}\frac{.01616}{3} = .005387$

$\frac{1}{34.84} = .02870 + .08419 \div 21$ — 5376

$\frac{1}{29.29} = .03414 + .08419 \div 22$ — 5379

$\}\frac{.026872}{5} = .005375$

$\frac{1}{137.38} = .007268 + .08419 \div 17$ — 5380

$\}\frac{.021572}{4} = .005393$

$\frac{1}{34.68} = .02884 + .08419 \div 21$ — 5382

$\}\frac{.01623}{3} = .005410$

$\frac{1}{22.19} = .04507 + .08419 \div 24$ — 5386

$(1 + .344\frac{b}{a}) = 1.0240$
$\frac{1}{Log} = .01245$
$\frac{3}{.037245}$
$.01862$
6888
6.186
$e = 4.789$ 6802

$\frac{.04307}{8} = .005384$

$\frac{1}{500} = .002000 + .08419 \div 16$ — 5387

$\}\frac{.09629}{4}$ (?) $= .005421$

$\frac{1}{19.69} = .05079 + .08419 \div 25$ — 5399

$\}\frac{.03784}{7} = .005401$

$\frac{1}{77.69} = .01245 + .08419 \div 16$ — 5390

$\}\frac{.01079}{2} = .005395$

$\frac{1}{43.30} = .02364 + .08419 \div 20$

mean = .005386

5392

= mean = 5384

$v_1 + v_2 = 5384 \times 1.021$
$= .005497$
$\log = -3.7402$

$.08419 \times 1.021 = .08594 \div 16$ 5.555 $\log = -2.9337$, -1.46685

$\log = -3.7402$
-1.46685
3.1965
-6.40535
3.7063
-10.69905
50004
3
$e_1 = 4.9974$
$e_1 = 4.991$
e^5
-10.6988
2
-14.3976
7.7992
$62.98 = e^5$
$62.93 = e^5$

a
-16.4299
3.7063
-20.1337 (?)
-13.0600
-3.2740
$3) -13.3108$
-4.4399
1.87
3.3969 (?) 613

l
-4.8547
1.5736
-5.0961
-4.4398
-2.5382
$.03418$
$.024246$
$.002769$
$.0002751$

5.13
4.99

.35%
low

Error

(5a)