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 ONE:
October 1911-March 1912

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Pasadena, California

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

Administrative information

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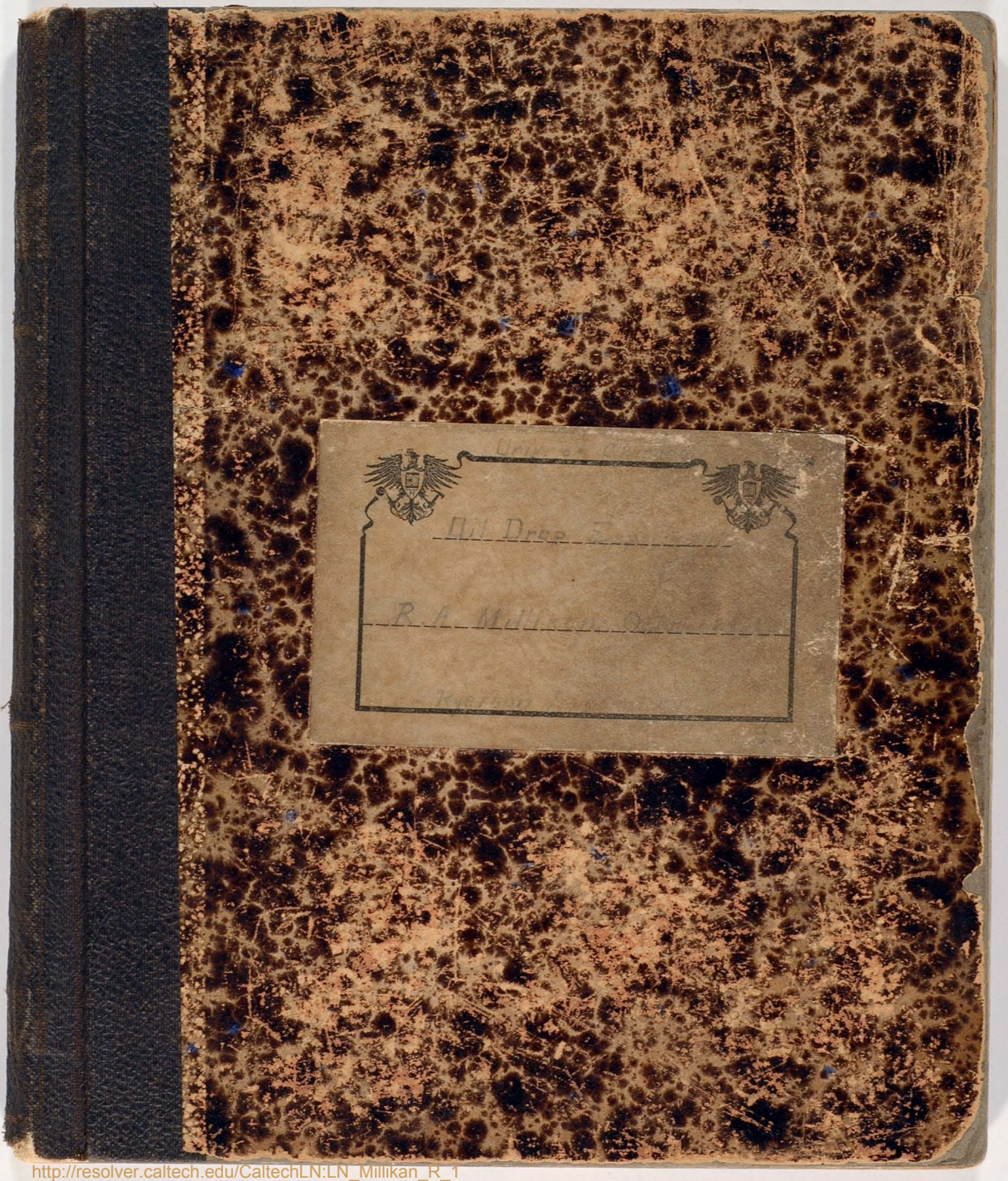
Preferred citation

Robert A. Millikan Oil Drop Experiment Notebooks. Lab Notes Online. California Institute of Technology Archives. Retrieved [supply date of retrieval] from the World Wide Web:
http://resolver.caltech.edu/CaltechLN:LN_Millikan_R_1

Contact information

Archives, California Institute of Technology
Mail Code 015A-74
Pasadena, CA 91125
Phone: (626) 395-2704 Fax: (626) 793-8756
Email: archives@caltech.edu



Thermometer Readings & Corrections—

Standard	Beckman	$\frac{1}{10}^{\circ}$ small stem (.15° low)	$\frac{1}{10}^{\circ}$ large stem
22.79	1.76		
22.81	1.78		
23.00	1.97	22.85	22.95 (?)

Corrections to Standard Thermometer.

	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
22°	-0.025	-0.025	-0.025	-0.025	-0.024	-0.024	-0.024	-0.023	-0.023	-0.023
23°	-0.023	-0.022	-0.022	-0.022	-0.022	-0.022	-0.021	-0.021	-0.021	-0.021
24°	-0.021	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020	-0.019	-0.019

605	14.0
685	16.2
725	18.0
750	18.0
800	16.0
805	15.8
810	15.6
815	15.2
820	14.8
825	14.5
830	14.1
835	13.6
840	13.2
845	13.0
850	12.9
855	12.8
860	12.8
870	12.9
880	13.3
896	13.8
900	14.4

590	12.8
555	8.0
540	6.5
447	0.0

Density of clock oil

10/28/11

By R. A. Millikan

Oil & bottle

Rest point 10.9 Wt. 20.171 Sens. 2 div per mg. temp 18°C

Bottle alone

Rest point 10.6 Wt. 10.9180

Water + Bottle

Wt 20.933 → temp 18° C

Wt of oil alone = 20.171 − 10.918 = 9.253

Wt of water alone = 20.933 − 10.918 = 10.015

Relative Wts = .9239

Absolute Wt = .9239 × .99867 = .9230

(.9656, .9941, 1.9647)

Determin. by L. J. Larrabee, 10/31/11.

Density at 14°C = 0.9252
" " 22°C = 0.9202

} ∴ Mean change per degree C. = .000625

(.0050, .9146)

Note:-

A correction of .004% per degree C. must be applied for change in viscosity of air. 23°C. is the temp. where no correction is needed. Below 23°, the correction must be subtracted.

A correction of .004% per degree must be applied for change in density of air. This correction can be applied with 23° as the point of no correction. It is also minus when the temp. is below 23°.

∴ Correction for (change of viscosity + change of density) = .0045% per degree C.

Saturday — 10/28/11. 3:30 P.M. to 4:30

(425)

Volts

	G
840. + 13.2	19.6
828 + 14.2	19.1
818 + 14.9	19.4
843 + 13.0	19.6
845 + 13.0	19.4
837 + 12.9	19.6
5011 + 81.2	19.3
81	
5092	

Lower field.

At Beginning

	19.4
	19.3
	19.4
	19.3
	19.5
	19.2
	19.6
	19.4
	19.3
	19.8
	19.6
	19.6
	19.6
	19.4
	19.3
	19.8

Middle of field.

5092
5039
53

Volts = 5052

Log = 3.7035

Weighted mean volts over this period = 5052 Volts

	19.8
	19.4
	19.5
	19.3
	19.7
	19.6
	19.6

Upper field.

Mean = 19.484

Volts 5039 At End.

F

Drop changed from Neg. to Pos. about middle of observation.

$t = 15.8$ $p = 20.51$

$\bar{1}.7187$	$\bar{1}.7187$	$\bar{1}.7187$	$\bar{1}.7187$
1.1523	1.3338	1.6035	2.7202
$\bar{2}.5664$	$\bar{3}.3949$	$\bar{2}.0782$	$\bar{4}.8985$

$\bar{1}.7187$
1.2897
$\bar{2}.4290$

$\bar{1}.7187$
0.9139
$\bar{3}.8643$

$\bar{1}.7187$
1.0056
$\bar{2}.7101$

$V_1 = \frac{.5232}{19.484} = 0.02685$

$V_2' = \frac{.5232}{8.2} = 0.0638$ (.02685 | 7 | 0.09065) 0.01295

$V_2'' = \frac{K}{10.2} = 0.0513$ (.02685 | 6 | 0.07815) 0.01303

$V_2''' = \frac{K}{14.2} = 0.03685$ (.02685 | 5 | 0.06370) 0.01294

$V_2'''' = \frac{K}{21.08} = 0.02482$ (.02685 | 4 | 0.05167) 0.01292

$V_2^{V} = \frac{K}{43.7} = 0.01201$ (.02685 | 3 | 0.03886) 0.01293

$V_2^{VI} = \frac{K}{525} = 0.000997$ (.02685 | 2 | 0.02585) 0.01927

where K = .5232

mean = 0.012926

Means

$(8.2)'$

$(10.2)''$

$(8.2)'_2$

$(10.2)''_1$

$(14.2)'''_1$

$(21.2)^{IV}$

(20.7)

$(43.8)^{V}$

$(43.2)^{V}$

$(8.6)'$

$(21.83)^{IV}_6$

$(43.7)^{V}_4$

$(525.0)^{VI}_1$

$(21.2)^{IV}$

$(21.2)^{IV}$

$(14.2)'''$

$(21.2)^{IV}$

$(44.2)^{V}$

$(21.0)^{IV}$

(75.0) Blown with 9 for one divis.

$(43.6)^{V}$

Explanation:-

$(10.2)''_1$ means the mean of 1 values of the 2nd speed.

and $(43.7)^{V}_4$ means the mean of 4 values of the 5th speed.

$\log V_1 + V_2 = \bar{2}.1115$
$\bar{1}.2145$
$\bar{3}.1983$
-6.5243
3.7035
-10.8208

6.619
.214
$6.405 = e$ 10^{-10}
$\log = -10.8182$

$e^{2/3}$

-10.8132
$\bar{2}$
3 | -19.6264
-7.8755

75.08×10^{-8}

l

-4.8548
1.3120
-5.5428

.0000349

a

-16.4327
2.4290
3.7035
-14.5652
-2.1115
3 | -12.4537
-4.1512

.0001417

$\frac{l}{a}$

-5.5426
-4.1512
-1.3914

.2463

(P)

Density of Clock oil

10/28/11

By R. A. Millikan

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Absolute Wt = .9239 × .99867 = .9230

9650
9941
19647

Determin. by P. J. Fassale, 10/31/11.

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" " 22°C = 0.9202

∴ Mean change per degree C. = .000625

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A correction of .0004% per degree must be applied for change in density of air. This correction can be applied with 23° as the point of no correction. It is also minus when the temp. is below 23°.

∴ Correction for (change of viscosity + change of density) = .0045% per degree C.

#26 Oct 28 10/28/11 - 4:30 P.M. to 5:40

Positive – Normal Color

Beginning

Volts

838 + 13.4
823 + 14.6
813 + 15.4
840 + 13.2
804 + 15.8
834 + 13.6
4952 + 87.0
87
5039

weighted mean 5027 Volts

log = 3.7013

End

837 + 14.5
821 + 14.7
812 + 15.4
840 + 13.2
780 + 17.0
833 + 13.6
4933 + 88.4
88
5021

	G
90	8.7
90	8.9
90	8.6
80	8.6
80	9.0
82	8.4
81	8.6
81	8.7
81	8.8
81	9.0
81	8.8
81	9.0
83	8.8
80	9.0
81	8.9
82	9.0
80	8.7
81	8.8
80	9.0
81	9.0
82	8.6
80	8.7
82	8.8
80	
83	
80	8.8
80	
82	9.0
81	8.9

Mean = 8.82
97
Corrd mean = 8.723

Weighted mean Volts here = 5027 Volts

F

T.7187 + 0.9407 = 2.7780
T.7187 + 1.0956 = 3.6201
T.7187 + 1.1933 = 3.5254
T.7187 + 1.4680 = 2.2567
T.7187 + 2.3284 = 3.3903

12.6	$(12.55)'_2$
12.5	
28.8	
29.2	
15.8	
15.8	
15.6	$(15.607)''_6$
15.6	
15.6	
15.6	$(29.97)'''_6$
29.2	
29.0	
28.8	
211.0	
215.0	$(213.0)^{IV}_2$

$t = 16.0$ $p = 21.58$

$V_1 = \frac{0.5232}{8.723} = 0.05998$

$V_2' = \frac{0.5232}{12.55} = 0.04170$ (.05998) 13 | 0.10168 — 0.00782

$V_2'' = \frac{K}{15.607} = 0.03353$ (.05998) 12 | 0.09351 — 0.007793

$V_2''' = \frac{K}{29.97} = 0.01806$ (.05998) 10 | 0.07799 — 0.007799

$V_2^{IV} = \frac{K}{213.0} = 0.00246$ (.05998) 8 | 0.06274 — 0.007805

mean = 0.007799

where K = .5232

$\log K_1 + V_2 = -3.8920$

$\frac{1}{2}\log V_1 = -1.3890$

-3.1983

-6.4793

3.7013

$\log e = -10.7780$

$C = (5.998 - .188)10^{-10} = 5.81 \times 10^{-10}$

$\log = -10.7642$

(P)

Stop watch corrn

26) 240 | 9.2
234
60

8.092 = 1.1% high

$e^{3/2}$

-10.7642
$\frac{2}{3}$
$3 \mid -19.5284$
-7.8428

69.63×10^{-8}

l

-4.8547
-1.3380
-5.5207

.0000 3317

a

-16.4327
-2.7780
-3.7013
-14.9120
-3.8920
$3 \mid -11.0200$
-4.3400

.0002188

$\frac{l}{a}$

-5.5207
-4.3400
-1.1807

.1516

(#27)

10/28/11 - 5:45 P.M. to 6:20

Red - Positive

$t = 15.8$ $p = 22.07$

Volts
5021
at Beginning

Weighted
Mean Volts =
4993 Volts

log = 3.6984

	G		F
Middle of field	15.2	151	
	15.4	148	
	14.7	151	
	15.1	150	
	14.9	149	
	15.1	147	
	14.9	153	
	15.2	151	
Lower field	14.9	152	
	15.1	151	
	15.2	151	
	15.1	149	
	15.2	146	
	15.0	146	10.4
		150	
Upper field	15.2	150	8.7
	15.0	151	8.8
	14.8	150	10.3
	14.9	151	13.4
	15.2	151	13.2
	14.8	151	18.3
	14.8	150	
Bottom			69.4
Middle			68.8
Top			69.3

← weighted mean here = 4993 Volts.

Mean = 15.033

Corrected Mean = 15.011

Slope heckt

checks
1502
(g. $\frac{1}{7}$ % high)

Volts at End
835. + 13.6
820 + 14.9
807 + 15.8
840 + 13.2
761 + 17.8
832 + 13.7
4895 + 89.0
89
4984

10.4, 8.7 → $(8.75)_2'$
8.8, 10.3 → $(10.35)_2''$
13.4, 13.2 → $(13.3)_2'''$
18.3 → $(18.3)_1^{IV}$
69.4, 68.8, 69.3 → $(69.17)_3^{V}$

$\bar{1}.7187$
1.1764
$\bar{2}.5423$

$\bar{1}.7187$
1.0149
$\bar{2}.7038$

$\bar{1}.7187$
1.1239
$\bar{2}.5948$

$\bar{1}.7187$
1.2625
$\bar{2}.4562$

$\bar{1}.7187$
1.8399
$\bar{3}.8788$

$\bar{1}.7187$
1.9420
$\bar{2}.7767$

$$V_1 = \frac{0.5232}{15.011} = 0.03486$$

$$V_2' = \frac{0.5232}{8.75} = 0.05980$$
.03486
9 | 0.09466
0.01052

$$V_2'' = \frac{K}{10.35} = 0.05056$$
.03486
8 | 0.08542
0.01068

$$V_2''' = \frac{K}{13.3} = 0.03934$$
.03486
7 | 0.07420
0.01060

$$V_2^{IV} = \frac{K}{18.3} = 0.02859$$
.03486
6 | 0.06345
0.01058

$$V_2^{V} = \frac{K}{69.17} = 0.00757$$
.03486
4 | 0.04243
0.01061

mean = 0.010597

where K = 0.5232

log $V_1 + V_2$ = −2.0252
$\frac{1}{2}$ log V_1 = −1.2711
−3.1983
−6.4946
3.6984
log e = −10.7962

$e = (6.255 - .203)10^{-10}$
$= 6.052 \times 10^{-10}$
log = −10.7819

$e^{2/3}$
−10.7819
2
3 | −17.5638
−7.8546

71.60 × 10^{-8}

l
−4.8542.
1.3441
−5.5101

.00003237

a
−16.4327
−2.5425
3.6985
−14.6737
−2.0252
3 | −12.6485
−4.2162

.0001645

$\frac{l}{a}$
−5.5101
−4.2162
−1.2939

.1967

(P)

Nov 17/11

Newtelescope (Goertner) Focal distance 13.94 mm
Tem 21.7

C.	F.
22.6	502
22.6	504
22.4	344
22.6	344
22.55	

P = atmos. = 74.0 cm.

$V_1 = \frac{13.94}{23.55} = .06161$

$V_2 = \frac{13.94}{50.3} = .02771$

$V_3 = \frac{13.94}{344} = .04052$

1.08952
.01279
.06161
8.10233
.01279

.1443
1.5366
2.6077

Volts
837 +13.6
818 +15.0
828 +14.6
803 +16.0
774 +17.3
832 +13.8
489.6

4892
90
4982

$\log(V_1+V_2) = \bar{2}.1069$

$\frac{1}{2}\log V_1 = \bar{1}.3956$

-3.1983

$\bar{6}.7008$

3.6974

-9.0034

8.025×10^{-9}
.947
$7.978 \cdot 10^{-9}$

$\log V_1+V_2 = \bar{3}.9519$
$\frac{1}{2}\log V_1 = \bar{1}.3956$
-3.1983
$\bar{5}.5458$
3.6974
-9.8484

70.54

Nov. 18, 1911.

18 small divisions, starting from 2nd long division at bottom of field.

$t = 18.0\ ^\circ C.$

$p = 73.95$ cm.

G	F			
17.0	8.9			
17.2				
17.1		→ 8.83	0.1048 + 1.2287 = .8761	$V_1 = \frac{1.273}{16.93} = 0.075\,18$
16.9	8.6			
16.9	9.0		0.1048 + 0.9460 = T.1588	$V_2 = \frac{1.273}{8.83} = \frac{0.14410}{0.21928 \div 7}$
17.1	9.9			
	10.3			
	10.1		0.1048 + 1.0025 = T.1023	$V_2' = \frac{1.273}{10.06} = \frac{0.1266}{0.20198 \div 3} = 0.005605$
	10.2			
	9.8	10.06	1.0045 + 1.2148 = .8900	$V_2'' = \frac{1.273}{16.4} = \frac{0.07762}{0.15280 \div 27} = 0.005658$
16.8				
16.9	9.9			$V_2''' = \frac{1.273}{29.6} = \frac{0.04300}{0.11518 \div 21} = 0.005621$
16.8	10.2		0.1045 + 1.4713 = .6335	
17.0				
17.3	16.6			
	16.2	16.4	0.1048 + 1.9360 = .1688	$V_2'''' = \frac{1.273}{86.3} = \frac{0.01475}{0.08993 \div 16} = 0.005621$
16.8	16.4			
16.7			0.1048 + 2.5607 = T.5441	$V_2''''' = \frac{1.273}{363.7} = \frac{0.00350}{0.07868 \div 14} = 0.005620$
17.0	29.4	29.6		
17.0	29.8		0.1048 + 2.1436 = T.9812	$V_2'''''' = \frac{1.273}{139.2} = \frac{0.009145}{0.08432 \div 15} = 0.005622$
17.0	86.3	→ 86.3		
16.8	363.7	→ 363.7		
16.6	139.2	→ 139.2		

mean = 16.93

weighted mean = $(V_1 + V_2)$ from last 4 readings = 0.005622

$\log V_1 + V_2 = \bar{3}.7449$

$\frac{1}{2}\log V_1 = \bar{1}.4381$

$= 3.1983$

-6.3863

3.7084

$\bar{1}0.6779$

Not sure of distance 1.273

4375

Very low Something wrong

Volts

847 + 13.0

837 + 14.5

809 + 15.7

850 + 13.3

838 + 14.5

845 + 13.0

5026 84.0

5110

12.78 = dist between cross-hairs

mm = 1.273 cm

log 5110 = 3.7084

log 1.273 = 0.1048

Mon. Nov. 20, 1911.

$p = 75.22$

$t = 17.6$

Volts	G	F
849 + 13.2	45.7	37.2
842 + 13.5	45.9	
813 + 15.4	45.6	
853 + 13.5	46.1	37.4
836 + 14.4	46.2	
846 + 13.0	45.8	37.3
5039 + 82.0	46.4	76.1 = 17 div. 76.1
82	45.96	31.4 = 7 div.
5121 = Volts		

1.6624

37.3 1.5705

1.8814

$V_1 = \frac{1.357}{45.96} = .02953$

$V_2 = \frac{1.357}{37.3} = .03638$ .02953 .06591

$V_2' = \frac{1.357}{76.1} = 0.1783$ .02953 .04736

0.1326 + 1.6624 = 2.4702

0.1326 + 1.5717 = 2.5509

0.1326 + 1.8814 = 2.2512

$\log 5121 = 3.7094$

dist. between cross-hairs = 1.357 cm.

$\log (V_1 + V_2) = -3.9752$

$\frac{1}{2}\log V_1 = -1.2351$

3.1983

-6.4086

3.7094

10.6992

Mean $V_1 + V_2 = .05444$

$e_1 = 5.002$

Very low. Something wrong. Found most of distances to fine hole did not agree. Took most to focus.

5:30 P.M. ← 11/22/11 Big Telescope all fixed up anew

$t = 18.0$

$p = 75.0$ dist. = 10.23

Volts - at 6:00	G	F
848 + 13.2	9.9	19.1
840 + 13.8	10.2	19.0
821 + 14.7	10.1	19.0
854 + 13.5	10.1	19.0
845 + 13.3	10.1	17.2
844 + 13.1	10.2	17.5
5052 + 81.6	10.1	58.0 → 58.0
82	9.9	83.6 → 83.6
5134	10.0	145.8 → 147.1
log 5134 =	10.1	(47 = (one for 4 add.)
3.7104	10.4	1484
	9.9	56 times for 8/3
	10.0	
	10.0	
	10.2	
	9.9	
	10.1	
	10.1	
	9.9	

19.025 = 19.0 19.0 19.0 19.0

17.35 = 17.2 17.5

0.0098 + 1.0000 = T.0098

$V_1 = \frac{1.023}{10.098} = 0.1013$

$V_2 = \frac{1.023}{19.025} = \frac{1.023}{0.05376}$ 0.05506 ÷ 30 = 0.005202

0.0098 + 1.2793 = 2.7305

$V_2' = \frac{1.023}{17.35} = \frac{1.023}{0.05897}$ 0.16127 ÷ 31 = 0.005202

0.0098 + 1.2392 = 2.7706

$V_2'' = \frac{1.023}{58.0} = \frac{1.023}{0.01765}$ 0.01995 ÷ 23 = 0.005215

0.0098 + 1.7634 = 2.2464

$V_2''' = \frac{1.023}{83.6} = \frac{1.023}{0.01224}$ 0.11454 ÷ 22 = 0.005206

0.0098 + 1.9222 = 2.0876

$V_2'''' = \frac{1.023}{147.1} = 0.006954$ 10930 20 | 0.109254 = 0.005202

0.0098 + 2.1676 = 3.5422

Mean = 0.005206

Mean = 10.058 − .058 Stiffwetel correction = 10.000

$\log (V_1 + V_2) = \bar{3}.7165$

$\frac{1}{2}\log V_1 = 7.5049$

$\bar{3}.1983$

-6.4197

-6.4198

3.7104

-10.7094

$e = 5.121$ 115

$e = 5.006$

Wednes – 11/22/11 → 4:15 P.M.

4:45 P.M.

Volts	G	F
855 + 13.5	16.2	12.2
849 + 13.2	15.9	12.3
835 + 14.4	16.2	
861 + 12.9	16.0	20.2
854 + 13.5	16.0	100.2
852 + 13.5	16.2	
5106 + 80.0	= 16.083 = Mean	
80		
5186		

log 5186 = 3.

$t = 17.5$ $\quad p = 75.0$ $\quad dist = 10.23\,mm$

12.25

.0098 / 1.2063 / 2.8036

$V_1 = \frac{1.023}{16.083} = .06362$

.0098 / 1.0981 / 2.9218

$V_2 = \frac{1.028}{12.25} = .08352$ $\quad 6362$ $\quad .14714$

.0098 / 3.0334 / 2.7045

$V_2' = \frac{1.023}{20.2} = .05065$ $\quad 6362$ $\quad .11427 \div 17 = 006722$

.0098

$V_2'' = \frac{1.023}{100.2} = .01021$ $\quad 6362$ $\quad .07383 \div 11 = 006712$

mean = 006717

$\log V_1 + V_2 = \bar{3}.82791$

$\frac{1}{2}\log V_1 = -1.4018$

$\bar{3}.1983$

-6.4272

3.7148

10.7124

$e = 5.158$ $\quad 1.58$ $\quad 5.030$

11/22/11 → 5:10 P.M.

5:25 P.M.

Volts	G	F
850 + 13.2	35.2	25.7
844 + 13.4	35.2	25.2
827 + 14.0	35.4	49.8
857 + 13.2	35.2	49.8
848 + 13.1	35.2	50.0
846 + 13.1	35.4	147. = 5 small divisions
5072 + 80.0	35.267 = Mean	
80		
5157		

log 5157 = 3.7124

$t = 18.3$ $\quad p = 75.0$ $\quad dist = 10.23$

49.867

0.0098 / 1.5473 / $\bar{2}$.4625

0.0098 / 1.3160 / $\bar{2}$.6938

0.0098 / 1.4057 / $\bar{2}$.6041

0.0098 / 1.6979 / $\bar{2}$.3179

0.0098 / 3.3715 / $\bar{4}$.6383

$V_1 = \frac{1.023}{35.267} = 0.02901$

$V_2 = \frac{1.023}{25.7}$ $\quad 0.02901$ $\quad 0.04941$ $\quad 0.07852$

$V_2' = \frac{1.023}{25.45} = 0.02901$ $\quad 0.04019$ $\quad 0.06920 \div 7 = 009885$

$V_2'' = \frac{1.023}{49.867} = 0.02901$ $\quad 0.02051$ $\quad 0.04952 \div 5 = 009904$

$V_2'' = \frac{1.023}{147 \times 16}$

$= \frac{1.023}{2352} = 0.02901$ $\quad 0.00043\,48$ $\quad 0.02944\,48 \div 3 = 009815$

$\log(V_1 + V_2) = \bar{3}.9958$

$\frac{1}{2}\log V_1 = \bar{1}.2318$

$\bar{3}.1983$

-6.4254

3.7124

-10.7136

$e = 5.165$ → correction

$.105$

$e\ 5.057$

Thurs - 11/23/11 5:10 P.M. $t = 20.5$ $P = 75.05$

Volts at 5:00	G
	16.8
853 + 135	16.8
855 + 135	16.6
829 + 140	17.0
860 + 135	16.9
851 + 135	16.6
852 + 135	17.0
5100 + 810	16.6
810	16.8
5910	16.6
	16.8
	16.5
	17.0
	16.769

F	
15.6 → 15.6	
12.9 → 12.9	
39.15 → 39.03	
53.0	52.6
52.2	
39.0	
26.0	
25.7	25.73
25.5	
39.0	

$V_1 = \frac{1025}{16.769} = .06113$

$V_2 = \frac{}{12.9} = .07945 - .06113 = .01832$

$V_2' = \frac{}{39.03} = .02626 - .06113 = .00739 \div 13 = .000722$

$V_2'' = \frac{}{52.6} = .019485 - .06113 = .080615 \div 12 = .006718$

$V_2''' = \frac{}{25.73} = .03483 - .06113 = .00096 \div 15 = .006731$

mean $V_1 + V_2 = .006724$

$\text{Log } V_1 + V_2 = \bar{3}.8277$

$\frac{1}{2}$ " $V_1 = \bar{1}.3931$

3.1983

-6.4191

3.7142

10.7059

$e_1 = \frac{5.080 \quad 5.6}{5.024}$

29.1 low

11/23/11 – 5:40 PM.

$t = 21.5$
$P = 75.05$

Volts at 5:30

850+
851+
820+
860+
847+
849+
5077

G	F
12.8	
12.3	
12.8	
12.4	
12.8	
12.8	
12.8	
12.8	
13.0	
12.8	
13.0	12.4
13.2	
12.9	17.2
13.1	17.4
12.9	24.3
12.8	24.5
12.8	24.8
12.8	
12.9	
12.80	

Volts at 6:00

847+
845.+
818+
858+
843.+
848+
5183.

$v_1 = \frac{1.025}{12.91} = .08194$ (.0107, 1604, −2899)

$v_2 = \frac{1.025}{19.3} = .05925$ (.0107, 2380, −2.7727)

$.08194 + .05925 = .14129 \div 2 = .07065$

$v_3 = \frac{1.025}{24.53} = .04178$ (.0107, 3897, −2.6210)

$.07065 + .04178 = .11243 \div 2 = .05621$

mean = .06343

$\log v_1 + v_2 = \bar{3}.7636$
$\frac{1}{2}\log v_1 = \bar{1}.4518$
3.1983
-6.4137
3.7146
-10.1283

5.0041
34
4.967

3% low

Tues.- Nov. 28, 1911

$t = 21.3\ ^\circ C.$
$p = 75$

Volts	G	F
823+14.6	(5) 19.0	
800+16.0	" 19.0	
791+15.6		
827+	(5) 18.8	
797+	" 18.8	
825+	" 18.8	9.0
	" 19.2	45.2
		45.1
		45.2
		45.1

Sat., Dec. 9, 1911.

$t = 24.0$
$p = 75.23$
dist. in between cross-hairs = 1.022 cm.

Volts	G	F
	(S) 26.6	
	(S) 26.4	
838. +13.4	(S) 26.2	11.1
840 +13.2		
826 +14.4		19.8
853 +12.8		20.1
845 +13.0		
824 +14.5	(S) 26.2	29.4
5026 +81.3	(S) 26.5	
81		
5107	(S) 26.1	56.4

log 5107 =

Mean of G(S,W) = 26.33

Mean of F(C) = 26.06

Note.
Manometer has gotten air into it. The correction that must be applied on this account at pressure of 73.63 (on manom.) is + 1.18 cm.

12/9/11

$t = 24.4$

$p = 76.73$

dist = 10.06

Volts	G	F
829 + 14.2	22.2	
832 + 13.9	21.8	
795 + 15.8	22.1	17.2
845 + 13.0	22.2	46.9
827 + 14.3	22.0	151.6
818 + 15.0	22.0	70.6
4946 / 86.2	22.0	71.6
50322	22.043	71.8
	21.898	71.4
	22.076	71.4
	21.996	152.8
	21.960	
	22.008	
	22.036	
	22.060	
	22.156	
	176190 / 22.024	

slight curve

chromatic aspirin

$v_1 = \frac{10.06}{22.024} = .045\,67$ — .0025, 1.3429, 2.6596

$v_2 = \frac{10.06}{152.2} = .0066\,09 = .05\,228$ — .0025, 2.1824, 3.8201

$v_2' = \frac{10.06}{71.36} = .0\,1469 = .0\,5977$ — .0025, 1.8535, 2.1490

$v_2'' = \frac{10.06}{46.7} = .0\,2144 = .0\,6911$ — .0025, 6717, 2.3313

$v_2''' = \frac{10.06}{1967} = .0\,5114 = .0\,9681$ — .0025, 1.2939, 2.7086

$v_2'''' = \frac{10.06}{17.2} = .0\,5847 = .10474$ — .0025, 2355, 2.7670

7) .05228 — 007468

8) .05977 — 007471

9) .06711 — 007457

13) .09681 — 007447

007424

mean $v_1 + v_2 = .007462$

$\log v_1 + v_2 = -3.8728$

$\frac{1}{2} \log v_1 = -1.3298$

3.1983

−4.4009

3.7018

10.6991

5.001

32

5.033 which is 3.2 %, low

12/9/11

Item 24.25 $\rho = 75.23$ $d = 1022$

G F

~~26.50~~

5,300	9.116	c	9.4
5,209	9.046	c	
5,266			
5,274	9.270	c	
5,260	9.400	c	
5,190			
5,268	9.516	c	
5,194			
5,116			
5,198			
5,238	30.6	s	30.6
5,224	~~39.69~~	c	39.5
5,350	39.2	s.w	
5,260			
5,186			
5,362			

~~44.6~~	s.w	45.3
45.1	s.w	
45.8	s.w	
45.6	s.w	

5,270
~~5,446~~
19/89100
5.245
minus 1%
= 5.192

829 + 14.2
831 + 14.0
803 15.9
842 + 13.1
827 + 14.3
816. + 15.1
4948. 86.6
86.6
5034.6

.00094 / 0.71454 / 1.293 $V_1 = \frac{1.022}{5.192} = .19663$

.00094 / 6561 / .3533 $V_2 = \frac{1.022}{4.55} = .02246$
.19663
.21909 ÷ 60 = .003658

.00094 / 5966 / 1.26 $V_2' = \frac{1.022}{9.92} = .02607$
.19663
.22270 ÷ 61 = .003654

.00094 / 4437 / 5237 $V_2'' = \frac{1.022}{30.6} = .03340$
.19663
.23003 ÷ 63 = .003651

.00094 / 9633 / .0419 $V_2''' = \frac{1.022}{9.28} = .1101$
1966
3067 ÷ 83 = .003695

mean $v_1 + v_2 = .003661$

$\log v_1 + v_2 = -3.5684$
$\frac{1}{2} \log v_1 = -1.6469$
3.1483
-6.4076
3.7020
10.7020

5.035

Unfortunately this cannot be counted since number is uncertain but must get some of these rapid speed with chronograph and 10000 volts.

Sat., Dec. 16, 1911.

$t = 17.5°C.$
$p = 75.14$

dist. = 1.022 cm.

Volts	Stop watch G	Stop watch F	Chronoscope G	Chronoscope F
844 + 13.0	25.2	32.8	212.86	
847 + 13.0	25.2	26.3	87.45	
823 + 14.6	25.2	26.4	125.41	
850 + 12.9	25.4	33.2		
840 + 13.2	25.6	32.9		
673 + 16.8				
4977 + 82.7				
83				
4960				

log 4961 = 3.

Volts	S.W. G	S.W. F
4945	107.4	41.3
log 4945 = 3.	107.3	41.2

Sat., Dec. 16, 1911

dist = 1.022 cm.

$t = 17.5$
$p = 75.4$

Sat., Dec. 16, 1911. dist. = 1.022 cm. t = 17.5 °C. p = 76.18 cm.

Volts
838 + 13.3
839 + 13.3
822 + 14.6
846 + 13.0
834 + 13.7
670 + 17.2
4849 + 85.0
45
4934

Stop watch G	Stop watch F	Chronoscope G			Chronoscope F		
		159.61	268.23	172.52	66.56	222.52	264.64
29.9		10.67	59.61	23.34	8.23	79.88	71.61
30.0		148.94	148.62	149.18	58.33	142.64	193.04
30.0		"	"	"	"	"	"
29.9		29.788	29.724	29.836	11.666	28.528	38.608
29.6							
29.8	38.4	171.61	213.66	162.89	211.34		
30.2		22.52	64.65	13.66	62.99		
	28.9	149.09	149.01	149.23	148.49		
29.9		"	"	"	"		
	56.9	29.818	29.802	29.846	29.698		
29.9	29.0						
29.6	38.6	159.63					
29.4	38.9	11.38					
		148.25					
G. sw mean 29.8	38.8	"					
	23.2	29.650					
	57.8						

29.788
29.724
29.836
29.818
29.802
29.846
29.698
#208512
G. c. mean 29.780
8)238162
29.770

Means.

	sw	c
G.	29.80	29.780
F.	38.685	38.608
T.	28.95	28.53

.0094 .4734 .3356 $v_1 = \frac{1.022}{29.78} = .03433$

.0094 .5470 .4224 $v_2 = \frac{1.022}{38.64} \cdot \frac{.02650}{.03433} = .06088 \div 7 = .008698$

.0094 .7386 .2508 $v_2' = \frac{1.022}{57.35} \cdot \frac{.01782}{.03433} = .05215 \div 6 = .008691$

.0094 .4583 .5509 $v_2'' = \frac{1.022}{28.74} \cdot \frac{.03556}{.03433} = .06989 \div 8 = .008736$

~~$v_3 = \frac{1.022}{}$~~

.0094 .3655 .6439 $v_3''' = \frac{1.022}{23.2} \cdot \frac{.04404}{.03433} = .07637 \div 9 = .008701$

.0094 .0670 .1942 $v_3'''' = \frac{1.022}{11.666} \cdot \frac{.03758}{.03433} = .12191 \div = .008708$

mean $v_1 + v_2 = .008691$

$\log_{10}(v_1 + v_2) = -3.9391$
$\frac{1}{2}\log_{10} v_1 = -1.2678$
3.1483
6.4052
3.6932
10.7120
5152
128
5.024

This is 4 % low.

Mon. - Dec. 18, 1911. | d = . | t = 18.1 °C. p = 76.36 cm.

Volts	G	F
847 + 13.0	(s) 37.6	(s) 10.5
846 + 13.0	(s) 37.9	
828 + 13.9	(s) 37.8	(s) 10.0
849 + 12.9	(s) 37.9	
840 + 13.2	(c) 37.69	(s) 24.2
709 + 16.8	(s) 38.0	(c) 14.48 ?
		(s) 24.0
	(c) 38.23	(s) 24.4
	(s) 38.2	(c) 24.51
	(s) 38.2	(s) 46.4
	(s) 38.2	

Mon. Dec. 18, 1911 | d = | t = 18.0° C. p = 76.83

G	F
(s) 32.0	(s) 14.8
(s) 32.6	(s) 16.2
(s) 32.2	(s) 19.8
(s) 32.1	(s) 24.9
(s) 32.2	(s) 27.8
(s) 32.6	

Volt dropping

Tues. Dec. 19, 1911. Pos. and reddish | d = ——— | t = 21.0 C. p = 76.13 cm.

F

Commenced observ. at 2:00 P.M.
Ended obs. at 2:20

G	F
(s) 26.9	(c) 8.07
(c) 27.34	(s) 20.7
(s) 27.3	(s) 31.2
(c) 27.39	(c) 43.17
(s) 27.4	
(c) 27.37	
(s) 27.3	
(c) 27.35	
(s) 27.5	

Volts at 2:00 P.M.

856 + 12.8
858 + 12.8
842 + 13.2
860 + 12.8
852 + 12.9
858 + 12.8
5126 + 77.3
77
5203

Volts at 2:20 P.M.

846 + 13.0
848 + 13.0
834 + 13.7
857 + 12.8
849 + 12.9
855 + 12.8
5089 + 78.2
78
5167

Tuesday, Dec. 19, 1911 | d =

$t = 21.0°C.$
$p = 76.34$

Readings from 2:40 to 3:00

Volts at 4:05 P.M.

844 + 13.0
845 + 13.0
829 + 14.2
852 + 12.9
843 + 13.1
849 + 13.0
5062 + 79.2
79
5141

G	F
(s) 31.8	
(s) 31.8	(s) 19.9
(c) 31.56	(s) 14.8
(s) 31.6	
(c) 31.70 {1/3 adjusted}	(s) 24.4
	(s) 14.6
(c) 31.62	
(s) 31.6	(s) 31.6
(c) 31.53	(s) 44.4
(s) 31.8	(c) 31.54
	(s) 73.7
(c) 31.76	(s) 44.2
(s) 31.7	

Tues., Dec 19, 1911 $\left\{ d = \frac{G}{F} = 8 \text{ divisions} \right.$ $t = 21.6^\circ C.$ $p = 76.46$

Readings from 3:15 to 3:59 P.M.

1st (s) 63.6 = 1 division time
2nd (s) 78.2 = 1 division "
3rd (s) 56.6 = 1 division "
4th (s) 68.6 = " " "
5th (s) 44.0 = " " "
6th (s) 60.0 = " " "
7th (s) 66.0 = " " "
8th (s) 66.8 = " " "
(s) 63.0 = " " " 31.8 = 8 divs. time.
1st (s) 45.2 = " " "
(s) 46.0 = " " "
to (s) 50.8 = " " "
(s) 55.0 = " " "
(s) 58.2 = " " "
8th (s) 58.0 = " " "

31.8 = 8 divisions

1st (s) 38.8 = " " "
2nd (s) 45.0 = " " "
3rd (s) 49.0 = " " "
4th (s) 54.6 = " " "

Thus work on varying close distances done used whether there were appreciable convection currents. The results indicate that there were. Must look more carefully hereafter into problem of rooms.

Thurs. Dec. 19, 1911 { d = } t = 22.5 °C. p = 77.38 cm.

5:55 to 6:12 P.M.

Volts at 6:15

841 + 13.2
841 + 13.2
817 + 15.0
846 + 13.0
834 + 13.7
840 + 13.2
5019 + 81.3
81
5100

G

(s) 27.4
(s) 27.6
(c) 27.74
(s) 27.6
(s) 27.9
(c) 27.72
(c) 27.85
(c) 27.60
(c) 27.76
(c) 27.76
14.2 = (s) time 1st ½ dist.

27.76
27.76
27.60
27.85
27.72
27.74
4.43
74

mean = 27.74

(s) 72.1
(s) 72.2
(s) 45.7
(s) 25.7
13.2 = time 1st ½ dist.
s 33.4
17.0 = time 1st ½ dist

F

.0094 / 14431 / 2.5663 $V_1 = \frac{1022}{27.74} = .03684$

.0094 / 8582 / 1512 $V_2' = \frac{1022}{7215} = .01416$ / 3684 − .05100 ÷ 6 = .008500

.0094 / 4049 / 2.5945 $V_2'' = \frac{1022}{2517} = .03477$ / 3684 − .07661 ÷ 9 = .008512

.0094 / 5233 / 4827 $V_2''' = \frac{1022}{3341} = .03060$ / 3684 − .06744 ÷ 8 = .008430

$\frac{1022}{457} = .02236$ / 3684 − .05920 ÷ 7 = .008457

mean $V_1 + V_2$ = ~~.04~~ .03848

$\log V_1 + V_2 = \bar{3}.9284$
$\frac{1}{2}\log V_1 = -1.2831$
3.1983
~~3~~ 4098
3.7076
10.7022

5038
11
~~5039~~
5.027

about 3½ % low.

Wednes., Dec. 20, 1911. { d = } { t = 22.8° C. p = 76.9 }

obs. from 3:30 to 3:45 P.M.

Volts at 3:15 P.M.

852 + 12.9
853 + 12.9
839 + 13.2
859 + 12.8
848 + 12.9
857 + 12.8
5108 + 77.5
76
5184

Volts at 3:50 P.M.

849.5 + 12.9
851.5 + 12.9
826 + 14.5
855 + 12.8
844 + 13.0
854 + 12.8
5080.0 + 78.9
79
5159

G

(s) 29.8 / 14.6 = 1st half distance

(s) 29.8 / 14.9

(s) 29.8 / 14.9 = 1st 1/2 dist.

(s) 30.1 / 15.2 = 1st 1/2 dist.

s 29.6 / 14.6 = 1st 1/2 dist.

(c) 29.84

(c) 29.89

s 30.2 / 15.21 = 1st 1/2 dist.

s = 29866
c = 29865

F

(s) 7.4

(s) 11.3

(s) 102.8 / 50.2 = 1st 1/2 dist.

.00094
.47351
2.5345

$v_1 = \frac{1.022}{29.86} = .03422$

$v_2 = \frac{1022}{101.6} = .01006$

$v_1 + v_2 = .04428 \div 5 = .008856$

$\log v_1 + v_2 = 3.9472 = 1.2672$

$\frac{1}{2} \log v_1$ 3.1983
6.4127
3.7126
10.7001

5013
22
4.991

Conditions throughout were particularly good & results should be more than usually reliable. Air kept temp. constant much as a precaution not necessary taken in room 12 but found

yesterday to suggest constant

Wednes., Dec. 20, 1911. | d = | t = 22.2°
p = 78.03 cm.

pos. drop. Volts at 4:30 P.M.

847 + 13.0
849 + 12.9
820 + 14.8
852 + 12.9
841 + 13.2
851 + 12.9

50 60 + 79.7
80
5140

Obs. taken from 4:20 to 4:30 P.M.

G

(s) 14.0
(s) 14.0 7.0 = 1st ½
(c) 14.11
(e) 14.28
(c) 14.11
(c) 14.13
(c) 14.02
(c) 14.00
(c) 14.18
(c) 13.95
(c) 13.89

11) 15 4 5 9 | 14.05

14.0
14.11
13.89
13.95
14.00
14.02
14.13
14.11
14.18
6) 3 5 9 | 14.074

F

(s) 29.2 at top of field
(s) 28.8 / 14.4 = 1st ½ div
(s) 28.7 / 14.6 = 1st ½ div
(s) 24.2
(s) 24.6
(s) 24.7
(s) 24.6 — 24.5
(s) 43.6
(s) 44.4
(s) 45.1
(s) 45.6 — 4) 1787 / 44.68
(s) 102.6
(s) 104.0
(s) 104.0 — 104.1
(s) 105.8 / 52.4 = 1st ½ div.

.0044 / 1476 / 2618 $v_1 = \frac{1022}{14.05} = .072744$

.0044 / 0174 / 4920 $v_2 = \frac{1022}{104.1} = .009817$ → .08256 ÷ 13 = .006351

.0044 / 6501 / 3593 $v_2' = \frac{1022}{44.68} = .02288$ → .09562 ÷ 15 = .006375

.0044 / 3892 / 6202 $v_2'' = \frac{1022}{24.5} = .04171$ → .11445 ÷ 18 = .006358

.0044 / 4609 / 5485 $v_2''' = \frac{1022}{28.9} = .03536$ → .10810 ÷ 17 = .006359

.006351
.006375
.006358
.006359
4) .025443
.006361 = mean $v_1 + v_2$

$\log v_1 + v_2 = -3.8036$
$\frac{1}{2} \log v_1 = -1.4309$
3.1983
6.4328
3 7110
10.7218

5.270
19
5.251

There is a good drop and a high

Wednes., Dec. 20, 1911 { d =

t = 22.3°C.
p = 78.23 cm.

obs. from 4:45 to 5:30 P.M.

Volts at 5:30 P.M.

841 + 13.2
844 + 13.0
817 + 15.0
851 + 12.9
840 + 13.2
856 + 12.9

5043 60.2
802
5123.2

G

(5) { 93.0 / 42.3 = 1 ax half

(5) { 96.7 / 48.7 = 1 ax ½ dist.

(5) { 96.2 / 49.0 = 1 ax ½ dist.

(5) { 96.2 / 48.7 = 1 ax ½ dist.

(5) { 95.5 / 49.0 = 1 ax ½ dist.

(5) { 93.0 / 49.0 = 1 ax ½ dist.

(5) { 92.0 / 46.0 = 1 ax ½ dist.

right in middle portion of field.

F

(5) 29.7

(5) { 51.5 / 26.0 = 1 ax ½ dist.

(5) { 97.4 / 49.0 = 1 ax (½) dist.

(5) { 28.7 / 14.6 = 1 ax ½ dist.

(5) { 51.0 / 26.0 = 1 ax ½ dist.

(5) 227.5

(5) { 29.0 / 14.8 = 1 ax ½ dist.

(5) { 232. / 106.0 = 1 ax ½ dist.

In middle portion of field.

In upper portion of field.

97	49.0
93.0	42.3
96.7	48.7
96.2	49.0
96.2	48.7
95.5	49.0
93.0	49.0
92.0	46.0
756.6	380.7
94.95	47.74

.0094
-1.9786
-2.0379

$v_1 = \frac{1022}{94.95} = .01077$

$v_2 = \frac{1022}{51.60} = .019806 - .010795 = .009011$ ... $.030584 \div 2 = .01529$

$v_2' = \frac{1022}{227.5} = .004492 - .010490 = -.005998$ ... $.015262 \div 1 = .01526$

$v_3'' = \frac{1022}{97.4} = .01049 - .010795 = -.000305$ ... $.045855 \div 3 = .01528$

$v_3''' = \frac{1022}{249.3} = .03508 - .010795 = .024285$

mean $v_1 + v_2 = .025705$

Sum $v_1 + v_2 = -2.1839$
$\frac{1}{2}$ " $v_1 = -1.0159$
3×1.9483
-6.3981
3×2.1327
-10.6486

$\sigma = 4.98 \times$ which means that this could not have been an arc Drop.

Wednes., Dec. 20, 1911

pos. drop.

$t = 22.2°C$

$p = 79.18$

Obs. from 5:45 to 6:15 P.M.

Volts at 6:20

845 + 13.0
846 + 13.0
814 + 15.3
850 + 12.9
839 + 13.2
847 + 13.0

5041. 80.4
80.4
5121.4

C	S
10.30	10.20
10.28	10.30
10.27	10.20
10.24	~~10.20~~
10.32	10.30
10.31	10.25
10.36	
10.25	
~~10.26~~	
10.26	
10.33	
10.24	
10.26	
~~10.286~~	
10.29	

G

(c) 10.30
(s) 10.20
(c) 10.28
(c) 10.27
(s) 10.30
(c) 10.24
(s) 10.20
(c) 10.32
(s) 10.3
(c) 10.31
(c) 10.36

(c) 10.28

~~(c) 10.23~~

(c) 10.28
(c) 10.26
(c) 10.33
(c) 10.24
(c) 10.26

F

.0044 1.0222 2.9978

$V_1 = \frac{1022}{10.29} = \frac{.09932}{.09931}$

.0044 9765 0326

$V_2 = \frac{1022}{94.8} = \frac{.01078}{.09932} - .11010 \div 21 = .005243$

.0044 8007 7087

$V_2' = \frac{1022}{63.2} = \frac{.01617}{.09932} - .11549 \div 22 = .005249$

.0044 6785 3309

$V_2'' = \frac{1022}{47.70} = \frac{.021431}{.09932} - .12096 \div 23 = .005260$

.0044 2193 .7991

$V_2''' = \frac{1022}{38.1} = \frac{.02683}{.09932} - .12615 \div 24 = .005256$

$V_2'''' = \frac{1022}{16.23} = \frac{.06298}{.09932} - .16230 \div 31 = .005231$

Diffs

11568	12095	12634	16249
11029	11566	12095	12634
10539	10527	10539	03615
			05165

mean diff = .005304

mean $V_1 + V_2$ = .005249 5

(s) 16.3
(s) 16.2
(s) 16.2
(s) 37.8 / 18.9 = 1 ~~ax~~ ½ diss
(s) 38
(s) 38.0 / 19.0 = 1 ax ½ diss
(s) 38.6 / 19.2 = 1 ax ½ diss.
(s) 47.6 / 23.9 = 1 ax ½ diss.
(s) 62.2 / 30.95 = 1 ax ½ diss
(s) 63.3 / 31.7 = 1 ax ½ diss.
(s) 63.3 / 31.9 = 1 ax ½ diss.
(s) 64.2
(s) 94.0 / 47.0 = 1 ax ½ diss.
95.6 / 49.4 = 1 ax ½ diss.

$\log V_1 + V_2 = -3.7206$
$\frac{1}{2}$ " $V_1 = -1.4986$
-3.1983
-6.4169
3.7094
$.7075$

5099 5096 — 5099 18 — 5081

This is almost exactly right + the best one I ever had !!!

An exactly balanced speed.

Never look better conditions than with this one. It was midway between plates and no indications of convection

Thursday Jan. 4, 1917.

Volts

1 –	857 + 12.8	869.8
2 –	862 + 12.8	874.8
3 –	~~823~~ 663 + 15.6	678.6
4 –	862 + 12.8	874.8
5 –	853 + 12.8	865.8
6 –	860 + 12.8	872.8
	4957 + 79.6	5036.6
	79.6	
	5036.6	

t = 17.2 p = 74.01 (1)

b

21.60 (S)
21.53 (C)
21.80 (S)
21.51 C
21.80 S
21.68

13.46 (C)
14.15 (C)

22.62 (C)

46.2 (S)

21.71 (C)

46. (S)

21.77 (C)

45.8 (S)

21.57 (C)

46.0 (S)

21.63

t = 17.2 p = 74.01-

volts

1- 853 + 12.8 = 865.8
2- 847 + 13. = 860.0
3- 825 + 14.5 = 839.5
4- 855 + 12.8 = 867.8
5- 842 + 13.1 = 855.1
6- 854 + 12.8 = 866.8
5076 + 79.0 = 5155.0
79
5155

.0094
3351
6743

$V_1 = \frac{1022}{21.63} = .04724$

$V_2 = \frac{1022}{46.0} = .02222$
.04724
.06946

$\log V_1 + V_2 = -2.8418$
$\frac{1}{2}\log V_1 = -1.3372$
-3.1983
5.3773
3.7122
9.6651

4625
122
9) 45.03
$e_1 = 5.003$

3½ % low

$t = 17.4$ $P =$

Volts

1 - 849 + 12.9 = 861.9
2 - 844 + 13.0 = 857.0
3 - 820 + 14.8 = 834.8
4 - 850 + 12.9 = 862.9
5 - 834 + 13.6 = 847.6
6 - 851 + 12.9 = 863.9

~~Volts~~ 5048 + 80.1 = 5128.1
801
5128.1

6.		7.	
17.2	(S)		
17.07	(C)		
17.3	(S)	14.99	(C)
17.51	(C)	42.7	(S)
17.48	(C)	42.4	(S)
17.46	(C)		
		32.7	(S)
		33.0	(S)
17.49	(C)		
		32.8	(S)
17.46	(C)		
		42.4	(S)
17.50	(C)		
		42.0	(S)
17.47	(C)		
		42.6	(S)
17.39	(C)		
		10.1.0	(S)

8) 139 76
17.47

.0044 / 1.2422 / 2.7866 $V_1 = \frac{1022}{17.47} = .05850$

$V_2 = \frac{1022}{101.0} = .01011$ / 05850 = .06861 ÷ 10 = .006861

.0044 / 6266 / .3828 $V_2' = \frac{1022}{42.82} = .02410$ / 05850 = .08260 ÷ 12 = .006883

$V_2'' = \frac{1022}{32.83} = .03113$ / 05851 = .08964 ÷ 13 = .006895

$V_1 + V_2 = .006880$

$\text{Log } V_1 + V_2 = \bar{3}.8376$
$\frac{1}{2} \text{ Log } V_1 = \bar{1}.3836$
$\bar{3}.1983$
6.4195
7100
.7095

5,122
1285
$e_1 = 4,9935$

which is 3% low

Thursday Jan. 11th 1912. **New Menometer**

t = 19.1 t = 19.2

Volts

1 - 858	+ 12.8 =	870.8
2 - 859	+ 12.8 =	871.8
3 - 842	+ 13.1 =	855.1
4 - 863	+ 13.0 =	876.0
5 - 851	+ 12.9 =	863.9
6 - 857	+ 12.8 =	869.8
5130	+ 77.4 =	5207.4
774		
5207.4		

@ 12.05

@ 2:13

1 - 851 + 12.9 =	863.9
2 - 852 + 12.9 =	864.9
3 - 838 + 13.4 =	851.4
4 - 853 + 12.8 =	865.8
5 - 849 + 12.9 =	861.9
6 - 847 + 12.9 =	859.9
5090 + 77.8 =	5167.8
778	
5167.8	

B F

obs. taken at 3:25 P.m. t = 19.4 P = 76.61 (no correction - New menometer)

volts at 4:00 P.M.

65.3	12.8
32.2 65.1 } = ½	21.6
32.2 65.1 } ½	
32.2 64.9 } ½	31.8
31.7 64.7 } ½	31.7
32.6 64.8 }	32.0
64.9	32.0 64.8 } = ½
	16.4 } = ½
63.8	
31.3 63.2 } ½	16.0 32.2 } = ½
62.8	32.6
31.6 63.1	21.2

Obs. finished at 3:55

2nd Obs. starts @ H. 10 t = 19.4 P. 76.90

Volts at 4:00

1 = 846 + 13.0 = 859
2 = 846 + 13.0 = 859
3 = 819 + 14.9 = 833.9
4 = 852 + 12.9 = 864.9
5 = 834 + 13.5 = 847.5
6 = 843 + 13.1 = 856.1

5140 + 80.4 = 5220.4

16.6-s
16.38-c
16.4-s
16.3-s
16.49-c
16.39-c
16.49-c
16.6-s
16.41-c
16.5-c
16.60-c
16.50-c
16.45-c

14.00-s
15.80-s
31.20-s
25.20-s

3rd Obs. starts at 4:38 t = 19.5 P = 77.16

Volts at 4:30

1 – 844 + 13.0 = 857.0
2 – 845 + 13.0 = 858.0
3 – 816 + 15.1 = 831.1
4 – 851 + 12.9 = 863.9
5 – 833 + 13.8 = 846.8
6 – 843 + 13.1 = 856.1

5032 + 80.9 = 5112.9
80.9
5112.9

Volts at 4:55

1 – 843 + 13.1 = 856.1
2 – 843 + 13.1 = 856.1
3 – 815 + 15.2 = 830.2
4 – 850 + 12.9 = 862.9
5 – 834 + 13.6 = 847.6
6 – 841 + 13.2 = 854.2

5026 + 81.1 = 5107.1
81.1
5107.1

G		F	
26.6	s	84.8	s
		24.2	s
26.45	c	45.8	s
26.35	c (too short)	45.9	s
26.31	c	41.9 = ½ 83.8	s
26.30	c		

Finished at 4:53

4th Obs. starts at 5:10 t=19.5 P=78.05

Volts taken @ 4.55 see last page

B.		F
~~12.87~~		
~~12.81~~		
13.65	c	
13.71	c	
13.83	c	
13.76	c	
13.70	c	
13.71	c	
13.70	c	
13.82	c	22.9 – s
		22.6 – s
		26.2 – s
		26.3 – s
13.75	c	26.0 – s
13.76	c	68.0 – s
13.71	c	49.1 – s
13.77	c	

16487
13.74

Volts taken again - see next page.

$V_1 = \frac{1022}{13.74} = .07438$ (.0044 + .1380 − .0714)

mean volts = 5098

$V_2 = \frac{1022}{68.0} = .01503 = \frac{.01503}{7438} = .08941 \div 15 = .005960$

$V_2' = \frac{1022}{49.1} = .02082 = \frac{.02082}{7438} = .09520 \div 16 = .005950$

$V_2'' = \frac{1022}{26.17} = .03905 = \frac{.03905}{7438} = .11343 \div 19 = .005970$

$V_2''' = \frac{1022}{22.75} = .04492 = \frac{.04492}{7438} = .11920 \div 20 = .005960$

$V_1 + V_2 = .005960$

$\log V_1 + V_2 = -3.7752$
$\frac{1}{2} \log V_1 = -1.4357$
-3.1483 — cont. log volts
6.4092
3.7074
$.7018$

5032
75
4,957

which is nearly 4% low

.0045 for degree
3
23 1,2
20

5th Obs. @ 6:05 $t = 19.6$ $P = 78.4$

Volts at 5:45

1 - 842 + 13.1 = 855.1
2 - 839 + 13.2 = 852.2
3 - 810 + 15.6 = 825.6
4 - 850 + 12.9 = 862.9
5 - 833 + 13.9 = 846.9
6 - 839 + 13.2 = 852.2

5013 + 81.9 = 5094.9
81.9
5094.9

Volts at 6:35

1 - 836 + 13.6 = 849.6
2 - 831 + 14.0 = 845.0
3 - 808 + 15.7 = 823.7
4 - 845 + 13.0 = 858.0
5 - 832 + 13.9 = 845.9
6 - 839 + 13.2 = 852.2

4991 + 83.4 = 5074.4
83.4
5074.4

95.9
17.5
78.4

S.	F
74.7 } = ½ S 152.4 } 77.7	27.8 S
73.0 } = ½ 149.8 } S 76.8	-33.6 } = ½ 67.4 } 33.8 f
73.4 } = ½ 149.3 } 75.9	34.6 } = ½ 68.6 } 34 S
75.3 } ½ 151.6 } 76.3	14.0 } ½ 27.8 } 13.8 S
74.0 } = ½ 151.0 } 77.0	14.3 } = ½ 27.8 } 13.5 S
73.6 } = ½ 149.8 } 76.7	33.6 } = ½ 68.1 } 34.5 f
74.3 } = ½ 149.8 } 75.5	

695

747 .0044
730 .1775
152.4 3.8219
149.8
149.3
151.6
151.0
149.8
149.4
2)1053.7
150.5

$V_1 = \frac{1022}{150.5} = .006636$

$V_2 = \frac{1022}{68.03} \cdot \frac{.015523}{.006636} = .02187$

$V_2' = \frac{1022}{27.8} \cdot \frac{.03676}{.006636} = .04340$

$V_1 + V_2 = .02178$

$\log V_1 + V_2 = -2.33381$
$\frac{1}{2} \log V_1 = -2.91110$
3.1983
6.4474
3 7054
-10.74^{-20}

$e = 5.521 \times 84$
5.437

which is 4 or 5% low

Friday, Jan. 12th 1912

Volts taken at 4:15 P.M. $t = 20.5$ $p = 76.3$

1 - 850 + 12.9 = 862.9
2 - 855 + 12.8 = 867.8
3 - 838 + 13.4 = 851.4
4 - 858 + 12.8 = 870.8
5 - 852 + 12.9 = 864.9
6 - 854 + 12.8 = 866.8

5107 + 77.6 = 5184.6

77.6
5184.6

b	F
25.4 —	
25.2 —	
25.196	
25.2 —	
25.166	39.6
	29.7
25.022	23.8 } 23.9
25.264	24.0
25.0 —	

Finish @ 4:35

25.196
25.166
25.022
25.264
100.648
25.162

mean volts = 5177.7

$V_1 = \frac{1022}{25.162} = .040015$ .00945 + 1.40734 − 2.60211

$V_2' = \frac{1022}{39.6} = .025808$ .00945 + 1.59770 − 2.41175

$V_2'' = \frac{1022}{29.7} = .03441$ .00945 + 47276 − 2.53669

$V_2''' = \frac{1022}{23.9} = .04276$ .00945 + 37840 − 2.63105

$V_1'' + V_2' = .040015 + .025808 = .065823 \div 8 = .008228$

$V_1 + V_2'' = \frac{.040015 + .03441}{6} = .074425 \div 9 = .008269$

$V_1 + V_2''' = .040015 + .04276 = .082765 \div 10 = .008276$

$V_1 + V_2' =$

$r_1'' + r_2 = .008258$

$\log r_1 + r_2 = -3.91687$

$\frac{1}{2}\log \frac{1}{2} r_1 = -1.30105$
-3.19830
-6.41622
3.71408
$.70284$

$e = \frac{5029}{4.974}$

1% low

2nd Obs.

95.0
18.2
76.8

Volts taken at 4:40 $t = 20.5$ $p = 76.8$

1 - 848 + 12.9 = 860.9
2 - 852 + 12.9 = 864.9
3 - 836 + 13.5 = 849.5
4 - 856 + 12.8 = 868.8
5 - 850 + 12.9 = 862.9
6 - 851 + 12.9 = 863.9
5093 77.9 5170.9
774
5170.9

$V_2^{V} = \frac{1022}{6305} = .01621$ .00945 .79969 .20976
15849 ÷ 36 = .004402 →

$V_2^{IV} = \frac{1022}{856} = .01166$ .00945 .93247 .06698
.14228
.15394 ÷ 36 = .004398 →

$V_2^{VII} = \frac{1022}{109} = .009376$ .00945 .03343 .97202
.14228
.151656 ÷ 34 = .004460

Obs. taken at 4:50

G.	7	
7.238		
7.306		
7.158		
7.130		
7.174		
7.056		
7.124		
7.448 -		
7.174		
7.062 -	19.402	
	10.236	
7.197	10.288	10.305
	10.392	
7.218		
	11.830	
	14.008	
7.094		
	down with G.	
	60s = 1 small div.	
	124.0 = ½ dist.	
	259.8 = whole dist.	(34) .004300
		(33) .004431
	136.6 = ½ dist.	
	282.9 = whole "	(33) .004421
	62.8	
7.214	63.3	
	85.6	
	54.0 = ½ of 1 division	
7.228	109.0 = ½ " "	
5 | 2816	finished at 5:29.	
7.188		

$V_1 = \frac{1022}{7.188} = .14228$ .00945 .85667 -1.15284 → 1,15284 - 2 .07642 - 1

$V_2' = \frac{1022}{10.305} = .099175$ .00945 1.01305 -2.99640

$V_2'' = \frac{1022}{11.830} = .086392$ .00945 1.07298 -2.93647

$V_2''' = \frac{1022}{14.008} = .072958$ .00945 1.14638 -2.86307

$V_2^{IV} = \frac{1022}{19.402} = .05268$ .00945 1.28780 -2.72165

$V_1 + V_2' = .14228 + .099175 = .241455 \div 36 = .006707 \div 55 = .004395$

5170.9
5148.9
119.8
5159.9

$V_1 + V_2'' = .14228 + .086392 = .228672 \div 34 = .006726 \div 52 = .004439$

$V_1 + V_2''' = .14228 + .073958 = .216238 \div 33 = .006726 \div 49 = .004392$

$V_1 + V_2^{IV} = .14228 + .05268 = .19496 \div 29 = .006723$
$.006720 \div 44 = .004430$

.004395
4397
4392
4430
4402
4398
24124
.004402

$\log V_1 + V_2 = \log .382740 - 64365$

$\frac{1}{2}\log V_1 = -1.57642$ 57642
-3.19830 19830
-6.60212 1.41837
71264
.70573

$\log 51599 = \frac{3.71264}{.88948}$

7753
85.5
7.6676

5078
51
5.027

$\varepsilon =$

3rd Obs. t = 20, p = 76.35

Volts at 5:30 P.M.

1 - 846 + 13.0 = 859.0
2 - 851 + 12.9 = 863.9
3 - 828 + 14.3 = 842.3
4 - 853 + 12.8 = 865.8
5 - 845 + 13.0 = 858.0
6 - 847 + 12.9 = 859.9

5070 + 78.9 5148.9
78.9
5148.9

Volts taken at 6:05

1 - 846 + 13.0 = 859.0
2 - 850 + 12.9 = 862.9
3 - 827 + 14.4 = 841.4
4 - 853 + 12.9 = 865.9
5 - 844 + 13.0 = 857.0
6 - 847 + 12.9 = 859.9

5067 + 79.1 = 5146.1
79.1
5146.1

S.	F	
18.912		
18.932		
18.868		
19.052	19.5 (S)	19.33
18.980	19.2 (S)	
18.964		
	17.0 (S)	
18.976	17.1 (S)	17.07
19.108 (?) out of train	17.1 (S)	
	19.3 (S)	
18.984	42.2 (S)	42.2
18.912	42.2 (S)	
18.990	101.9 (L)	
9570		
18.957		
6:03 p.m.		

$V_1 = \frac{1022}{18.957} = .005391$ .00945 / 1.27777 / 2 2.73168 / -1.36584

$V_2' = \frac{1022}{17.07} = .05987$ .00945 / 1.23223 / -2.77722

$V_2'' = \frac{1022}{19.33} = .05287$ .00945 / 1.24623 / -2.72322

$V_2''' = \frac{1022}{42.2} = .02422$ .00945 / 1.62531 / -2.38414

$V_2^{IV} = \frac{1022}{101.9} = .01003$ .00945 / 2.00817 / -2.00128

$V_2' + V_1 = \frac{.05391}{.05987} / .11378 \div 16 = .007111$

$V_2'' + V_1 = \frac{.05391}{.05287} / .10678 \div 15 = .002994$ .007118

$V_2''' + V_1 = \frac{.05391}{.02422} / .07813 \div 11 = .003005$ .007103

$V_2^{IV} + V_1 = \frac{.05391}{.01003} / .06394 \div 9 = .003044$ .007104

039 .007109

85181. $r'+r^2 = .003009$

$\log(r_1+r_2) =$ 47842
$\frac{1}{2}\log r_1 =$ 36584
19830
6.04256
3.91164
.35092
48595
71164
.0431

volts = 5148

5062
68

e = 4.994

Saturday. Jan. 20, 1911. Magnification 1005.

Volts at 2:45 $t = 23.$ $P = 9563 - 1754 = 7709$

1 - 869 + 12.9 = 881.9
2 - 872 + 13.0 = 885.0
3 - 860 + 12.8 = 872.8
4 - 876 + 13.1 = 889.1
5 - 855 + 12.8 = 867.8
6 - 870 + 12.9 = 882.9
520 + 77.5 = 5279.5
77.5
5279.5

t.	Volts at 3:50 P.M.	
17	1 - 852 + 12.9 = 864.9	5279.5
46	2 - 826 + 14.5 = 840.5	5168.1
15	3 - 845 + 13.0 = 858.0	111.4
14	4 - 863 + 12.9 = 875.9	
10	5 - 845 + 13.0 = 858.0	
18	6 - 858 + 12.8 = 870.8	
120	5089 + 79.1 = 5168.1	
	79.1	
	5168.1	

Obs. began at 3:13 P.M.

G	F
25.2	27.8
	27.8
	19.2
25.558	
25.2	52.4
25.494	
	91.7
25.8	
25.566	91.5
	{46.3 = ½
25.278	{92.4
	{46.6 = ½
25.260	{93.4
	{47.
25.564	{94.
	93.4
25.382	
	47.2 = ½
	94.4
25.394	
8 | 3.496	
25.437	
3:48	
25.462	

$V_1 = \frac{1005}{25.462} = .03947$ .002166 × 405892 = 1.596274 − 1.298137

$V_2' = \frac{1005}{19.2} = .05234 - .03947 = .01287$ .002166 × 13.3301 = 8.718865-2

$V_2'' = \frac{1005}{27.8} = .03615 - .03947 = .00332$ .002166 × 1.444045 = 3.581121-2

$V_2''' = \frac{1005}{52.4} = .01918 - .03947 = .02029$ .002166 × 1.719321 = 2.828335-2

$V_2^{IV} = \frac{1005}{93.0} = .010885 - .03947 = .028585$ .002166 × 1.968453 = 2.033683-2

5279.5
5168.1
111.4

$V_1 + V_2' = .09181 \div 11 = .00835$

$'' = .07562 \div 9 = .00840$

$''' = .05865 \div 7 = .00838$

$^{IV} = .050355 \div 6 = .00839$

.00838

$\log (V_1 + V_2) = .920123 - 3$

$\frac{1}{2}\log r_1 = .298137 - 2$

$.171830 - 3$

$.4.16550$

$\log 5200 = .716003$

$.700547$

$e = .5,0182$

2nd Obst at (mag. 1022)

Blue drop.

4:35 P.M. $t = 22.8°$ 96.12 / 17.40 $p = 78.72$

b.	F
47.3	~~18.3~~
47.2	22.052
47.1	29.756
47.0	14.652
6	
47.15	

4:50

~~18.3~~
14.652
~~29.952~~
14.652
22.052
29.750

Volts at 4:55

846 + 13.0
830 + 14.1
834 + 13.6
858 + 12.8
836 + 13.6
841 + 13.2
5045 + 80.3
80
5125

5168
5125
43 = drop

$v_1 = \frac{1022}{47.15} = .01472$ $\quad$ .009450 / 1.673472 / .335968-2 / .167984-1

$v_2' = \frac{1022}{14.652} = .06976$ $\quad$ .009945 / 1.843981-2 / .06476 / .01472 / .08448

$v_2'' = \frac{1022}{22.052} = .04635$, .01472, .06107 $\quad$ .009945 / 1.343409 / .666041-2

$v_2''' = \frac{1022}{29.750} = .03435$, .01472, .04907 $\quad$ .009945 / 1.471787 / .535963-2

$v_1 + v_2 = .08[illegible] \div 7 = .01207$

$= .06107 \div 5 = .01221$

$= .04907 \div 4 = .01227$

55

.01218

.085647 - 2
.167984 - 1
.198300 - 3
.451931 - 6
.709694
.742237

5.52 (?)

3rd " obs. at
5:05 P.M.

$t = 23.0$

$p = 96.30 - 17.30 = 79.00$

G F

50.4
50.8
50.4
50.9
50.1

16.0
26.1
20.0
16.3 10
26.1 16
20.39 2

5:20

4th obs. at
5:30 P.M.

94.92 − 18.61 = 76.31

t = 23°

Volts at 6:10 P.M.

G	F
~~17.9~~	
~~17.9~~	9.786
~~8.1~~	7.364 } 7.594
18.378	7.824
	35.6
	36.250 —(?)
18.370	35.214
? 19.098	24.340 —
? 19.170	28.466 } 35.610
18.506	35.650
18.556	35.906
18.554	
18.606	
18.420	57.202
18.612	18.07 } half
18.758	35.9 } whole dist.
18.408	
12/~~28~~3.430	
~~18~~ 18.620 6:05	

7.594
9.786
24.340
28.466 —(?)
35.610
36.250 —(?)
57.202

8830 + 14.1
8828 + 12.2
8826 + 14.5
8855 + 12.8
8829 + 14.1
8504 12.9
5018 + 80.6
80
5098

5125
5098
27 = drop.

$V_1 = \frac{1022}{18.62} = .06910$

.009451
1.269982
2 | .839471-2
.419735-1
.009451
.880471
.128980-1

$V_2 = \frac{1022}{7.594} = .13458$
06910
.20368

$\frac{1022}{4.786} = 0.10448$
06910
.17358

009451
990428
.019023-1

$\frac{1022}{24.34} = .04199$
06910
.11109

009451
1.386321
.623130-2

$\frac{1022}{35.61}$ ~~$\frac{1022}{28.466}$~~ = .02870
06910
.09780

.009451
1.551572
.457879-2

$\frac{1022}{57.202} = .01787$
06910
.08697

.009451
.787396
.252055-2

.20368 ÷ 19 = .01072
.17358 ÷ 16 = .01085
.11109 ÷ 11 = .01809 —?
.09780 ÷ 9 = .01086
.08697 ÷ 8 = .01086
.01084

Friday, Jan. 26, 1912

$t = 23.$ $P = 9415 - 1925 = 749$

Volts at 3:15 P.M.

1 - 847 + 13.0 = 860.0
2 - 850 + 12.9 = 862.9
3 - 831 + 14.0 = 845.0
4 - 857 + 12.8 = 869.8
5 - 837 + 13.5 = 850.5
6 - 852 + 12.1 = 864.9

5074 + 791 = 5153.1
791
5153.1

Positive drop

5153
5138
91
5146

$v_1 = \frac{.00945}{.98457}$ $\frac{1022}{9.651} = 1059$
$v_2 = \frac{.02488-1}{.51244-1}$

Obs. at 3:23

b_1	F
9.642	
9.630	
(9.570)	
9.662	
9.661	
9.648	7.430
	7.436
9.608	
	55.8
	17.3
9.668	17.8
(9.532)	
	17.4
	17.6
	17.4
9.662	17.2
	17.6
	17.6
9.674	17.6
	77.0
9.632	23.7
9.658	24.0
9.7	24.0
9.7	23.8
9.7	21.2
9.6	21.4

b_1 (cont.)	F (cont.)
9.670	24.0
	24.4 (?)
9.670	24.2
	28.6 $\frac{1}{2}$
	57.0
9.620	
	28.0 $\frac{1}{2}$
9.658	56.4
	28.4 $\frac{1}{2}$
	56.4
9.7	

Finished at 3:55

mean 9651

7.433
17.500
23.950
56.400
77.000

$\frac{1022}{7.433}$

$\frac{.00945}{.87116}$ $\frac{1022}{7.433} = .013750$
$.13829-1$ $.10590$
$.24340 \div 49 = .004965$

$\frac{.00945}{1.24304}$ $\frac{1022}{17.500} = .05840$
$.76641-2$ $.16430 \div 33 = .004950$

$\frac{.00945}{1.37971}$ $\frac{1022}{23.950} = .04263$
$.62974-2$ $.14853 \div 30 = .004951$

$\frac{.00945}{1.75128}$ $\frac{1022}{56.400} = .01812$
$.25817-2$ $.17402 \div 25 = .004961$

$\frac{.00945}{1.88649}$ $\frac{1022}{77.000} = .01327$
$.12296-2$ $.17917 \div 24 = .004965$

297
.004958

51244
69531
56914
19830
46275
71147
25128
46605
71147
.69458

$E = .4950$

2nd Obs. $t = 23.3$ P 94.10 − 19.40 = 74.70

Blue drop − Positive drop.

Volts at 4:00

1	844 + 13.0	=	857.0
2	848 + 12.9	=	860.9
3	827 + 14.3	=	841.3
4	855 + 12.8	=	867.8
5	836 + 13.5	=	849.5
6	849 + 12.9	=	861.9
	5059	79.4	5138.4
	79.4		
	5038.4		

00945 / 1.72754 / 2.28191−2 / .14095−1 ; 1022 / 53.4 = .01914

V = 5134

log V =

00945 / 1.74194 / .26751−2 ; 1022 / 55.2 = .01852 ; .01914 / .03766 ÷ 3 = .01255

B.	F
Began at 4:15 P.M.	88.6 } ½
27.0 } = ½	172.8 }
53.4 }	28.0 } = ½
26.6 } = ½	55.2
53.4 }	
Finished at 4:29	

.00945 / .23754 / .17191 ; 1022 / 172.8 = .005915 ; .01914 / .07829 ÷ 6 = .01304 / .025055 / .02587 / .01293 / .01253

mean = .01254

.0483 / .14095 / .1963 / .4376 / .7104 / .7272 ; .11160−2 / .14095−1 / .19830 / .45085 / .71046 / .74039

$\varepsilon = 5.5008$ 5336 Correct = 5452 e.s.u.

5.4912

2.1 % low

3rd Obs Jan. 26, 1912

t = 23. P = 74.80

Volts at 4:30

1 - 843 + 13.1 = 856.1
2 - 847 + 13.0 = 860.0
3 - 825 + 14.5 = 839.5
4 - 854 + 12.8 = 866.8
5 - 834 + 13.5 = 847.5
6 - 848 + 12.9 = 860.9
5130.8

Blue drops - positive,
Very much like the one taken at the 2nd Obs.

b.	F
(35.9 / 71.8) Red drop.	
Obs. begun at	19.0
26.0 } - ½ 51.6 }	35.0
	~~22.3~~
26.0 } - ½ 51.8 }	60.7
	~~52.0~~
26.3 } - ½ 52.0 }	
52.3	
52.0	
mean 51.94	

5(2597 / 6194)

$\frac{.00945}{1.71550} \quad \frac{1022}{51.94} = .01968$

$\frac{.00945}{1.27875} \quad \frac{1022}{19.00} = .05379$

$.73070-2 \qquad .01968$

$.07347 \div 6 = .012245$

$\frac{.00945}{1.54407} \quad \frac{1022}{35.00} = .02920$

$.48538-2 \qquad .01968$

$.04888 \div 4 = 012.22$

$\frac{.00945}{1.78319} \quad \frac{1022}{60.70} = .01684$

$.22626-2 \qquad .01968$

$.03652 \div 3 = .012178$

$.012224$

6

.0891 .08707
.1470 .14196
.1963 .19830
.4324 .42733
.7101 .71012
.7223 .71721

$\mathcal{E} = 5.215$

5.276

3½ % low

Probably a double drop

4th Observation at 5.10 t = 23.1 P = 74.80

Was not taken immediately after blowing.
May be a dust particle

.009451 / 2.721597 / 2 | .787854-3 / .893927-2

1.022 / 166.57 = .007833 ± .006135

5130 / 5111 / 41 / 5120

b	F
83.4 } = ½ / 167.0	29.4 } = ½ / 57.8
84.2 } = ½ / 167.2	29.0 } - ½ / 57.4
84.0 } = ½ / 167.4	24.4
84.6 } = ½ / 166.2	24.7
82.0 / 165.0	29.4 } = ½ / 58.4

5 | 16-32.8 / 166.56

Finished at 5.37

24.4 / 24.7 / 11 / 24.55

57.8 / 57.4 / 58.4 / 3 | 173.6 / 57.86

.009451 / 1.390051 / .619400-2

1.022 / 24.55 = .04163 (6135) / .007833 / .049463 ÷ 2 = .024733 (4777 / 02388)

.009451 / 1.762378 / .247073-2

1.022 / 57.86 = .017667 (6135) / .007833 / .025500 (2380)

.024733 / .025500 / 2 | .050233 / .025116

2380.

mean .02384

.399949-2 / .893927-2 / .148300-3 / .492176 / .709270 / ~~.201446~~ / .782906

ε = 6.066

.3773 / 8934 / 1983 / 4695 / 7093 / .7602

5751 / 3 / 5.760 Correct = 5.71

1% high
error 1%

5th Obs. – Jan 26, 1912 $t = 23.5$ $P = 74.80$

Volts at 5:38 White drop –

1 – 839 + 13.2 = 852.2
2 – 842 + 13.1 = 855.1
3 – 818 + 14.9 = 832.9
4 – 853 + 12.8 = 865.8
5 – 832 + 13.9 = 845.9
6 – 846 + 13.5 = 859.5
5111.4

5:45 P.M.

G	F	
43.4		
21.6	25.3	
43.0	49.4	
43.6		
43.3		

Finished at 6:00

.009451
1.636488
2|.372963-2
.186481-1

$\frac{1022}{43.3} = .02360$

.009451
1.693727
.315724-2

$\frac{1022}{49.4} = .02069$ ÷ 2 = .01034 5

.02069
.02360
4|1.04429
.01107

.2028
2360
4|43 88
1097

.64636 -2
.18648 1
.03108 7

1967
.530840-2
.186481
.915621

.044048
.186481
1983
.428829
.708421
.720508

E = 5.2547
5.2710

Correct 5305

.7% low error 1%
but probable direction of this
1% is to reduce the
value of e still
more

6th (1/26/12) 6-P.M. t = 23.2 P = 74.75

Perhaps Reddish drop

Obs. began at 6:05 Volts at 6:18 P.M.

1 - 838 + 13.3 = 851.3
2 - 843 + 13.1 = 856.1
3 - 817 + 15.0 = 832.0
4 - 853 + 12.8 = 865.8
5 - 830 + 14.1 = 844.1
6 - 844 + 13.0 = 857.0

5106.3

b.	F
71.2	17.6 } = 1/2
	35.2 }
35.0 } = 1/2	
71.0 }	11.9 }
	23.8 }
35.6 } = 1/2	
71.4 }	36.0 } = 1/2
	71.0 }
71.6	
71.3	

.009451 | 1.853090 | .156361-2 | .078180-1 — 1022 / 71.3 = .01433

.009451 | 1.376577 | .638874-2 — 1022 / 23.8 = .04294 — .01433 — .05727 ÷ 4 = .01432

balanced

.009451 | 1.546543 | .462908-2 — 1022 / 35.2 = .02906 — .01433 — .04339 ÷ 3 = .01446

.009451 | 1.851258 | .158193-2 — 1022 / 71.0 = .01439 — .01433 — .02872 ÷ 2 = .01436

107

.01439

t	t'	n'	n	
71.2	35.2	1 .01436	3	.01415
71.0	23.8	2 .01399	4	1401
71.4	71.0	.01408	2	1406
71.6				1403
4)142	3)1235	3)1411		25
71.3				1408

.158061-2
.078180
1983
.434541
708081
.726460

$V_1 = .01403 \times 1021 = .014325$

$V_{1+2} =$

$\frac{1}{71.3} = .01403$

$\frac{1}{35.2} = .02841$

$\frac{1}{23.8} = .04202$ .01408 .02944

$\frac{1}{71} = .01408$

1403 / 2541 / 3)142.44 / 1415 / 1403 / 4202 / 4)5605 / 1401

5.2561

$\mathcal{E} = 5.2561$

5,331

2% low

Error .5%

Saturday, Jan 27th 1912

Volts at 10:30 a.m.

t = 23,0

P = 94.45 − 18.95 = 75.50

1 - 830 + 14.1
2 - 830 + 14.1
3 - 758 + 18.0
4 - 840 + 13.2
5 - 815 + 15.2
6 - 832 + 14.1

4905 + 887 = 4993.7

B	F
11.756	
11.654	
11.734	
11.578	
11.934	
11.792	
11.810 ?	
	7.424
	49.~~60~~
	24.67 = ½
	49.4
	42.0 = ⅝ 66.7
	66.7
	33.9 = ½
	66.6
11.740	16.6 = ½
	32.5
11.678	16.3 = ½
	32.4
11.686	32.5
10 | 7562	
11.756	

324
325
325
32.46
49.20
66.65

.009451
1.060538
2 .979193-2
.148596-1

009451
1.511349
.498182-2

009451
1.691985
.317486-2

009451
87380
.185651-2

009451
.07026
.958189

1022 / 11.756 = .08694 (.08673)

.03148
.18673
.11821

1022 / 32.46 = .03148 ÷3 = .005236
.08896 ÷24 = .005018
.12044 ÷22 = .005475
11442

5475
5487
5484
5383
281
.005480

1022 / 4920 = .02077
.08596 ÷21 = .005225
.10974 ÷22 = .004984
10771 ÷20 = .005487

1022 / 66.65 = .01533
.08896 (20 = .005214)
.10429 ÷21 = .004966
10227 ÷19 = .005489

5386
5383
105477

mean = 005384

.739572-3
.474596-1
.1983
.412468
.698449
.714019

7311
4696
1983
3990
6984
7006

ε = 5.176 in error

e_1 = 5.002 correct

2% low

error ~~6~~ .8%

2nd Obs. 1/28/12 t = 23 P = 75.50

b	F
13.6 } = ½	25.6 } = ½
— }	49.6
13.6 } = ½	49.0
27.0 }	
13.3 } = ½	~~49.1~~
26.6 }	
13.6 } = ½	
26.8 }	
26.8	
13.4 } ½	42.6 } = ½
26.6 }	83.0
13.6 }	18.0 } = ½
27.2 }	35.2
13.9 }	~~49.3~~
27.3 }	

11:45 35.2
49.3
83.0

27
26.6
26.8
26.8
26.6
27.2
27.3
7 | 483
26.9

11:20

Voltsat. 11:10

1 - 830 + 14.1 = 844.1
2 - 829 + 14.1 = 843.1
3 - 746 + 18.0 = 764.0
4 - 839 + 13.2 = 851.2
5 - 814 + 15.2 = 829.2
6 - 832 + 14.1 = 846.1
4978.7

.009451 / 1.429752 / 2.579699-2 / .289849-1 — 1022 / 26.9 = .03799

.009451 / 1.546542 / .462907-2 — 1022 / 35.2 = .02838 ; .03799 ; .06637 ÷ 8 = .008296 ; 06694 = .008368

.009451 / 1.692847 / .316604-2 — 1022 / 49.3 = .02073 ; .03799 ; .05872 ÷ 7 = .008389

.009451 / 1.919078 / .090373-2 — 1022 / 83.0 = .01231 ; .03799 ; .05030 ÷ 6 = .008383 ; 3 | 106 ; .008835 ; .008380

3 2
.92 ~~16~~ 86 - 3
289849
198-3
~~.48 84 35~~
697055
.712780

4114
6471
7143

ε = 5.162 5.180 5.247 correct

.75% low step watch gs possible error 1%

3rd Obs. 1/27/12 t = 23.

1 - 829 + 14.1 = 843.1
2 - 829. + 14.1 = 8431
3 - 740 + 18.0 = 758.0
4 - 838 + 13.2 = 851.2
5 - 813 + 15.2 = 828.2
6 831 + 14.1 = 845.1

4968.7

Volts at 1.1.:50

~~Test for Conv~~

temp = 23.2° C.
pres = 75.9

12:15

TEST FOR CONVECTION

F

Within 4 small divs. from bottom to within 7 small div. of top

24.6 = 1st 2 large divs
25.6 = 2nd " 2 large divs
25.6 = 3rd 2 divs
25.4 = 4th 2 "
25.6 = 5th " "
24.0 = 6th " "

From 5 small from bottom to within one div. of top

21.3 = 1st 2 large divs
20.1 = 2nd "
21.6 = 3rd "
21.9 = 4th "
21.4 = 5th "
21.6 = 6th "
22.0 = 7th "
21.2 = 8th "
21.0 = 9th "
21.0 = 10 "
20.6 = 11 "

(12:40)

Thus seems to show clearly that the field is not exactly uniform, being stronger at the edges than in the middle

t = 23.0° C
p = 75.60

(12:45)

F

within 5 small divs. of bottom to within 7 large div.

15.4 = 1st 2 large divs. = 15.0 (2nd reading)
16.0 = 2nd 2 " " = 16.0
16.0 = 3rd 2 " "
16.0 = 4th 2 " " 15.6 = 15.8 (3rd read.)
15.4 = 5th 2 "
15.6 = 6th 2 "
15.6 = 7th 2 "

too many divisions here, toward the middle there must be a duplication

within 5 small divs. of bottom to within 2 divs. of plate

15.6 = 1st 2 l. divs.
16.2 = 2nd " "
15.9 = 3rd " "
16.0 = 4th " "
15.6 = 5th " "
15.6 = 6th " "

which overlaps 5 mill into 6th 2 large divs. = 15.6 (2nd reading)

within 5 small divs. of bottom to within 2 small divisions of plate

118.8 = 1st div — 122.5 = 1st div
121.0 = 2nd " — 125.5 = 2nd "
131.6 = 3rd " — 135.0 = 3rd "
145.2 = 4th " — 147.0 = 4th "
140.0 = 5th " — 152.4 = 5th "
141.0 = 6th " — 151.6 = 6th "
137.8 = 7th " — 146.2 = 7th "
138.4 = 8th " — 141.4 = 8th "
131.0 = 9th " — 147.2 = 9th "
119.0 = 10th "
113.0 = 11th "
110.0 = 12th "

2nd reading after all the left were taken out these show that voltage was dropping.

2:05 P.M.

Same drop as used for testing for connection on last page.

from 2:05 P.M.

$t = 23.2°$ C.

$p =$

Volts at 2:25 P.M.

(1)	8277 + 14.3
(2)	8237 + 14.6
(3)	7227 + 18.8
(4)	8388 + 13.4
(5)	8137 + 15.3
(6)	8274 + 14.3
	4650 + 89.9
	90
	4740

↓ G

11.4	1st half of 8 divs
22.8	2nd " " 8 "
22.810	for all 8 divs
22.980	" " "
22.990	" " "
22.998	" " "
22.974	

F

60.0	for 1st half
120.6	" 2nd "
121.0	" all 8 divs.
32.0	= 1st half of 8 divs
63.7	= 2nd " " " "
63.3	= all 8 divs.

in middle of field.

to 2:25 P.M.

$$V_1 = \frac{1022}{22.96} = .04450$$

.04945
3610
2.64645

$$V_2 = \frac{1022}{63.5} = \frac{.01609}{.06059}$$

$\log V_1 V_2 = 2.7824$

$\frac{1}{2} \log V_1 = 1.3242$

3.1483

5.3049

3.6937

9.6112

$8) 40.85$

$5.106 - 5$

$e_1 = 5.111$

error .6%

1.8% low

Friday 7 Feb. 2, 1912. t = 23.1 P = 74.92

Test for Convection.

Volts at 3; 25'

1 – 851 + 12.9 = 863.9
2 – 850 + 12.9 = 862.9
3 – 822 + 14.7 = 836.7
4 – 859 + 12.8 = 871.8
5 – 833 + 13.5 = 846.5
6 – 847 + 13.0 = 860.0
5062 + 79.8 = 5141.8

G

22.6 1st 2 div
45.6 2nd 2 div.
22.6 3rd 2 div.
45.2 4th 2 div.
22.4 5th
38.8 1/2

22.6 –
23.0 –
22.6 –
22.6 –
22.4 –
24.6 –
Arrows within 3 small div of the bottom.

2nd Obs. - 4:00 P.M. $t = 23$ $p = \frac{94\frac{7}{25}}{74.95}$

Red drops.

102.6
53.4
49.2

136
26.8

G	F
53.4 - 1st div.	13.6 - 1st 4 div.
49.2 - 2nd div. 1+2=6	26.8 - 1st + 2nd 4 div.
50.2 - 3rd div.	
54.4 - 4th div.	
52.4 - 5th "	
47.6 - 6th "	
48.0 - 7th "	
52.2 - 8th "	
48.4 - 9th "	

3rd Obs. – at. 4:55 P.M

Volts at 4:40

1- 849 + 12.9 =
2- 848 + 12.9 =
3- 814 + 15.3 =
4- 857 + 12.8 =
5- 831 + 14.1 =
6- 843 + 13.1 =

5042 + 81.1 = 5123.1

.00945
.88110
1.72835-1
.08541
.08945
1.31345
.69600-2

.00945
1.39620
.61325-2

$t = 22.9$ $p = 74.95$

1022 / 7.605 = √3447

10.22 / 20.58 = .04966
13442
.18408 ÷ 42 = .004383

1022 / 24.9 = .04104
13442
.17546 ÷ 40 = .004386

00945
1.51055
.49890-2

1022 / 32.4 = .03154
13442
.16598 ÷ 38 = .004367

00945
1.74468
.26477-2

1022 / 5555 = .01840
13442
.15282 ÷ 35 = 004366

00945
2.97313
.03632-3

1022 / 940.0 = .001087
13442 0
.13550 7 ÷ 31 = .004371
204
.004368

Elongation	Obsvn	F		Whole
	7.558	1st 1/2		
7.4	7.566			
7.5	7.532			
7.6	7.786			
7.8	7.440		20.58	
7.4	7.658		6 | 35	
7.6	7.660	10.6	– 20.6	
7.4	7.596	10.6	– 20.8	
7.6	7.418	10.6	– 20.6	
		10.3	– 20.6	
7.8		10.2	– 20.4	
7.4	7.716	—	– 20.6	
55				
755	7.608	12.6	– 24.9	24.9
	7.580	12.5	– 24.7	
		1st dist = 113.0		
		2nd " = 111.6		
		3rd " = 123.0		117.5
		4th " = 119.0		940.0
		5th " = 120.0		
	7.644	6th " = 118.6		
		—	– 32.2	324
	7.700	—	– 32.6	
	7.676	—	– 55.7	55.55
	7.550	27.0	– 55.4	
		35.0	–	
16 | 9.678				
7.605				

64028-3
56417-1
19830-3
X40275-6
log .5115 = 70885-3
6.9390-10

5123.1
5111

4.942

Correct = 5055

2.1% low

1.00862
431

17546
13556
03990
444
431
435
439
1749
4372

16548
13556
03047
435

16548
15282
01316
439

1848 (45
164
208
205

4th Observation at 5.35 t= p=

Volts at 5.26

1 - 848 + 12.9 = 860.9
2 - 844 + 13.0 = 857.0
3 - 813 + 15.4 = 828.4
4 - 854 + 12.8 = 866.8
5 - 829 + 14.1 = 843.1
6 - 842 + 13.1 = 855.1

5030 + 81.1 = 5111.1

G	F	
	1/2	whole

Saturday - Feb. 3rd 1912 $t = 21.8$. $P = \frac{94.15}{19.30} / 74.85$

Volts at 10:25 A.M.

1 - 837 + 13.4 = 850.4
833 + 13.9 = 846.9
780 + 17.0 = 797.0
847 + 13.0 = 860.0
813 + 15.4 = 828.4
830 + 14.1 = 844.1
4940 + 86.8 = 502.6.8

Note: Take value of volts on next page -

G		F	
½ Distance	Whole Dist	½ Distance	Whole Dist
—	48.6	38.6	77.0
24.4	48.7	8.7	17.3
24.3	48.6	—	11.3
24.4	48.8	—	17.2
4	2.7		
	48.675		

.00945 × 1.68730 × ½ = .32215-2 = .16108-1

1022 / 48.675 = 02100

1022 / 11.3 = .09044 + .02100 = .11144 ÷ 10 = .01144

.00945 × 1.05308 = .95637-2

.00945 × 1.23679 = .77266-2

1022 / 17.25 = .05925 + 02100 = .08025 ÷ 7 = .01146

.00945 × 1.88645 = .12800-2

1022 / 77.0 = .01327 + 02100 = .03427 ÷ 3 = .01142

.01144

.05843
.16108
.19830
.41781
.69627
.72154

5.267
28
5.239

5,340 Const

2% low

2nd Obs. at 11:05 A.M.
t = 22 p = 74.95

Volts at 10:55

1 - 836 + 13.5 = 849.5
2 - 832 + 13.9 = 845.9
3 - 726 + 18.0 = 744.0
4 - 846 + 13.0 = 859.0
5 - 812 + 15.5 = 827.5
6 - 829 + 14.1 = 843.1

4881 + 98.0 = 4969.0
88
4969

½	whole	½	whole
G		F	
56.0	109.0	20.0	40.4
—	107.6	20.0	40.2
52.6	107.6	20.6	40.6
52.4	107.0	—	24.2
53.4	108.0	66.6	133.6
52.4	106.6	20.0	40.2
56.6	107.8		
7) 55.6			
107.9			

24.20
40.35
133.60

.00945
2.03302
2.97643-3
.98821-2

1022 / 107.9 = .009472 ✓

.00945
1.38382
.62563-2

1022 / 24.20 = .04223
.00947
.05170 ÷ 3 = .01723 ✓

.00945
1.60584
.40361-2

1022 / 40.35 = .02533
.00947
.03480 ÷ 2 = .01740 ✓

.00945
2.12581
.88364-3

1022 / 133.60 = .007650
.009472
.017122 ÷ 1 = .01712 ✓

3 | .017 | 75
.01725

.23679-2
.98821-2
.19830-3
.42330
.69627
.72703

5.335
24
5.311

4% low

3rd Obs - 11:48 AM.

t = 21.9 p = 74.95

Volts at 12:

1 - 834 + 13.5 = 847.5
2 - 830 + 14.1 = 844.1
3 - 720 + 18.0 = 738.0
4 - 844 + 13.0 = 857.0
5 - 808 + 10.6 = 823.6
6 - 825 + 14.5 = 839.5
= 4949.7

G		F	
79.7 = 1st div.			
82.4 = 2nd "			
102.0 = 3rd "			
95.6 = 4th " (1200)			
		13.3	26.4
57.0	1st div.		26.5
57.9	2nd div.		5
60.6	3rd div.		
128.0	4th + 5th div.		
135.6	6th + 7th div.		
59.4	8th div.		
60.0	6th div.		
120.6	6th + 7th		
59.0	8th div.		
58.4	1st div.		
48.6	2nd div.		
56.6	3rd div.		
60.0	4th div.		
62.3	5th div.		
62.9	6th div.		
61.4	7th div.		
	8th div.		
4102			
56.6			

Mean fall (121.80)

60.3 x 8
= 482.4

$V_1 = \frac{.00945 \times 6534 \times 1022}{3268 \times 468.8} = .002118$

$V_2 = \frac{1022}{26.45} = .03864$

$V_1 + V_2 = .040482$

Log $V_1 + V_2$ = -2.6109
$\frac{1}{2}$ log V_1 = -2.6630
-3.1983
-6.4613
-3.6946
-10.7776

$e_1 = \frac{5.993}{5.968}$ (2.5)

from 5% low. (a guess however not normal one)

Great machinery small one

4th Obs -- at 12.45 $t = 22$ $p = \frac{94.1}{19.3} / 74.80$

Stopwatch - Chronograf ½ Whole

G	F	
7.100	25.6	50.3
7.058	24.7	49.8
7.028		
7.184	31.9	63.2
7.174	31.6	63.4
7.154	31.7	63.3
7.090	11.3	22.4
7.154	14.4	
7.216		22.6
7.078	11.6	
7.182	11.6	23.0
7.158		
7.120		
7.142		
7.088		
7.136		14.7
7.086		
7.094		14.8
18 2.242		28.4
7.125		66.6
	33.4	66.6
		16.8
		17.0
	12.6	25.6
	12.9	25.4

1:10 (Om)

Volts at 1:13

1 - 833 + 13.8 = 846.8
2 - 829 + 14.1 = 843.1
3 - 715 + 18.0 = 733.0
4 - 843 + 13.1 = 856.1
5 - 803 + 15.8 = 818.8
6 - 822 + 14.7 = 836.7

4345

.00945
.8524
-1.15665

$v_1 = \frac{1022}{7.125} = .14344$

$v_1' = \frac{1022}{50.05} = .02042$ / 14344 = .16386 ÷ 39 = .0042015

Differences

203413 - 158785 = 44628 / 116 / .004102

18352 - 158785 = 24435 / 6 / .004125

18852 - 15959 = 2893 / 7 / 004133

17943 - 158785 = 20645 / 5 / 004129

21293 - 158785 = 54145 / 13 / .004165

42015 42000 41898 4177 41615 4171 — 6 | 11203 — 4183

4102 4133 4125 4129 4165 — 5 | 154 — 4131

$\frac{1022}{63.3} = \frac{.016155}{14344} = 15959 \div 38 = .004200$ (39 = 4091; 00427)

$\frac{1022}{22.67} = .04508$ / 14344 = .18852 ÷ 45 = .0041893 (46 = .0049)

$\frac{1022}{14.75} = .06934915 = 21293$ / 14344

$\frac{1022}{28.4} = .035986 = 17943$ / 14344

$\frac{1022}{66.6} = .015345$ / 14344 = 158785 ÷ 38 = .004177 (39 = 4072)

$\frac{1022}{16.9} = .06049$ / 14344 = .203413 ÷ 49 = .0041615 (50 = 4078)

$\frac{1022}{25.5} = .04008$ / 14344 = .18352 ÷ 44 = .004179 (45 = 4076)

$\log v_1 + v_2 = \bar{3}.6215$
$\frac{1}{2} \log v_1 = -2.5783$
-3.1963
-6.3981
3.6932
-10.7049

$e = 5064$
23
$e_1 = .5046$ exact enough

4046
4091
4069
4072
4078
4078

6) 4086

These fit better than the others max. dif being .5% against 1%. And they fit the difference better. Hence take this

$\log k_1 r_2^2 =$ 3.6113
-1.5763
3.1483
-6.3879
3.6932
10.6947

4.951
22
4929

Error 3%

2 2% low

Friday, Feb. 9th 1912 $t = 23$

$94.4 - 19.15$
$p = 75.25$

Blue - positive drop
Observed at 10:30 A.M.

A Blue drop -

Volts at 10:15
1 - 836 + 13.5 = 849.5
2 - 833 + 13.8 = 846.8
3 - 779 + 17.0 = 796.0
4 - 846 + 13.0 = 859.0
5 - 818 + 16.0 = 833.0
6 - 833 + 13.8 = 846.8
4945 + 86.1 = 5031.1
861
5031.1

G		F	
½ dist.	whole D		
—	57.6		
27.6	57.6		
27.7	58.4		
28.6	58.1		
28.0	58.2		
—	58.6	82.0	172.0
29.0	58.6	82.0	174.8
28.4	—	29.6	59.2
28.0	56.6		

Insertion in accd. f
Correction as shown on next page.

2nd Observation at. t= p=

Volts at 11:00 A.M.

1 - 835 + 13.6 = 848.6
2 - 832 + 13.9 = 845.9
3 - 781 + 17.0 = 798.0
4 - 845 + 13.0 = 858.0
5 - 817 + 15.0 = 832.0
6 - 832 + 13.9 = 845.9

494.2 + 86.4 + 5028.4
86.4
5028.4

G		F	
½ dist.	whole ♀	½ dist	whole dist.
Middle.			
30 2 divs			~~376 6 divs~~
35.6 " "			
34.8 " "			
31 " "			~~64~~ " "
35.4 " "			
34.6			~~+424~~
88.2 2 divs		426	2 divs
		89.4	4 divs
83.4 2 divs			29.24 divs
97.8 2 divs			9.54 " "

3rd Observation – at 3:35 P.M. t = 23.0 p = 75.75

946 - 18,85

Volts at 3:35 P.M.

1. - 834 + 13.7 = 847.7 } Only one back was used
2. - 8 +1 =
3. - +1 =
4. - 8 +1 =
5. - 8 +1 =
6. - 8 +1 =

G	F ½ dist	F whole d.
21.4 - 2 div 21.4 2 div 22.6 - 2 div 21.7 - 2 div 87.1	15.6	31.0
21.6 - 2 div. 22.2 - 2 div 23.0 - 3 div. 22.2 - 2 div 89.0	54.0	108.7
? →	96.5	197.0
62.8 - 3 div. a different drop →		
40.3 - 2 div. 41.5 - 2 div. 45.4 - 2 div. 43.0 - 2 div. 170.2	31.4	62.4
41.6 - 2 div. 43.6 - 2 div. 45.2 - 2 div 42.5 - 2 div 172.9	—	80.4
41.0 - 2 div. 42.0 - 2 div. — — — — 170.4	—	80.4
40.4 - 2 div 44.2 - 2 div 45.2 - 2 div. 43.2 - 173.0	—	37.4
130.4 - 6 div. = 173.9 170.6		

Finished at 4:18

$V_1 = \frac{1022}{88} = .01161$

.00945 / 1.94448 / .64497-2

$V_2' = \frac{1022}{81} = .03297$ / 01161 / .04458 ÷ 17 = .002622

.00445 / 1.49136 / .51809-2

$V_2'' = \frac{1022}{108} = .009402$ / 01161 / .021012 ÷ 8 = .002626

mean = .002624

.00945 / 2.03342 / .97603-3

$V_2''' = \frac{1022}{197} = .005187$ / 01161 / .016797 ÷

.00945 / 2.9447 / .71498-3

$\varepsilon = 5.266$ 5.481 correct 4.3 % low

.41901-3 / .03248-1 / .19830-3 / .64981-7 / 2.92834- / .72757-10

Volts at 4:20 = 8.33 + 13.8 = 846.8

.00945 / 2.23401 / .77544-3

$V_1 = \frac{1022}{171.4} = .05963$

$V_2' = \frac{1022}{197} = .005187$ / 05963 / .064817 ÷ 18 = .003601 ÷ 17 = 3812

.00945 / 1.79518 / .21427-2

$V_2'' = \frac{1022}{62.4} = .01638$ / 05963 / .07601 ÷ 21 = .003620 ÷ 20 = 3800

.00945 / 1.90526 / .10419-2

$V_2''' = \frac{1022}{80.4} = .01271$ / 05963 / .07234 ÷ 20 = .003617 ÷ 19 = 3801

.00945 / 1.57287 / .43648-2

$V_2'''' = \frac{1022}{37.4} = .02733$ / 05963 / .08696 ÷ 24 = .003623 ÷ 23 = 3787

61 / .003615

4) 15194 / .003799

Differences

.07601 / .06497 / 3) .01104 / .00373 (1)

7601 / 7234 / .00367 (2)

.55811-3 / .88722-2 / .19830-3 / .64413-7 / 3.92824- / .71589-10

5.199

.5796 / .8877 / .1983 / 66556 / 9247 / 76274

5.462

4th Obs. at 5:10 $t = 23.0$ $P = 75.75$

Volts at 4:25

1 − 833 + 13.8 = 846.8
2 − 832 + 13.9 = 845.9
3 − 731 + 18.0 = 749.0
4 − 842 + 13.1 = 855.1
5 − 808 + 15.7 = 823.7
6 − 827 + 14.3 = 841.3

4873 + 88.8 = 4961.8

88.8
4961.8

G		F	
½ - d	whole d	½ d	whole d
17.0	34.0	—	16.2
—	34.2	—	19.0
—	34.2	11.6	23.0
—	34.2		

.00945
1.5334
-2.47605

$v_1 = \frac{1022}{34.15} = .02993$

.00945
2093
-2.79495

$v_2 = \frac{1022}{16.2} = .06310$
.02993
.09303 ÷ 10 = .009303

.00945
2788
.73055

$v_2' = \frac{1022}{19.0} = .05376$
.02993
.08369 ÷ 9 = .009299

00945
3617
.64775

$v_2'' = \frac{1022}{23.0} = .04443$
.02993
.07436 ÷ 4 = .009262

mean $v_1 + v_2 = .009288$

Log $v_1 + v_2 = -3.96799$
½ " $v_1 = -1.23288$
-3.1983
-6.40442
3.6957
-10.7085

5.117 correct = 5.255
2.85 %
2.7 % low

error .5 % or less

.005187
.005963
.01115 ÷ 3 = .003702

.01638
.005963
.02234 ÷ 6 = .003720

.01271
.005963
.018673 ÷ 5 = .003734

.02733
.005963
.033293 ÷ 9 = .003700
4 | 56
.003714

Log $v_1 + v_2 = \bar{3}.56999$
½ " $v_1 = -2.88771$
-3.1983
$\bar{3}.65559$
2.9282
-10.7277

$e_1 = 5.342$ Correct about 5.65
5.5 % low.

There's good for so little a one but use these very small ones I must devise correction still better

t = 23. P = 75.75

Obs. at 5.25

Volts at 5:15

1 − 833 + 13.9 = 846.9
2 − 832 + 13.8 = 845.8
3 − 730 + 18.0 = 748.0
4 − 842 + 13.1 = 855.1
5 − 807 + 15.7 = 822.7
6 − 827 + 14.4 = 841.4
4871 88.9 = 4959.9
88.9
4859.9

G		F	
½d.	D	½d	D
	35.7	27.4	54.7
17.5			54.8
17.6	35.5		

.00945 × .5514 = −2.45805

$v_1 = \frac{1022}{35.6} = .02871$

.00945 × 7384 = −2.21105

$v_2 = \frac{1022}{54.75} = .01867$

5 | 1.04738

$v_1 + v_2 = .009476$

$\text{Log}_4 v_1 + v_2 = -3.9766$
$\frac{1}{2}\text{Log}_4 v_1 = -1.2290$
-3.1983
6.4039
3.6955
$\overline{10.7084}$

$e_1 = 5.110$ 5.267 = correct

3% low error .5%

Obs at 5:30

$\theta = 23.0$ $p = 75.77$

Volts at 6:00 P.M.

1 - 832 + 13.8 = 845.8
2 - 831 + 13.7 = 844.7
3 - 726 + 18.0 = 744.0
4 - 842 + 13.1 = 855.1
5 - 803 + 15.9 = 818.9
6 - 827 + 14.4 = 841.4
4949.9

G	F	
4.746	14.0	—
4.832	14.0	27.6
4.860	—	27.4
4.822	13.6	27.2
4.776	—	27.4
4.842	13.6	27.5
	37.4	75.6
C 28878	37.6	75.0
4.813	37.6	76.0
	15.0	30.4
	15.6	30.8
	—	30.5
	15.6	31.0
	15.6	31.0
	15.3	31.0
	15.6	31.0
	31.4	62.8
	31.4	62.8
	~~27.2~~	22.2
	—	22.2

$\frac{1}{4.813} \times 10^{22} = .20778$

$v_1 = .21237$

$\log v_1 = -1.32708$

$\frac{1}{2} \log v_1 = -1.66354$

$27.42 = .03647$

$\frac{1}{75.53} = .013244$

$\frac{1}{30.81} = .03246$

$\frac{1}{62.8} = .01592$

$\frac{1}{22.2} = .04505$

.2078 .2078
.02647 .013244
74|.24427 64|.221044
.003301 .003299

.2078 .2078
.3246 .1592
73|.24026 64|.22372
.003291 .003290

.2078
.4505
77|.25285
.003284

3301
3299
3291
3290
3284
5|16465
.003293

mean =

This is by far most probable mean If the series of drops had been higher we shd have got mean = 3248. This does not agree so well with differences but is possible.

$v_1 + v_2 = .003365$

Differences

$\frac{1}{27.5} = .03636$
$\frac{1}{75.6} = .01323$
} .02313 ÷ 7 = .003304

$\frac{1}{30.4} = .03289$
$\frac{1}{76} = .01316$
} .01973 ÷ 6 = .003289

$\frac{1}{31} = .03226$
$\frac{1}{62.8} = .01592$
} = .01634 ÷ 5 = .003268

$\frac{1}{222} = \frac{.04505}{.01592}$
$\frac{1}{62.8}$
} = .02913 ÷ 9 = .003237

mean = .003275

and the true value is probably more nearly mean of 1st 3 diffs i.e. .003287 since a ½ sec slop would error in last reading would make last diff come up together 3

$\log v_1 + v_2 = -3.52[illegible]$
$\frac{1}{2} \log v_1 = -1.66354$
3.1963
-6.38887
-3.64446
-10.6943

$e_1 = 4.449$ correct 5.03

1.7 % low.

Finished at 5:58

Obs. at 6:15 $\theta = 23.$ $p =$

G		F	
—	38.6		10.2
19.0	38.4		11.3
	38.4		

Saturday Feb. 10th 1912 $\Delta = 22$ $p = 75.40$

Volts at 3:10 P.M.

G	½ F	whole F
12.200	11.9	23.8
12.182	11.9	23.8
12.324	14.0	27.8
12.176	16.3	32.5
12.278	34.2	68.4
12.206	34.3	68.8

1-829+14.0
2-827+14.2
3-873+17.0
4-840+13.2
5-811+15.6
6-824+14.6
4904+88.6 = 4992.6

Lost it at 3:33 P.M

6|13 6 6
12.228

$$\frac{.00945}{.08358} = \frac{1.022}{12,228} = .083588$$

$$v_2 = \frac{1.022}{23.8} \cdot \frac{.04294}{.08358} = .126521 \div 23 = .005501$$

$$v_2' = \frac{1022}{27.8} \cdot \frac{.036763}{.08358} = .120343 \div 22 = .005470$$

$$v_2'' = \frac{1022}{32.5} = .031446 \cdot \frac{1}{.08358} = .115026 \div 21 = .005476$$

$$v_2''' = \frac{1022}{68.6} \cdot \frac{.014894}{.08358} = .098479 \div 18 = .005471$$

Differences

.115026	.126521	.120343
.098479	.120343	.115026
3|.016547	.006178	.005217
.005516	mean .005697	

↑ by far most reliable

mean weighted $v_1 + v_2$ = .005473

$\log v_1 + v_2 = \bar{3}.7374$
$\frac{1}{2} \log 4 = \bar{1}.4611$
$\bar{3}.1463$
6.3968
3.6483
-10.6985

4,944
23
4,971 e, corrected = 5.109

2.7% low.
% error 1.2%

2nd Obs @ 3:45 Blue drop. $d = 22.$ $p = 94.4 - 19 = 75.40$

G.		F	
½ D.	D	½ D	D.
28.0	56.4	16.4	32.8
27.7	56.4	—	18.4
28.0	56.0	27.4	54.8
27.8	56.2 ←	~~27.6~~	~~55.2~~
		16.6	33.0
27.7	56.0	27.0	53.8
	10		18.40
Mean	56.2		32.90
			54.30

Volts at 3:35

1 - 828 + 14.3
2 - 827 + 14.2
3 - 772 → 17.0
4 - 839 + 13.2
5 - 817 + 15.4
6 - 822 + 14.6

4899 + 88.7 = 4987.7

$\frac{1}{56.2} = .01779$

$\frac{1}{18.4} = .05435$ $\quad .01779$ $\quad .07214 \div 6 = .012023$

$\frac{1}{32.9} = .03040$ $\quad .01779$ $\quad .04819 \div 4 = .012047$

$\frac{1}{54.3} = .01842$ $\quad .01779$ $\quad .03621 \div 3 = .012070$

3 | 140

.012065

.58018 ✓

$\frac{1}{2}\log(.01779)$ → .08013 − 2
$\frac{1}{2}\log V_1$ → .00945 − 1
.12509 − 1
.00472
.19830 − 3
.41769 − 6
3.69793
.71976 − 10

5.2444
± 25

~~5.2252~~

5.222 5.363 = correct

2.8 % low

error .4 %

3rd Obs - 3:57. θ = 22,1 p = 75.35

White - nearly reddish. Volts ab - P.M.

G		F	
l/r	w	l/r	whole.
31.7	64.4	22.0	43.2
31.7	64.4		
31.7	64.0		

1
2
3
4
5
6

4th Obs at 4:14 $\theta = 22.1$ $p = 75.40$

Volts at 4:30

st watch	Gram	½	F D
14.9	15.282	14.0	27.3
	15.286	13.6	~~26.6~~
	15.360	14.0	27.2
		16.3	32.4
15.6			
14.9	15.308	—	20.280
45 4		10.2	20.4
1513	15.328	11.6	22.8
	15.340	27.0	53.0
		38.0	77.0
		38.6	77.5
	15.334	26.4	53.0
	7 | 2138		
	15.305		

Finished at 4:25

$\frac{1}{27.03} = .03700$ — .006644, .005483

$\frac{1}{32.4} = .03086$ — 3 \| .01845, .006150

$\frac{1}{20.28} = .04931$ — 4 \| .02499, .006248

$\frac{1}{22.84} = .04386$ — 5 \| .03044, .006089

$\frac{1}{53} = .01887$

$\frac{1}{77} = .01244$

.005930

5 \| .030~~39~~, .006063

$\frac{1}{15.305} = .06534$

.06534	.06534	.06534	.06534	.06534
3700	03086	04931	04386	01887
17 | .10234	14 | .09620	16 | .11465	18 | .10920	13 | .08421
.006020	.006012	.006034	.006067	.006015

.06534 .01244

.06784 .006027

Differences
.5930
.6089
.6150
mean .006056

828 + 14.3
827 + 14.2
764 + 17.6
839 + 13.2
808 + 15.7
819 + 14.9
4885 + 89.9 = 4974.9

mean = .006022

$v_1 = .06677$

$\log .06534$

-2.8152

$\bar{3}.7797$
.00945
$\bar{1}.4076$
.00472
3.1983
-6.39977
3.6971
-10.70267

5.043
20
$e_1 = 5.023$ Correct: 5.136

2.5% low

Error 3%

5th Obs. at 4:40 $\theta = 22.1$ $p = 94.6 - 18.9 = 75.7$

contact chronograph

G	F		
18.344	93.4	187.4	$\frac{1}{187.4} = .005336$
18.356	41.6 / 42.4	83.2 / 84.1	$\frac{1}{83.65} = .011955$
18.373	16.0	31.6	$\frac{1}{31.7} = .03155$
18.376	16.2	31.8	
18.4	27.0	54.2	$\frac{1}{54.2} = .01845$
18.422	42.0	83.8	$\frac{1}{83.8} = .01193$
18.362			
6	4233		
M →	18.372		

$\frac{1}{18.372} = .05444$ $v_1 = .056638$

Finished at 5:00

Differences

.01845	.03155	.031555	.011955
.01193	.01845	.011955	.005336
.00652	2) .01310	3) .019595	.006619
	.00655	.006532	

mean = .006555

.005336 + .011955 = .017291 ÷ 9 = .006641

.01193 + .01845 = .03038 − .03155 = .00117 ÷ 2 = .000585

.066395 ÷ 10 = .006639

.03155 − .01845 = .01310 ÷ 2 = .00655

.5444 − .4549 = .0895 ÷ 13 = .006846

.5444 − .7269 = −.1825 ÷ 17 = −.010735

.5444 − .6637 = −.1193 ÷ 10 = −.011930

.01193 + .01845 = .03038 ÷ 2 = .01519

.01519 − .00585 = .00934 ÷ 14 = .000667

.5444 − .6637 = −.1193 ÷ 10 = −.011930

5) 15.9

.006631

$\log .006631 = -3.82155$

.00945

-2.7354	-1.36795
-1.3660	-3.1983
	-6.39725
	-3.6963
	-10.70095

5022

20

$e_1 = 5,002$ Corrected =

110

6th Obs at 5:05.

θ = 22.2 / 9.46 - 19.1 = 75.5

G watch	G Chro-	F 1/2	F 2	
	4.810	—	33.6	
	4.686	17.0	34.0	33.93
4.6		17.2	34.2	
		30.4	61.2	61.20
		13.0	25.7	
		12.8	25.8	25.73
		12.6	25.6	
			25.696	25.76
			25.828	
		39.3	79.4	79.41
			79.416	
			17.182	17.26
			17.344	
	4.694			
	4.684			
	4.754			
	4.732			
	4.760			
	4.658			
	4.706			
	4.732			
	4.680			
	4.766			
	4.768			
	4.762			
	4.700			
	4.744			
	4.690			
	4 696			
	4.644			
	4.662			
	141 26			
	14 11 6			
	4.7058			

Finished 5:30

mean = 4.7058

1/4.706 = .2125

V_1 = .21717

log = -1.33680 / -1.66840

Volts at 5:30

1 - 827 + 14.4
2 - 826 + 14.6
3 - 754 + 18.0
4 - 838 + 13.3
5 - 806 + 15.8
6 - 819 + 14.8

4870 + 909 = 4960.9

1/34.2 = .02924
.02924 = .01634
.01290
41
00330

1/61.20 = .01634

1/257 = .03891

1/325.76 = .03882

1/79.41 = .012589

1/17.26 = .05794

Differences

.02924	.03891	.03882	.05794
.01634	.01634	.012589	.012589
.01290	.02257	.026231	.04535
00330	003224	003279	003240

3300
3224
3279
3240
4)1043
.003261 = mean diff

.2125	.2125	.2125	.2125
.01634	.03882	.012589	.05794
.22884	.25132	.22509	.27044
70	77	69	83
003269	.003264	003262	.003260

mean = .003263

log -3.51362
00945
-1.66840
3.1983
6.38977
3.69548
-10.69429

4.9465
200
4.9265

e_1 = 4.9265 corr = 5.029

2% low.

7th Obs - at. 5.37 $\delta = 22.3$ $\rho =$ (45)

G		F	
v_2	d		
~~24.5~~	~~60.0~~		
~~69.0~~	~~59.8~~	~~1510~~	18.0
24.0	57.7	—	31.8
—	57.5		
		2637	52.0
28.7	57.7		
	57.63		

~~$v_1 = .0552$~~

$\frac{1}{18} = .05556$

$\frac{1}{31.8} = .03145$

$\frac{1}{52} = .01923$

$\frac{1}{57.63} = .01735$

$v_1 = .01773$

$\log = -2.248704$

$\frac{1}{2}$ " $= -1.12435$

Differences

.05556	.03145
.03145	.01923
.02411	.01222

mean = .01211

.05556	.03145	.01923
.01735	.01735	.01735
6|.07291	4|.04880	3|.03658
.01215	.01220	.01219

mean = .01218

$\log .01220 = -2.085565$

" -1.12435

$.00945$

3.1983

-6.41875

3.69513

-10.77262

Volts = 4956

5.2801

164

$e_1 = 5.2637$

5363 = correct

1.9% low.

error 5%

44/8th Obs at 5:57 P.M. θ = 22.2 P. 943-19.4

Volts at 6.33

G	F			
	1/4	D		
	18.3	36.4	1/30.7 = .03257	
	15.6	30.7	1/36.4 = .02747	
	——	82.2	1/82.2 = .01217	
	18.3	36.4		
11.112				
11.056				
11.176				
11.144				
11.146				
11.124				
11.126				
11.086				
11.088				
11.086	12.0	23.4	1/234 = .04274	
11.160	——	26.4	1/26.4 = .03769	
→ good 11.168	13.0	26.4		
	13.6	26.6		
11.124				
11.196	18.4	36.4	1/36.8 = .02717	
	18.8	37.2		
11.146	18.3	36.7		
11.084	42.2	83.7	1/83.7 = .01193	
11.134	10.6	20.8	1/20.8 = .04808	
11.127				

Finished at 6:21 P.M.

1/11.127 = .08987

V = 2.09185 log = -2.963066 -1.48154

= 759
826 + 14.6
825 + 14.5
752 + 12.0
837 + 13.4
802 + 15.9
819 + 14.8
4861 + 91.2
= 4952.2

Differences.

.03257 .02747 .02717
.02747 .01217 .01193
.00510 3|.01530 3|.01524
.00510 .00508

.04808 .03767 .03769
.01193 .02717 .02717
7|.03615 .01050 .01052
.005165 .00510
.510
.508
.5165

Taking the 4 big groups

Mean .005111

.03257 .02747 .01217
.08987 .08987 .08987
24|.12244 23|.11734 24|.10204
.005102 .005102 .005102

.04274 .03764 .02717
.08987 .08987 .08987
26|.13261 25|.12756 23|.11704
.005100 .005102 .005090

.01193 .04808 .5102
.08987 .08987 .5102
20|.10780 27|.13795 5102
.005090 .005109 5100
5102
5090
5109
51|.797
5100

log .005100 = -3.707570
.009455
-1.481454
3.19483
-6.396886
3.694781
-10.704080

Mean 5036/18 = 5.018

Correct = 5.094

Error not over .4%

1.6% low

Tuesday - Feb. 13th 1912 — $\theta = 23.0$ $p = 94.6 - 18.8 = 75.8$ (43)

First Observation →

Volts at 3:40 PM,

857 + 12.0
858 + 12.0
844 + 12.3
856 + 12.0
839 + 12.8
849 + 12.9
5103 + 73.2 = 5176.2,

(51)

G	F
	~~17.5~~ 17.514
	17.5—
	46.724
	46.494
	18.727
	18.616
	56.280
	56.276
	21.362
	21.476
	58.936
	58.194
	58.456
	58.904
	20.412
	20.404
	20.332
	10.710
	10.660
	20.290
	20.298

4.346
4.400
4.310
4.376
4.370
4.422
4.392
4.290
4.392
4.360
4.346
4.368
4.350

13) 47.272
4.363
4.328

$\frac{1}{4.328} = .2308$

$V_1 = .23565$
Log. -1.37227
-1.68613
$\frac{1}{2}u = -1.68483$

$V_1 =$

finished at 4.28

$\frac{1}{17.51} = .05711$

$\frac{1}{46.62} = .02145$ 2142 → $\frac{.03569}{11} = .0032444$

$\frac{1}{18.68} = .05356$ → $\frac{.03216}{10} = .03216$

about 2 min. elapsed. → $\frac{.03582}{11} = .03256$

$\frac{1}{56.28} = .01777$ .01774 → $\frac{.02895}{9} = .03217$

$\frac{1}{21.42} = .04671$ .046691

$\frac{1}{58.62} = .01706$ .01703 → $\frac{.03199}{.003226}$

$\frac{1}{20.380} = .04904$ .04902

$\frac{1}{10.69} = .09355$

$\frac{1}{20.293} = .04928$ 4926

$v_1 + V_2 = .0032225 \times 1021 = .0032927$

Log $.0032927 = -3.51755$
-1.68613
-3.19776
-6.40144
3.7133
-10.68814

-3.51755
$.00945$
1.68613
3.19783
6.39341
-10.68810

$C_1 = 4877$

$3/14 \; 37628$
2.79209

Differences

.05711	.05356	04671	.04904	.09355	
.02145	.02145	.01777	.01756	.04928	
.03566	.03211	.02894	.03198	.04427	
.003242	.003211	003216		.003182	

.3242
.3211
.3216
.3198
.3180
.3162
6) 1209
.3201

2288 3217
3235 3213
3233 3213
3233 3207
3228 3208
3227 3198
3219 3198
3216 3191
3211 3191
5) 16020
3204
.0032245

2308 5711 .28791 .003199
2308 5711 .28222 .003199 3193
2308 5356 .284476 3176
2308 4774 .2484 3165

89 .003235 78 3233 88 3233 77 3228

2308 4669 .27749 3171
2308 1703 .24882 3157
2308 4902 .27982 3167
2308 9355 .32435 3165

86/3227 77 3218 87/3216 101 3215

2308 4926 .28008

87. 3218 — .00445

a cot
-16.4209
3.7133
-1.68613
-13.82033
-3.51755
3 | -10.30278
-4.7676
1.8797
-2.6473
1.3527

1
-4.8547
1.8787
-.69758
-4.7676
-2.20882

.01615 = l/a
.0005856 = a
22.52 = 1/fa

34% low

2nd Observation 4:45 $\theta = 23{,}00$ $p = \frac{947}{1.613}$ 76.0

Red drop

Volts at 4:30

855 + 12.0
856 + 12.0
840 + 12.7
855 + 12.6
834 + 13.4
847 + 13.0
5087 + 75.1 = 5162.1

49

Q		F	
10.3	1st div		
21.2	2nd div		
31.6	3rd "		
42.3	4th "		
53.0	5th		
63.6	6th		
74.3	7th		
84.6	8th	19.6	$\frac{1}{196} = .05102$
10.3			
10.9			
10.4			
10.7			
10.7			
10.6			
10.7			
10.3			
8 | 84.6			
10.57			
42.3	85.2	28.570	
within 5 div of plate		within 5 div of bottom of plate	
42.3	85.1	35.6 − 35.6	
9.8	9.8	71.0 − 35.4	
20.0	10.2	104.0 − 33.0	
30.3	10.3	137.3 − 33.3	
41.3	11.0	169.4 − 32.1	
51.6	10.3	200.6 − 31.2	
62.6	11.0	232.6 − 32.0	
73.0	11.0	265.0 − 32.4	
84.0	11.0	33.3 − 33.3	
10.9	10.9	70.3 − 37.0 − 36.0	
21.6	10.7	37.0	
31.7	10.1	33.6	
—	10.2		
12 | 126.5		12 | 479	
	10.54	34.00	
		272	
10.3	10.3		
20.5	10.2		
31.0	10.5		
41.0	10.0		
52.0	11.0		
62.4	10.4		
73.0	10.6		
83.6	10.6		
10.3	10.3		
21.0	10.7		
31.6	10.6		
42.3	10.7		
	10492		

mean = 10.5 × 6 = 84.6 = .01188

$\frac{1}{84.6} = .01214$

$v_1 = .05422$ $\log v_1 = -2.05422$

$v_2 = .04211$ $\log v_2 = -1.04211$

5.2 3 P.M.

.01188 .05102 → 4 | .06290 → 01572
.01188 .03501 → 3 | .04689 → 01563
.01188 .003676 .015556

$\frac{1}{28.57} = .03501$

.015566 .01563 .01566 → 3 | .04685 → .01560 mean

$e^{x/3}$

3 | −10.7244
−4.4100
7.8200
66.07 = $e^{x/3}$

$\frac{1}{272} = .003676$

$p = .0000416$

a	
−16.42270	−4.8547
3.72299	1.8808
−2.08842	−6.9739
−14.24111	−4.0128
−2.2026	−2.9611
3 | −12.03385	.09144 = $\frac{p}{a}$
−4.0128	.0001030 = a
1.8808	
−3.8936	
2.1064	1278 = $\frac{1}{a}$

Error .5%. must calculate slow one get worked on.

log .0156 = −2.1931
.00945
−1.04211
3.1483
−6.44296
3.71307
−10.72989

5.364 correct = 5.464

1.86% low

3rd Observation — 5:38 — Blue drop

Q = 23.0

Volts at 6:25

849 + 12.9
852 + 12.4
836 + 13.5
851 + 12.9
830 + 14.1
842 + 13.1
5060 + 79.4 = 5139.4

p = .946 / 16.75 / 15.85

Volts at 5:50

846 + 12.2
851 + 12.0
834 + 13.4
851 + 12.0
829 + 14.3
841 + 13.6
5052.4 + 76.5 = 5128.5

411

G

22,824
22,890
22,818
22,720
22,774
4026
5) 22,8005

Finished at 5:45

F

7.610
4,400
30.2
36,683

$\frac{1}{22.8} = .04386$

$\frac{1}{30.2} = .03311$

$\frac{1}{36.68} = .02726$

$\frac{1}{7.610} = .1314$

$v_1 = .044825$

$\log = 2.65152$

$\frac{1}{2}\log = 1.32576$

$v_2 = .02786$

$.072685$

$\log v_1 + v_2 = \bar{2}.86145$
-1.32576
$-3\ 1983$
5.38551
-3.71024
-9.67522

9 | 47.34
52

Something the matter with the 36,683 speed

This computation is for the 30.2 speed

t_1: 843 − 84.5 − 840 − / 8427

t_F: 19.6 / 28.690 / 272.0

n: 4 | .01572 / 3 | .01561 / 2 | .01565 / 1 | .01554 / 3)1187 / 1562

2)1143 / 1571

$\frac{1}{8427} = .01186 \times 1021 =$

$v_1 = .01211$

$v_1 + v_2 = .01562 \times 1021 = .01545$

$\frac{1}{196} = .5102$

$\frac{1}{286} = .03497$

$\frac{1}{272} = .003676$

$\log_{t_1} = -2.0831$

$\frac{1}{2}\log = -1.04155$

$\log = -2.2028$
-1.04155
-3.19776
-6.44211
3.71114
-10.7307

$e_1 = 5.379$

3) 19.4614 / 7.8205

$e^{\frac{1}{2}} = 66.14$

.04388
.03311
.07697
1022
15394
15394
7697

$.07866334 = v_1 + v_2$

.5102 / 3676 / 3) 47346 / 1578

.5102 / 3497 / 1805

3497 / 3676 / 31294 / 1565

1186 / 3676 / 1553 63

3497 / 1186 / 4683 / 1561

5102 / 1186 / 4) 6288 / 1572

a

−16.4209
3.7114
−2.0831
−14.2154
−2.2028
3 | −12.0126
−4.0042
1.8808
−3.8855
2.7750

.00004657 = a

$\frac{1}{.00004657} = 1303 = \frac{1}{\mu a}$

$\log v_1 + v_2 = \bar{2}.8957$
$-\frac{1}{2}\log v_1 = -1.3257$
3.1983
-5.4197
-3.7103
-9.7094

$e_1 = 10 | 51.22$

$e = 5.122$

Correct 5.184 / 5122

Probable Worked up Aug 24 — 1.38 Millikan Exposure

1.39, low

(40)

Friday - Feb. 16, 1912

$\theta = 23.0$ $P = 28.0$ 72.9 - 44.9

Volts at 4:05 PM.

848 + 12.9
842 + 13.1
824 + 14.5
855 + 12.8
827 + 14.3
841 + 13.2
5037 + 80.8 = 5117.8

y		F	
½	1	½	1
29.4	59.3	~~23.5~~	22.8
29.0	59.4		23.0
29.0	59.8		
	59.8		

Second Observation.

$\theta = 23.00$

Volts at 5:10

$P = 28.88$

848 + 12.9
839 + 13.2
821 + 14.8
854 + 12.8
826 + 14.5
840 + 13.2
5028 + 71.4 = 5099.4

G		F	
12.2	24.0		
12.3	24.0		
11.9	24.0		
	24.170		10.354
	24.014		
	24.114		
	24.280		12.484
	24.108		
			22.138
			51.3 —
	24.108		35.7 —
	24.086	18.0 —	
	24.008	62.6 — 1st div.	
		60.7 — 2nd div.	
		63.9 — 3rd div.	
		57.8 — 4th div.	
		60.0 — 5th div.	
		58.7 — 6th div	
		58.8 — 7th div	
		59.6 — 8th div	
	24.210		
	24.386		~~47.334~~
			34.334
		46.00	92.20

Finished at 5:05

Saturday, 7 Feb. 17th 1912

Observation at 3:00 P.M.

$\theta = 23.0$ $\beta = \frac{75.75}{41.65} / 34.10$

Volts at 2:45

856 + 12.8
848 + 12.9
840 + 13.2
862 + 12.8
840 + 13.2
848 + 12.9
5094 + 77.8 = 5171.8

S		F	
16.6	32.6		
16.3	32.7		
16.0	32.3	47.6	94.4
16.6	33.2		

Lost at 3:07

Second Observation at 3.20 $d = 23.0$ $p = 36.17 \sim 36.04$

Volts at 3.10

856 + 12.8
848 + 12.9
839 + 13.2
862 + 12.8
839 + 13.2
847 + 12.9
5091 + 77.8 = 5168.8

G.		F
10.418		9.992
10.464		9.988
10.438		9.956
10.342		9.508 (?)
10.422		
→ 10.470	23.7 —	46.8 —
10.414		
10.402	47.6	94.4
10.402		15.702
10.476		17.624
	18.9	37.8 —
	31.7	62.6 —
	31.6	62.6 —
10.430		
		23.106
10.500		23.302
	11.9	23.7 —
	32.0	63.4 —
		63.2 —
	48.4	95.8

Finished at 3.45

Flint Obs. at 4:00 $\theta = 23.0$ $p = \frac{76.95}{40.15}\ \frac{7705}{4010}$ $\frac{}{36.80}\ \frac{}{3695}$

Volts at 3:50 — 852 + 12.8
847 + 12.9
837 + 13.4
861 + 12.8
835 + 13.6
847 + 13.8
5083 + 78.5 = 5161.5

	G		F	
	20.362		13.678	$\frac{1}{13.64} = .07331$
	20.418		13.590	
	20.380			$\frac{1}{358} = .02793$
10.2 —	20.3 —	18.3 —	35.8 —	$\frac{1}{49.8} = .02008$
	20.394	25.2 —	49.8 —	$\frac{1}{79} = .01266$
	20.442	39.9 —	79.0 —	
	20.340	102.2 —	202.8 —	$\frac{1}{202.9}$ 0.04928
	20.358	101.6 —	203.0 —	
	20.324			
	9|3318			
	20.369			
	$\frac{1}{20.37} = .04909$			

Differences

.07331	2008	.01266
.02793	1766	004928
6|.04538	.0742	.007732
007397		

Agreement poor. Will watch out

4909	4909	2008	4909	4904
7331	2793	4909	1266	4928
16|.12240	10|7702	9|69178	6175	5402
00765	.007702	.007686	7719.	7715

mean .007695

Found Obs at 5.15

θ = 23.

Volt at 4.23

p = 68.45 / 50.20 / 18.25

854 + 12.8
847 + 12.9
835 + 13.6
860 + 12.8
833 + 13.4
845 + 13.0
5074 + 78.5 = 5152.5

Pressures at 5.15 - 18.25
5.28 - 18.45
5.35 - 18.45

G	F		
	64.0 —	127.0 —	$\frac{1}{127} = .007874$
14.456		23.296	
14.464		23.300	$\frac{1}{23.28} = .04296$
14.522		23.206	
14.522		23.310	
14.588	11.6 —	23.2 —	
14.540	23.4 —	45.6 —	$\frac{1}{45.6} = .02193$
14.466	33.6 —	67.1 —	
14.548	33.4 —	66.6 —	$\frac{1}{66.7} = .01499$
14.514	33.6 —	66.4 —	
~~14.384~~	17.6 —	34.4 —	$\frac{1}{34.4} = .029007$
14.470	17.0 —	34.24 —	
11)160.90	Finished at 5.32		
14.509			

$\frac{1}{14.509}$ .068925 × 1022 = .070044

Log -2.845819

$\frac{1}{2}$ n = -1.4239

Differences

.04296	.04296	4296	2907	
.007874	2193	1499	1499	
5) .035086	3) .021003	4) 2797	1408	
.007017	.007010	.006993	704	

.068925	68925	68925	68925	68925	
7874	4296	2193	1499	2433	
11) .076799	16) 111985	13) 9085	6) 6391	98256	
.006981	.006999	6989	6993	7018	

Mean = .006996 × 1022

$v_1 + v_2$ = .007150

Log = ~~3.854306~~ 3.854306
1.42391
3.1983
6.476516
3.712229
10.764287

Volt = 5155

e_1 = 5.8113

34) 7 fpd Obs. θ = 23.2

at 5:40

G	F	
1		
17.232	———	23.2 —
17.382		23.0 —
17.320	11.6 —	23.100 $\frac{1}{23.1}$ = .04329
17.346	27.4 1st div.	22.9 —
	—— 2nd div.	
	—— 3rd div.	
	28.1 4th div.	
	27.0 5th div.	
	28.0 6th div.	
	28.6 7th div.	
	—— 8th div.	
17.324		
5)160.4	27.6 1st div.	
17.321	28.2 2nd div.	
	28.2 3rd div.	
	28.4 4th div.	
	27.9 5th div.	
$\frac{1}{17.321}$ = .05773 x 1022	28.1 6th div.	
= v_1 = .05900	27.8 7th div.	
	27.4 8th div.	
	223.6	

Log = -2.770852 mean 223.0 $\frac{1}{223}$ = .004484

$\frac{1}{2}$ = -1.38542

= v_1 = .05526

Trials at 6:15

Volts at 6:20

	at 5:37	at 5:55
	6879	6885
	4974	4975
	19.05	19.10

849 + 12.9
838 + 13.4
825 + 14.5
853 + 12.8
823 + 14.7
840 + 13.2
5028 + 81.5 = 5109.5

Diffs

.04329
.004484
5) .038806
.007761

.05773
.004484
8) .062214
.007777

.05773
.04329
.10102
.007771

mean = .007774 x 1022

= v_1 + v_2 = .07945

Log = -3.900094
-1.38542
-3.1983
-6.4838
3.7084
-10.7754

5.962
4
e_1 = 5.966

Jon Pruett

Beginning with Oil bath- not entirely covered with oil.

Friday - Feb. 23rd 1912.
Obs. began at 4:50 P.M.

$\theta = 23.2$ $P = 94.3 - 19.4 = 74.9$

Volts at 5:30

1 - 7.35 + 18.0
2 - 857 + 12.8
3 - 848 + 12.9
4 - 522 + 06.0
2962 + 49.7 = 3011.7

G		F		
21.4	42.6	33.8	68.4	
21.3	42.9	58.3	117.4	$\frac{1}{67.85} = .01474$
21.6	43.1	24.3	47.7	
22.0	43.3	34.0	67.3	$\frac{1}{47.325} = .02113$
21.0	42.8	23.6	47.2	
21.6	42.9	18.0	36.2	$\frac{1}{36.1} = .02770$
21.4	43.4	24.0	47.5	
21.0	42.7	—	36.0	$\frac{1}{117.4} = .008518$
21.6	43.2	23.6	47.0	
	9)386.9			
	42.98			

$\frac{1}{42.98} = .02327$ $\times 1022 = .02378$

$\text{Log} = -2.376212$

$\frac{1}{2}\ell_1 = -1.18811$

Finished at 5:25 P.M.

Differences

.02113	.02113	2770
.01474	.008518	8518
.00639	2).012612	3)19182
	.006306	6394

mean = .006363

.02327	.02327	.02327	23277
.01474	.02113	2770	8516
6 | .038017	6 | .044440	6 | .050973	31806
.006335	.006343	6375	6362

mean = .006354 $\times 1022$

$= v_1 + v_2 = .006494$

$\text{Log} = \cdot 3.812512$
-1.18811
3.1983
6.198922
3.476881
-10.72011

5.2495
70

$e_1 = 5.2565$ Corrd
$= 5.310$

1.0 g/cm low

32

Saturday - Feb. 24th 1912

[1067 = middle 7 plates]

First Obs at 3:15 $\theta = 23.5$

$p = 94.45 - 19.15 = 75.30$

Volts at 3:05 - 858 + 12.8
856 + 12.8
848 + 12.9
863 + 12.8
836 + 13.6
851 + 12.9
5112 + 77.8 = 5189.8

G		F	
15.750		8.750	
15.712		31.4	$\frac{1}{31.3} = .03195$
	15.6	31.2	
15.748	19.6	39.2	$\frac{1}{39.1} = .02558$
	19.9	39.0	
15.626	12.9	25.6	$\frac{1}{25.87} = .03856$
	12.9	26.0	
	13.0	26.0	
15.680			
15.564	26.4	52.2	$\frac{1}{52.02} = .01922$
15.716	26.0	51.8	
15.666	26.3	52.2	
	26.3	52.0	
15.712	26.2	51.9	
15.676		39.2	$\frac{1}{39.2} = .2551$
10 | 685.0			
15.685			

Diffrences

.03195	.03856	.03856	.02551
.02558	.02558	.01922	.01922
.00639	.01298	.01934	.00629
3 | .01298	3 | .01934		
.06490	.06413		

mean = .006398

.06375	6375	6375	6375
3195	2555	3861	1922
15 | .09570	14 | 8930	16 | 10236	13 | 4297
.006380	.006379	.006394	.006382

mean = .006384 × 1.022

$= v_1 + v_2 = .0065244$

Triumph at 3:45

$\frac{1}{15.685} = .06375 \times 1022 = .06515$

$\text{Log} = -2.813914$

$\frac{1}{2}n = -1.406957$

$\text{Log } v_1 + v_2 = -3.814541$

$\frac{1}{2}n \text{ Log } v_1 = -1.406957$

-3.1983

-6.419798

3.714414

10.705384

mean volts 5181

50743
115 amnt = 5138
5086

1.0% low

Second Observation — $\theta = \Sigma 3.7$ — Volt at 3:55 — $P = 9430 - 19.25 = 75.05$

4:05

857 + 12.8
855 + 12.8
843 + 13.1
862 + 12.8
832 + 13.8
849 + 12.9
5098 + 78.2 = 5176.2

G		F
11.6	1st div	12.8
11.4	2nd div	
11.9	3rd "	
11.7	4th "	
11.8	5th "	
11.5	6th "	
11.4	7th "	
11.3	8th "	
92.6		
11.9	1st	— 25.2 — *
11.7	2nd	
12.0	3rd	
11.0	4th	
11.4	5th	
11.6	6th	
12.0	7th	
11.6	8th	
93.2		44.018
23.6	(1+2)	
23.4	(3+4)	
23.6	(5+6)	
23.0	(7+8)	25.452
93.6		
47.0	93.5	44.094
	93.8	

Difference
.03424
.02270
.01654

.01070 + .03424 = .04494 ; 3 | .04494 ; .01666
.01070 + .02270 = .03340 ; 2 | .03340 ; .01670

mean = .01667 × 1022

$\frac{1}{444.06} = .02270$

mean volts 5166

$\frac{1}{25.45} = .03929$

$v_1 + v_2 = .01693$

$v_1 =$

$\log v_1 + v_2 = -2.22866$
$\frac{1}{2}$ " $v_1 = -1.01941$
$-.31483$
-6.44637
3.71332
-10.73305

5.408
.17
5.425

Corrected to $\left(\frac{d}{1074}\right)$ = 5.417 — Correct = 5.498

1.5 % low

Cf with Simons Feb 13th

Finished at 4:28

$\frac{1}{93.52} = .01070 \times 1022 = .010935 = v_1$

$\log = -2.03882$

$\frac{1}{2}$ " $= -1.01941$

a
−16.4270
+3.7133
−2.0388
−14.1791
−2.2287
3 | −13.9504
−5.9835
1.8754
−2.8589
÷ 2.1411

$\frac{1}{138.40} = \frac{1}{a}$

$l = .00004570$
−4.
−6.9805
−5.4835
−2.9970
$.04993 = \frac{l}{a}$

$e^{x/3}$

3 | −10.7338
−4.9913
−7.8226

$66.47 = e^{x/3}$

30

Third Observation

4:40

θ = 23.7

p = 94.35 − 19.15 = 75.20

Volts at 4:30

856 + 12.8
854 + 12.8
838 + 13.3
861 + 12.8
830 + 14.1
849 + 12.9
5088 + 78.7 = 5166.7

No 1

G		F	F
124 — ~~250~~			
25.486	——	23.6 —	$\frac{1}{23.6}$ = .04237
25.354	——	19.834	$\frac{1}{19.83}$ = .05043
25.376	28.4 —	56.6 —	
25.350	28.4 —	56.5 —	$\frac{1}{56.55}$ = .017685
25.398			
25.358	52.4 —	104.0 —	$\frac{1}{104}$ = .009615
6|2302			
25.384			

$\frac{1}{25.384}$ = .039396 × 10^-2 = .040263 = V_1

L_{04} = −2.604907

$\frac{1}{2}$ = −1.30245

Differences .017685 .009615 .008070 .024685 ÷ 3 = .008228

.05043 .017685 4\|.032745 .008086

mean = .008128

.039396 .05043 = .089826 11\|.008166

.039396 .017685 = .057081 7\|.008154

.039395 .009615 = .049010 6\|.008168

mean = .008167 × 1.022 = .0083423

L_{07} = −3.921286

$\frac{1}{2.11}$ = −1.30245

−3.1983

−6.42203 6

71315

70888

51155

158

e_1 = 5.1313 Corrected = 5.706

e_1 = 5.124 ohm corr

1.46 % loss

Finished at 4:55

$e^{2/3}$	a	l = .000009518
3|20.7102 −30	16.4270	−4.8547
6.9034 −10	3.71315	1.9762
2	2.60491	−6.9785
13.8068 −10	−14.74506	−4.2746
−11.64.09 −10^8	−3.92128	2.7039
	3|12.82378	
	4.27459	l/a = .05067
Nearest 1% 6403 = $e^{2/3}$ for Chromium	a = .0001882	
	log a 2.15082	μ_a = .01415
	log μ_a = 1.8492	
	μ_a = 7.067	

(2) Fourth Observation

θ = 23.5 p = 94.4 − 19.1 = 75.3

Volts at 4.56

856 + 12.8
854 + 12.8
837 + 13.0
861 + 11.8
830 + 14.1
848 + 12.9
5086 + 74.0 = 5160.8

Volts at 3.30

856 + 12.8
853 + 12.8
836 + 13.0
860 + 12.8
828 + 14.3
848 + 12.9
5081 + 78.2 = 5159.0

G	F		
	49.0 —	97.1 —	$\frac{1}{97.1} = .01030$
12,572	31.7 —	62.9 —	
12,522	31.4 —	62.8 —	$\frac{1}{62.85} = .01591$
12,578			
	27.6 − 1st div.		
	27.4 − 2nd "		
	27.4 − 3rd "		
	27.2 − 4th "		$\frac{1}{214.6} = .004660$
	26.4 − 5th "		
	27.3 − 6th "		
	26.1 − 7th "		
	25.2 − 8th "		
12,574	214.6		
		36.6	
12,430		37.0	$\frac{1}{36.85} = .027135$
		36.8	
12,594			
12,544	1.85 —	37.0	
12,562		63.0	$\frac{1}{63} = .01585$
12,510			
12,514			
10 | 54.00			
12.54			

Finished 4.57.8

Differences.

.01591	.01591	.027135	.027135
.01030	.00466	.00466	.01585
.00561	2 | .01125	4 | .022475	2 | .011285
	.00562	.005619	.00564

mean = .0056225

.07974	.07974	.07974
.01030	.1591	.04666
16 | .09004	17 | .095565	15 | .084440
.005627	.0056225	.005627

.07974	7974	5627
.027135	1585	5625
14 | .106875	17 | 95.59	5627
.005625	5623	5625
		5623
		.0056244

$\frac{1}{12.54} = .07974$

$v_1 + v_2$ = mean = .005623 × 1022 = .0057466

$v_1 = .07974 \times 1022 = .08148$

$\log = -2.91066$

$\frac{1}{211} = -1.45533$

a	
−16.4270	
3.7126	
−2.9106	
−13.0509	
3.7594	
3 | −11.2915	
4.4305	

$\log \frac{1}{a} = 1.6927$

$\frac{1}{a} = 49.29$

$\log = -3.75940$
-1.45533
-3.19683
$6.41926 = 5.5^{16}$
$3.71256 = 5.5^{16}$
-10.76600

$l = 4505$

4.8547	
1.8768	
6.4779	
−4.4305	
2.5474	

$l_a = .03527$ $\frac{1}{28.35} = \frac{1}{l_a}$ 5.0170 1.15

$a = .0002695$ 5.023

$\log a = -4.56968$ $\log a = -3.57026$ $= e_1$

$\log \frac{1}{a} = 3.3073$

$\frac{1}{a} = 2036$ $= 4952$

$e^{7/3}$

3 \| −10.7019

6.9006 − 10 \| 144.0000 = 7.8008

13.8012 − 20

$6327 \times 10^8 = e^{7/3}$

7004

Error 2%

error = 5.113

= 1.57% low

Publish this
Beautiful one
good for showing
method of
computation and
how error is made
up of

(78) Tuesday - Feb. 27th 1912

First Observation

Began ab. 3:10 P.M.

θ = 22.8 P = 94.3 - 19.2 = 75.1

Volts at 2:50 P.M.

855 + 12.8
859 + 12.8
841 + 13.2
864 + 12.8
838 + 13.4
852 + 12.8

G		F	
28.6	58.4		29.3 —
29.4	58.8		

Finished at 3:14 P.M.

1/58.6 = .01706 × 1021 = .017163 = v_1

1/29.3 = .03413

.05119 × 1021 = .052265 = $v_1 + v_2$ ÷ 4 = .013066

5109 + 77.9 = 5186.9 + 16 = 5166

Log = -2.23510

½ = -1.11755

Log -2.71821
-1.11755
3.19983
-5.03406
3.71120
9.32204

4) 20.992
5.248

e, 5.2443

Log -2.1161

5.375 = current

2.5% low

Error 1%

This curve not yet plotted on account of error in P & θ.

a

-16.4270
3.7120
-2.1161
-14.3751
-2.1161
3 | 12.2580
-4.0860 .0001219 = a
1.8756
-3.9616 .004154 = ℓ/a
12.0384 1009.2 = 1/ℓa

ℓ = .00000953

-4.85474
1.87756
-6.97914
-4.0860
-2.89314 .07818 = ℓ/a

$e^{2/3}$

3 | -10.75495
6.9065 - 10
2
13.8130 - 20
~~81.30 × 8~~ = $e^{2/3}$
65.02

ℓ = 9540

-4.8547
1.8756
6.9791
-4.4634
-2.5157

ℓ/a = .03278

a

-16.4270
3.7118
-2.4772
-13.1160
-3.7259
3) -11.3901
-6.4634 -10
1.8756
-2.3390 = log ℓa
.02183 = ℓa
1.6610
45.81 = 1/ℓa

a = .0002907

$e^{2/3}$

3 | -10.7008
6.9003 - 10
2
-7.8006
63.19 = $e^{2/3}$

Feb. 27th 2nd obs.

No 3 (47) ✓

$\theta = 22.85$ $p = 94.35 - 19.15 = 75.2$

Volts at 3:15

855 + 15.0
858 + 14.0
839 + 12.8
864 + 12.8
834 + 13.7
852 + 12.9
5102 + 78.3 = 5180.3
− 18
5162

Beauty
One of the worst

Q	P		
10.744	18.3 —	36.6 —	$\frac{1}{36.64} = .02729$
10.782	18.6 —	36.7 —	
10.746	18.3 —	36.7 —	
10.756	18.6 —	36.6 —	
10.756	—	36.6 —	
	—	10.644	$\frac{1}{10.645} = .09394$
	—	10.646	
10.784	18.5 —	36.6 —	
10.738	—	—	
	33.4 —	45.4 —	$\frac{1}{45.5} = .02198$
10.782	23.4 —	45.6 —	
10.862	15.6 —	30.7 —	
10.784	15.6 —	31.2 —	$\frac{1}{31.1} = .03215$
10.692	15.6 —	31.1 —	
10.740	—	31.2 —	
10.730	16.0 —	31.2 —	
	135.8 - 1st div		
	131.7 - 2nd "		
	120.0 - 3rd "		
	130.0 - 4th "		
	134.8 - 5th "		
	147.0 - 6th "		
	147.8 - 7th "		
	150.2 - 8th "		
10.712	23.4 —	45.6 —	$\frac{1}{45.9} = .02179$
10.806	23.4 —	46.2 —	
10.612	—	—	
	18.6 —	37.2 —	$\frac{1}{37.2} = .02688$
10.884	15.5 —	31.4 —	
10652	15.6 —	31.2 —	$\frac{1}{31.3} = .03195$
10.816	—	—	
	30.6 —	61.0 —	
10.792	—	61.0 —	$\frac{1}{61} = .01639$
10.7585			

finished at 4:26

see 3rd bell shaped field

$\frac{1}{1097} = .0009115$ 1097.3

$\frac{1}{10358} = .09294 \times 1021 = .09489 = r_1$

$\log = -2.97722$

Differences

.09394 — 2729 — 13 | .06665 — 005127

2729 — 2198 — 00531 — 2 | 1017 — 5085

3215 — 2198 — 1017 — 2 | 509 — 3 | 1556 — 5187

2688 — 2179 — 509 — 3 | 1556 — 5187

3195 — 1639 — 1556 — 3 | 5187

.03215 — .00091 — 6 | 3124 — 5207

2179 — 91 — 4 | 2088 — 5220

5127, 5310, 5085, 5090, 5187, 5207, 5220 — 7 | 1226 — 5190

.09294 — .02729 — 23 | .12023 — .005227

9294 — 9394 — 36 | .18688 — .005191

9294 — 2198 — 27 | 11492 — 5224

9294 — 3215 — 24 | 12509 — 5212

9294 — 00091 — 24 | 19385 — 5214

9294 — 2179 — 24 | 11473 — 5215

9294 — 2688 — 23 | 11982 — 5210

9294 — 3195 — 24 | 12489 — 5204

9294 — 1639 — 21 | 10933 — 5206

5227, 5191, 5224, 5212, 5214, 5215, 5210, 5204, 5206 — 9 | 1903 — 5211

Weighted diffs.

5207 × 6
5127 × 3
5310 × 1
5220 × 4
5187 × 3

5200

mean of last two 2/3
5207
5220
5213

fine one

mean = .005211 × 1021
$= r_1 + r_2 = .005320 4$

$\log_{r_1} = -3.72594$
-1.48661
3.1483
-6.41285
3.71329
-10.69995

mean volts 5163

5010 — 3 — 5007

e_1 = 5007
e_2 = 5.001

$e^{4/3}$
6991
3 | 19982
7.7994
$e^{4/3} = 63.00$

7 Feb. 27 — Third Observer at 11:40

204

46

θ = 22.87

p = 94.2 − 19.28 = 75.0

Volts at 4:27

851.0 + 12.9
853.0 + 12.8
827.0 + 14.3
861.0 + 12.8
827.0 + 14.3
849.0 + 12.8
5068.0 + 79.9 = 5147.9

G	G	F		
13.582	—	16.450	16.450	= .06079
13.588	—	20.458	20.431	.04895
13.504	—	20.498		
13.572	—	20.366		
13.544	63.6 —	126.0 —	126.66	.007893
13.542	63.9 —	127.6 —		
13.648	63.6 —	126.4 —		
13.582	—	27.010	26.932	.03713
13.536	—	26.854		
13.500				
13.580				
13.578				
13.562				

Differences

.04845	.06079	.03713	4 .03845
.00789	.04895	.7893	3713
7 | .04106	21 .01184	5 | .02924	2 | 11582
.005866	.0592	.005848	.005791

mean = .005857

.073746	.073746	.073746	.073746
.06079	.04845	.7893	.3713
23 | 1.345 26	21 | 1.224 96	14 | 1.639 14	11 | 1.068 86
5849	5842	5837	5835

mean = .005842 × 1021

5:00 P.M.

$\frac{1}{13.56}$ = .073746 × 1021 = .075294

$\log = -2.87676$

$\frac{1}{2}\log = -1.43838$

$V_1 + V_2 = .059618$

$\log = -3.77538$
-1.43838
3.1983
6.41206
3.71095
10.7071

mean volts = 5139.5

5.02570
36

5.124 = correct

Corrected for mean ← 5.0234
9.5857/8.5839 = 1.8% low

Error 5%

$e_1 = 5.016$

Prob. error 4.5%
too low judged from dif. but 5857 + 5839

a

−16.4270		
3.7108		
−2.8768		
−13.0146		
−3.7754		
3 | −11.2392		
−4.4180		
1.4751		
−2.2882		
1.7138		

$\rho = .00004542$

−4.8547		
1.8751		
−6.9796		
−4.4131		
−2.5665		

3702 / 3697 = $\frac{l}{a}$

.03686 = $\frac{l}{a}$

.000 2569 = a

2571

51.50 = $\frac{51.65}{.973}$ = $\frac{1}{ha}$

$e^{2/3}$

3 | −10.7017		
6.9006	−10	
−7.8017		

7003 / 2

3 \| 1.9406
−7.8002

63.26

63.13 = $e^{2/3}$

Feb. 27th

Fourth Observation at — 5:15

θ = 22.86

p = 94.2 − 19.2 = 75.0

Volts at — 5.05

705

Have used

Diff. to correct

V. Justified in discussion.

Perhaps Publish

G		F	
6.354		9.756	1/9.700 = .1031
6.394		9.776	
6.468		9.572	
6.402	35.6	70.6	1/70.62 = .01416
6.388	35.6	70.8	
6.448	35.2	70.4	
6.492	35.6	70.5	
6.424		70.8	
6.454		29.416	1/29.41 = .03400
6.438		29.384	
6.420		29.440	
6.430		33.2	
6.492		33.388	1/33.405 = .02944
6.494		33.460	
		33.366	
	84.0	166.5	1/166.5 = .006004
6.504		166.6	
6.446			

16704 / 6440.5

Threshold at 5.45

1/6.44 = .1553 × 1021 = v_1 = .15856

Log = −1.20019

½ " = −1.6001

l = .00004542

Differences

.1031	3400	3400	2994	3400
1416	1416	2994	6006	6006
27 | 208894	5 | 201984	.004066	23934	7 | 27994
4043	3968		3989	3999
				3989
				3968
				4043
				4 | 15999
				.004000

1031	.1553	1553	4037
.1553	1416	3400	4035
64 | 2584 43	16946 47	47 | 18930	4028
4037	4035	4028	4037
			4035
			4028
			4027
			4032
			5 | 159
			4032

7553 / 2994 / 46 \| 18524 / 4027

1553 / 6004 / 40 \| 161304 / 4032

mean of 4032 + 4000 = .004016 × 1021

= $v_1 + v_2$ = .004100

Log = −3.61278

½ = −1.6001

3.1983

−6.41118

3.70995

10.70123

Take rather 4000 as correct

Then ½ = .1540

instead of .1553

then $v_1 + v_2$ = 6.15723

4084

Log = −3.6111

−1.5988

3.1963

6.4077

3.7100

−10.6977

4.9877

3

Correct = 5.048 4.983

mean Volts = 5.048

5.026

3

5.023

e = 4.977

e = 62.80

.5% low

Probably about .8% too high

Judged from diff but 4000 & 4032

a

−16.4270

3.7099

−1.1965

−13.3334

−3.6178

3 \| −11.7223

−4.5744

1675

−2.9069

1.6500

−4.8547

1875

−5.9796

−4.5744

−1.4052

6.9796

−4.5748

−2.4048

.02548 = δ/a

.000376 = a = 3743

1/a = 3553 = final

1/a = 3644

a = 35.64

e^{2/3}

3 \| 10.7000 \| 10.6475

−4.6003 \| 3 \| 14.3950

7.8006 \| −7.7983

63.18 = $e^{2/3}$ = 62.84

Can't get shorter than this at present.

7 Feb. 27th
Fifth Observation
no 6
45

θ = 22.8 P. 94.25 − 19.25 = 75.0
Voltsat − 5.46

850 + 12.9
850 + 12.9
817 + 15.0
860 + 12.8
825 + 145
848 + 12.8
3050 + 70.9 = 5120.9

Voltsat 6.15

850 + 12.9
849 + 12.9
807 + 15.7
860 + 12.8
825 + 14.5
847 + 12.9
5038 + 81.7 = 5119.7

G	F		
8.328	50.266	1/50.26	= .01989
8.554	50.252		
8.664	50.4		
8.414	16.480	1/16.48 = .06068	
8.644	15.450	1/15.45	.06473
8.612	21.166	1/21.19	= .04719
8.460	21.220		
8.344	85.6 170.0	1/171.9	= .005817
8.512	87.6 173.8		
8.390			
41922			
8.492			

Diffs

06068 .04719 4719 6478
1989 01989 5817 1954
9|.04079 6|.02730 9|4137. 448
.004532 .004550 4597

4597
4550
4532
3|1679
4560

1178 1178 1178
1984 4719 5817
30|.13769 36|16499 27|.1236
4590 4583 4580

mean = 4584
lower 15% = 4574

6:15 P.M.

1/849 = .1178 × 1021 = V1 = .12027
Log = −1.08015
1/2 11 = −1.54008

mean of work = .004572 × 1021
= V1 + V2 = .004668
Log = −3.669131
−1.54008
3.1983
6.407511
3.70927
10.69824

4992
4
e1 = 4.988 5061 comet
e1 4.982
1.46% low

This makes V1 = .12027 just 5% higher than the work shown and gives e1 by .07% and e by .05%

ρ = 9542

a

-16.4270
3.7043
-1.0802
-13.2165
-3.6691
3|11.5474
-4.5158
1.8751
-2.3909
1.6091

-6.4796
-4.5158
-2.4638

.02419 = ρ/a
2478
2933

.0003274 = a
3270
3264

40.66 = ρa
4078
40.85

e^2/3

3|-10.6479
-4.8993
-7.7986

62.88 = e^2/3 = 62.82
6283

Wednesday - Feb. 28 - 1912 $\theta = 22.8$ $P = 60.92 - 39.00 = 1.92$

First Observation. Valtsat 4.5 = 853 + 12.8 = 865.8

5:00 P. M.

G		F		
31.0				
32.0				
31.2	61.6 —	—	9.9 —	$\frac{1}{10} = .1000$
30.4	63.8 —	—	10.1 —	$.01595$
4.46	1254			
31.15	62.7			

$.11595 \times 1021 = .11838 = v_1 + v_2$

$\frac{1}{62.7} = .01595 \times 1021 = .016285 = v_1$

$\log_{10} = -2.2117$

$\frac{1}{2} v_1 = -1.1059$

$\log_{10} = -1.0738$
-1.1059
-3.1983
-5.3775
2.9374
-8.4401

$e_n = 275.5$

$e_1 = 138.^{2} = 91.8^{3} = 69.0^{4} = 55.1$

Can't compute

a

-16.4770
$2.93 \quad 4$

Second Absevation Wed - Feb. 28 — θ = 22.8 P = 58.38 - 61.49 = 3.11

5:20

Volts at 5:41 = 850 + 12.0 = 862.0

G	F	
10.504	8.108	$\frac{1}{8.093} = .1236$
10.566	8.064	
10.628	8.106	
	15.770	
10.636	15.764	$\frac{1}{15.789} = .06333$
10.578	15.834	
10.836		
10.588	8.018	$\frac{1}{802} = .1247$
10.544	15.826	$\frac{1}{15.8} = .06329$
10.586	15.770	
10.486	28.440	$\frac{1}{2842} = .03519$
	14.3 — 28.4 —	
	28.418	
10.570	14.2 — 28.4 —	
10.458	30.662 (?)	$\frac{1}{30.66} = .03261$
126.980		
10.582		

709

.1236 .06329 .1247 3219
6333 3519 6329 3261
24) .06027 11) .02870 24) .06141 .00258
.002511 .002554 .002558

.002541

.09452 .09452 .09452
12.36 .06333 3519
86) .21812 63.15785 51) 12971
.002536 2543 .002541
2541
2536

mean = .002541 × 1021 =

$v_1 + v_2 = .0025444$

Log = -3.41404
-1.49227
3.14883 276
-6.10407
2.93557 $486^2 = V$
4.16870
9.1685
14.776 14.74
14.775 Constants
$e_1 = 14.73$

Finished at 5:40

$\frac{1}{10.58} = .09452 \times 1021 = v_1 = .096504$

Log -2.98454
$\frac{1}{2}i_1 = -1.49227$

$l = .0002301$

709 66

a

09
16.42705
2.4359
-2.4845
-14.34090
-3.41404
3) 12.92686
-4.3090
.4928
8018 -4.80188
3.1982 3.2461

-4.8547
.4928
-4.3619
-4.3090
.0508 · .1124 = l/a
.0529

1.130 = l/a

.0002046 = a

2000 = a

1578 = 1/r
1977 = 1/ra

9.1682
3) 18.3364
6.1121

$e^{2/3} = 1294$

3) 9.1687
-3.05623
2
-6.11245 $\times 10^{-8} = e^{2/3}$
$129455 = e^{2/3}$

-10.46136
2.9355
-7.39686
-3.41404
-5.98282
-4.3090
-1.67382
.0002
-1.67402
.32598 1/R

2.1185
Log 1.118 = .0485
3.1982
-4.8503
b = 70.85

.0485
.0529
9956

A = .9900

Third Observation Wed. Feb. 28 θ = 22.8

P = 61.74 − 58.09 / 3.65

~~No 8~~

Volts at. 848 + 12.4 = 860.4

G20

G		F	
17.6	35.8		21.7
	35.584		22.080
	35.912		22.036
18.0	36.2		22.196
17.6	35.2		21.940
	35.872		22.398
	36.4	29.4	57.8
18.0	35.5	29.0	57.6
17.5	35.2	29.0	57.7
18.0	35.5	19.3	37.8
17.6	35.2	19.2	38.6
~~18.6~~		18.6	37.6
17.6	35.8	18.9	37.5

6)619 (17)6)672 (35.6°

17.74

6.20

1/22.13 = .04519

1/57.7 = .01733

1/37.875 = 26.41

Differences

.04519 / .01733 / 3)02786 / 009286

2641 / 1733 / 00908

.02806 / .04519 / 8)07328 / 009160

2806 / 1733 / 1073 / 5)04542 / 009084

1806 / 2641 / 6)05450 / 009083 / 9084 / 9160 / 3)27327 / 009109

mean = 009287

×1021 = 009287

Log = −3.96788 / −1.22876 / 3.19776 / −6.39488 / −2.93505 / −9.45993

1/35.64 .02809 / 02806 × 1.021 = .02866

Log = −2.45737

1/2.11 = −1.22876

e^{2/3} = 202.54

3)19.9186 / −6.3062

e = 2880 / 27 / 32.978 / e = 32.32 corrected for low pressure

ρ = .0001461

−4.8547 / 5625 / −4.29229 / −5.94883 / .34347 / 22207 = ρ/a

a

76.42 09 / −2.4573 / +2.9350 / −15.813 / −3.4688 / 3)−13.8454 / −5.9488 / .5623 / −4.5 1100 / −3. 8800 / 4.890

.0008880 = a

3048 / 3044 / 3042 / 3155 = 1/ρa

Beauty for low pressure

Corrected Aug 26

e^{2/3} / 3)−9.5103 / −3.17012 / −6.3404 / e^{2/3} = 218.6

21.90 × 10 = e^{2/3}

a/c

−10.46136 / 2.9350 / −7.39636 / −3.9688 / −5.42856 / −5.9485 / −1.4800 6 / 00025 / −1.48031

log k = −1.48031

log 1/k = .57969

1/k = 3.8090

1 − 1/k = 2.8090

log = .36324 / −3.48910 / −4.87746

b = 0.000 7488

No 68

Cut for low pressure

.36324 / 3.437 / .02997

A = 1.0 7.6

(10) Thursday Feb. 29th 1912 $\theta = 38.88$ $P = 61.98 - 57.80 = 4.18$

First Observation 4.40. Only one bank of Battery used

Volts at 4.40 = 850+12.9 = 862.9

Volts at 5.26 = 849+12.9 = 861.9

This drop flickers as though it were unsymmetrical - in shape -

G		F	
8.680	—	12.834	
8.774	—	12.740	
8.824	—	12.902	→
8.652	—	40.402	(?) →
8.760	253	50.4—	
	—	50.338	
8.762	—	51.—	
8.704	—	51.—	
8.766	—	51.6—	
8.788	—	51.4—	
8.804	—	51.632	
8.616	26.6	52.6—	
8.856	—	51.434	
8.724	—	51.128	
8.672	—	51028	→
8.754	—	43.750	
8.778	—	43.758	→
	—	71.6—	
8.764		70.270	→
		78.390	
		78.0—	
		77.892	→
		56.466	
		56.0—	→

Finished at 5.25

2nd Observation – Feb. 29th 1912 θ= P=

Volts at 5:26 = 849 + 12.9 = 861.9
849 + 12.9 = 861.9
(2 troy used)
= 1723.8

q

Friday Mar. 1st 1902 — θ = 23.04 — P = 62.3 − 57.4 = 4.90

4:10 P.M. — Volts at 3:50

832 + 13.8 = 845.8
831 + 14.0 = 845.0
1690.8

G	F	A
13.972	49.224	
13.830		
13.880	51.700	
13.846	51.7—	
	52.606	
13.890	52.750	
13.864	43.530	
13.972	43.738	
13.826	43.464	
	90.942	
13.980	91.830	
13.938	88.480	
13.916	86.742	
13.926	85.128	
13.942	35.754	
13.974	35.980	
13.930	24.778	
13.780	24.840	
16 | 144.56		
13.903		

1/5.27 = .01898 — 1/43.56 = .02296 — 1/91.3 = .01095 — 1/85.1 = .01175 — 1/35.75 = .02797 — .02780 — .04030 — 1/2481

1/13.903 = .07194 × 1021 = ν_1 = .07345

$\log \nu_1$ = −2.86599

4:53 P.M. $\frac{1}{2}$ = −1.4330

Excellent

2296	2296	2797	4030
1898	1095	1175	2780
6 | 03983	04201	4 | 1622	3 | 1250
00 3980	00 4003	4055	4167
			4055
			4003
			3980
			4 | 16205
			4051

7194	7194	7194	7194	3953
1898	2296	1129	2789	3954
22 | 4092	23 | 9490	5 | 8323	24 | 7983	3964
13 4133	4126	4161	4160	3992
13 3953	24 3954	21 3964	3992	4004
				5 | 19872
				3974

3974 × 1021 =

$\nu_1 + \nu_2$ = .0040574

$\log \nu_1$ = −3.60825
$\frac{1}{2}\log$ = −1.4330
3.19778
−6.23985
3.22737 $\sqrt{}$ = 1685.0
−9.01168

e_1 = 10.279

a

−16.42099
3.2274
−2.6660
−14.5149
−3.6083
3 \| 12.9066
−4.3020 .0002005 = a
6902
−4.9922
3.0078

$\frac{1021}{1} = \frac{1}{1+a}$

l = .0001460

−4.8547
6902
−4.1645
−4.3040
−1.8625

$0.7287 = \frac{l}{a}$

$e^{2/3}$

3 \| −9.01768
−3.00590
$-6.00482 = \log e^{2/3}$
$10^{-6.00482} = e^{2/3}$
10.0410

Corrd $\log \frac{2b}{12}$

ak

−10.46136
3.22737
−7.68873
−3.60825
−4.08048 = log ak
−4.3020
−1.77848 = " k
.22152 = " $\frac{1}{k}$
.16654 = $\frac{1}{1K}$
$\log$ .16654 = −1.8231
3.0078
−4.8153

−1.8231
−1.4623
−1.9606

A = 9133

b = 6536
.0006536

Second Observation Mar. 1st 1912 $\theta = 23.0$ $p = 6249 - 57.20 = 5.29$ (Log) $62.48 - 57.20 = 5.28$ (mile) 5.285

5:05 Volts at 4:55 P.M. $827 + 14.4 = 841.4$ $830 + 14.2 = 844.2$ 1685.6

Volts at 5:55 P.M. $825 + 14.6 = 839.5$ $830 + 14.2 = 844.1$ 1683.6

G	F	
9.264	8.862	
9.144	8.792	2438 $\frac{1}{8.813} = .1135$
	8.784	
	16.244	
9.094	16.118	640 $\frac{1}{1621} = .06169$
9.104	16.278	
9.094		
	44.298	
	44.498	$\frac{1}{44.40} = .02252$
9.156		
	58.534	$\frac{1}{58.51}$ .01709
9.108	58.482	
9.144		
	40.212	$\frac{1}{40.30}$ .02481
9.076	40.348	Light readjusted and readings are more reliable hereafter
	40.328	
9.086		
	33.0 - 1 div.	
	31.4 - 2 "	
	32.6 - 3 "	
	32.6 - 4 "	
	31.4 - 5 "	
	30.6 - 6 "	
	30.0 - 7 "	
9.060	30.4 - 8 "	
	252.00	$\frac{1}{252} = .003968$
	31.6 - 1st div.	
	31.4 - 2 "	
	30.4 - 3 "	
	30.6 - 4 "	
	30.4 - 5 "	
	31.0 - 6 "	
	29.2 - 7 "	
	31.2 - 8 "	
9.054	243.80	
12 9.976	227.40	
9.097		
9.106		
9.106		

condition chosen.

$\frac{1}{100} \times 1021 = .1123 1 = V_1$ 5:55 P.M.

Log $= \bar{1}.0503$

$\frac{1}{2} = -1.5251$5

Good one, marked ast Aug 26

Differences

.1135	6169	2252	2481
6169	2252	1709	1704
20 | .05181	15 | 39917	20 | 0543	30 | 0772
.002598	2606	271	257
2481	.01709		2590
3968	397		2606
8 | .020842	5 | 01312		2605
.002605	.002602		2602
			4 | 10403
			.002601

.1099	1099	1099
1135	6169	2251
86 | 2234	66 | 17159	51 | 13241
.002601	.002602	.002609

1099	1099	1099
1704	2481	2968
49 | 12694	52 | 13471	44 | 11388
.002595	2593	2591

mean $= .002597 \times 1021 = V_1 + V_2 = 2.6526$

a

-16.42899
3.2264
$-1\ 0503$
$-14.\ 69\ 76$
$-3.\ 42\ 35$
$3 \mid -11\ 27\ 41$
$-4.\ 42\ 47$
$.7230$
$-3.\ 14\ 77$
$+2.\ 84\ 92$

$\ell = .0001354$

-4.8547
$.7230$
-4.1317
$-4.42\ 47$
$1.\ 7040$
$.5064 = \frac{\ell}{a}$
$.5093 = \frac{\ell}{a}$
$.0002658 = a$

$\frac{1}{7669} = \frac{1}{ka}$

$\text{Log} = -3.4235$
$\div 11 = -1.5251$
-3.1478
-6.1464
3.2264
-10.9299

$V = 1644$

$e_1 = 8.318$

$e^{2/3}$

$3 \mid -10.4766$
-4.9733
7.9466

$88.42 = e^{2/3}$

ak

-10.46136
3.2264
-7.68776
-3.4235
-4.26426
-4.4247
-1.83956

$\frac{1}{K} = .16044$
$\frac{1}{K} = 1.44869$
$\text{Log} = .45645 =$

$-1.6582$0
2.8523
$-4.9999$0
$b = .6446$

$-1.6582$0
$-.1709$0
-1.9432
$A = 9834$
$A = 8774$
$b = .6278$

10) Saturday - Mar. 2nd 1912 $\theta = 23.11$ $\rho = 63.22 - 56.32 = 6.90$

Volts at 4:00 P.M.

791. + 16.5 =
787 + 16.4 =
733 + 18.1 =
2311 + 51.0 = 2362.

G		F	
17.110		15.602	This drop flickered as the
17.176		15.536	unsymmetrical
17.242		17.126	
17.206		17.184	
		40.066	
17.280		40.384	
		72.8—	
17.534		73.090	
17.496		40.808	
17.512		40.928	
17.540		40.6—	
17.758		122.4—	
17.566		122.4—	
17.874	62.0	123.4—	
		74.2—	

5:05 P.M.

15) 7096 / 1543

ρ = 00004248

-4.8547
.8887
-5.9660
-4.3792
-1.6468
.4435 = a

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

3|-10.8906
-4.9635
7.9206
9.2706
84.55

-16.4209
3.3657
-2.8199
-14.6065
-3.6480
3|12.9585
-4.3192
.8887
-3.2079
2.7921

.0002085 = a

$\frac{1}{\mu a} = 6194$

ak
-10.46136
3.36568
-7.52704
-3.6485
-4.17854
-4.3193
-1.85924
.0000 20
-1.85904 = 9.44k
.14096 = 1.3k
1.3822

Log. 3822 = -1.5823
2.7922
-4.7901
h_2 = 61.67

-1.5823
-1.6469
.9354
A = 86.2

-16.4209
3.3657
-2.8199
-14.6065
3.6485
3|12.9580
-4.3193
.8885
-3.2078
7922

$\frac{1}{\mu a} = 6197$

this on the line

2nd Observation March 2, 1912 θ = 23.12 p = 63.63 − 55.89 = 7.74

5:20

Volts at 5:07

785 + 17.0
787 + 16.8
718 + 17.9
2290 + 51.7 = 2341.7 / 6

Volts at 6:05

776 + 17.2
776 + 17.2
707 + 17.2
2259 + 51.6 = 2310.6

G	F	
15.634	24.660	
15.562	24.514	1/24.56 = .04072
	24.512 →	
15.506	27.587	
	27.664	1/27.624 = .03619
	27.5— →	
15.488	31.868	
	31.830	1/31.85 = .03144
15.506 →		
15.478	37.258	
	37.520	1/37.39 = .02675
15.284 →		
15.496	55.4—	
	55.502	1/55.57 = .01800
15.566	(55.6—)	
15.462	55.646	
15.498 →		
	(45.2—)	.022275
	45.058	1/44.89
	(44.6—)	
	44.728	
15.430 →		
	37.648	1/37.58 = .026615
	37.524	
15.410	(37.4—)	
15.458 →		
	73.594	= .01361
15.472	36.6 73.4—	1/73.47
	73.346	
15.548 (too long)	(32.0)	
	32.146	= .03109
15.485	32.090	1/32.17
15.493	(32.3)	

Differences

.04072	3619	3144	2675
.03619	3144	2675	1800
.00453	475	469	4875
			4375

22275	2661	26615	3144
1800	22275	1361	1361
4275	4335	13005	17485
		4335	4370

4375
4335
4370
3 | 13080
.004360

.004360 × 1021 =
$v_1 + v_2 = .004451$

$\log = -3.648$
-1.40975
3.19776
6.25688
3.36568
10.89040

$v = 2321.5$

$\log v_1 = 3.81950$
$\frac{1}{2} = -1.40975$

Mean Volts = 2321

$e = 7.770$
$e_1 = 7.734$

8906 / 2
3 | 14781.2
−7.9271

$84.54 = e^{Y_3}$

Beauty corrected Aug 26

1057

14) Monday - Mar. 4th 1912 θ=2348 P=63,87-55.59=8.28

First Observation 11:02 P.M.

Voltage 3:55 - 830 + 14.2
833 + 13.6
836 + 13.4
2499 + 40.9 = 2540.*

G	F	
10.844		
11.014	13.854	
10.996	15.412	
10.994	14.260	
11.042	16.282	1/16.28 = .06142
10.984	31.426	1/31.53 = .03172
10.937	31.502	
	31.666	
	23.540	
10.956	23.704	1/23.66 = .04226
10.900	23.720	
10.932	77.0 —	
10.954	39.2 77.4 —	1/77.80 = .01292
	39.2 77.6 —	
10.928	42.6 —	
10.948	42.338	(42.4) 1/42.33 = .02362
10.920	42.312	(42.2)
10.920	46.3 — 1+2 div.	
10.880	46.6 — 3+4 div.	
10.712	47.5 — 5+6 "	
	45.0 — 7+8 div.	
18.5 7.65	185.4 —	
10.928	46.6 — 1+2 div.	1/185 = .005405
	46.4 — 3+4 div.	
	46.0 — 5+6 div.	
	46.1 — 7+8 div.	
10.892	185.0 —	
10.894	50.070	1/50.07 = .01997
mean = 10.924		
1/10.924 = .09154	4:53 P.M.	
v₁ = .09346	log = -2.97026	½ log = -1.48531

(44) Beauty Publicity

Differences

6142	04226	.04226	2362	2362	1997
3172	.0 3172	.1292	1292	.5405	5405
8|2970	3|01054	8|02934	3|1070	5|18154	14565
.003712	3513	3668	3567	3643	3641

mean = 3624

09154	9154	9154	9154
3172	4226	1292	2362
34|.12326	37|13380	28|10446	39|11516
.003625	3617	3602	3547

9154	9154
5405	1997
21|96945	31|111 51
3589	3547

mean = 3605

mean of means .003615 × 1021

= v₁ + v₂ = .003691

Log = -3.567144
½ log₁₀ = -1.48531

ρ = .00008654

3.1983	
-6.250754	V = 2534
3.40[illegible]634	
-10.84[illegible]120	

a

-.164270	
.34048	
-2.9706	
-14.8024	
-3.5671	
3|11.2353	
-4.4118	
4175	
-3.3293	
-2.6707	

-4.8547	
4175	
-5.9372	
-4.4098	
-1.5274	ρ
.3353 = a	
.3368	
.00025[illegible] = a	

7.0173
151
e₁ = 7.0324
e₁ = 7024

Error 9%
probably too low

4685 = 1/ka
4444
4707

e^{x/3}

3|-.108468	
-4.4489	
-7.8497[illegible]	
74,03 = e^{x/3} = 74,02	

8465/2
11.6930
7.8497

Seconds Mar. 4, 1912

θ = {begin at 23.45 / finish 23.45} p = 64.00 − 55.40 = 8.60

5.105

Volts at 4:55 — 829.5 ÷ 14.2 = 84.37
832.5 ÷ 13.2 = 84.57
836.0 ÷ 13.6 = 84.98
2538.5

no 8

43

b	F	
	1382	
11.688	39.542	
11.686	39.496	1/39.58 = .02526
11.628	39.544	
11.632	30.634	1/30.66 = .03261
	46.620	
	46.966	1/46.86 = .02134
11.640		
11.704	53.306	1/53.38 = .01873
	74.176	1/74.31 = .01346
11.640	58.396	(58.4) 1/58.48 = .01711
11.632	58.302	(58.4)
	43.8	-1+2 div.
	44.0	-3+4 div.
	43.6	-5+6 div.
	42.5	-7+8 div.
	173.4	1/173.4 = .005767
11.578		
11.855	27.0	-1+2 div.
	26.7	-3+4 "
	26.3	-5+6 "
	26.0	-7+8 "
	106.0	1/106.9 = .009443
11.578	105.810	
	48.760	(48.9) 1/48.64 = .02056
	48.388	
	59.462	(59.6) 1/59.54 = .01680
11.680	41.330	
	41.332	1/41.33 = .02419
	41.158	
11.680		
11.610	28.246	1/28.28 = .03536
	104.396	1/104.6 = .009560
14)92.31	104.6	
11.664		

1/11.66 = .085777 + 10 = V₁ = .87557

5.154

1/2 11 = −1.47112

Differences

3265	3265	2137	1896	1713	1713	2059	2423	3540	3540
2526	2137	1348	1347	1348	5767	1710	19529	2423	9579
2.0735	3)1128	3)0789	1528	.0365	3)113768	0349	4)148552	3)11917	3)65821
3675	3760	394			3788		3663	3973	3689

9443	2053	8577	8577	8577	8577	8577	8577	8577	443
5760	9443	2526	2134	5800	9443	2054	2423	9578	7)25722
3)11683	3)11087	11103	30)10714	29)9157	26)95213	24)10636	30)11000	26)95349	3675
3696	3696	3701	3695	3663	3662	3666	3667	3667	mean

3757
3650
3800
3676
3700
3695
3677
3686
mean .003705

Wrong Dfs = .003705 × 1021 = 3.7838

Log = −3.57078
−1.47712
3.19788
6.24668
3.40405
10.84287
.00009
10.84378
3)19.6874
7.8958

Volts 2535

e₁ = 6.9778
e₁ = 6.9778
e₁^2/3 = 28.360
e^2/3
3)10.8445
−4.9472
−7.8944
18.42

e^2/3 = 78.67

l = .00008322
−4.8547
9345
−5.9202
−4.3465
−1.5737
.3349 = 1/a

−16.4270 4209
34043 4040
2.9424 9424
−14.7737 5778
−3.5753 1895
3)11.1984 −4.3965
−4.3965 .0002509 = a
2488
9345
−3.3480
2.6690

463.4 = 1/a
466.7 = 1/a

Third Obs. Mar. 4, 1912

6,105

No 9

Voltsat 5'.55

Voltsat 6'.35

G	F
19.124	
19.220	
19.346	46.780
19.348	47.332
	47.224
	27.348
	27.350
19.116	27.422
	95.564
19.162	47.0 − 1.7 div
	47.0 − 3.4 div
	47.0 − 5.6 div
	46.4 − 7.8 div
	187.4 —
19.276	63.016
	62.846
19.227	

(2) $\frac{1}{47.28} = .02115$

$\frac{1}{27.37} = .03654$

(48.6) ÷ 2 (96,0) = whole. $\frac{1}{45.6} = .01046$

$\frac{1}{1874} = .005336$

$\frac{1}{62.93} = .01590$

6,134

Grand Central Aug 26

No 54

$\frac{1}{19.25} = .05198 \times 1021$

$= \nu_1 = .05347$

$L_{og} = -2.72858$

$L_{og}\ \nu_1 = -1.36400$

calc

−10.46136	−1.86326
3.4036	.13674 = log $\frac{1}{1.37}$
−7.86496	1.3701 = $\frac{1}{1c}$
−3.72754	log = −1.56833
−4.19956	2.7693
−4.27558	−4.7990
−1.86376	
−1.86326	

B = 62.95

a	
−16.4209	
3.4036	
−2.7286	
−14.5559	
3.7258	
3/−12.8301	
−4.2767	
9549	
−3.2307	
2.7693	

l = −4.8547	
9549	
−5.8998	
−4.2758	
−1.6240	

4112 = $\frac{l}{a}$ = 2533

1887 = a

5848 = $\frac{1}{ha}$ $e^{2/3}$

10.8854	
2	
3/14.7708	
−7.9233	

A = 87.96

$\nu_1 + \nu_2 = .005205 \times 1021 = .005314$

L_{og} = −3.72540	
−1.36400	
3.19776	
6.28716	
3.4036	
10.88356	
10.88343	
7.6578	
1.6	

8843 / 2 / 3/14.7686 / 7.9229 = $e^{2/3}$ 83.73

e_1 = 7.6614 e_1

$e^{2/3}$ = 83.80 rounded for chem comm 83.73

5188	5188	5188	5221
2115	3654	1046	5205
14/7303	17/8848	13/6240	5200
5246	5208	5194	5207
			5218
			5208 mean

5188	5188	5130	
5336	1540	5216	
11/57276	13/6784	5124	
5207	5212	5182	
		4/20752	
		5188	

Differences

.03654	3654	01046	
2115	1046	5336	
3/.01539	5/2608	.005124	
5130	5216		
1590			
5336			
2/10564			
5282			

9.03
9.015 at 23

828.0 + 14.3
830.5 + 14.1
834.0 + 13.5
2492.5 + 41.9 = 2534.4

827.0 + 14.3
830.0 + 14.1
833.0 + 13.7
2490.0 + 42.1 = 2532.1

Tuesday, Mar. 5, 1912 - at 5:1½ P.M.

θ = 23.03

2% Solution Cupric Chloride used in first Cooling tank (Flat tank)

p = 8645 − 54.80 = 9170

8340 + 13.5 = 8475
8360.4 + 13.5 = 8494
8405.4 + 13.7 = 8553
8429.0 + 14.1 = 8481
8380 + 13.3 = 8513
8397.3 + 14.3 = 8511.3
8425.6 + 14.4 = 8440
8460.0 + 80.4 (4244.6)

Voltrat 5:10 P.M.
8330 + 13.6
8345 + 13.4
8400 + 12.7
8270 + 14.3
3334.5 + 54.9 = 3388.5

G	F
34.9 − 1+2 div.	
33.7 − 3+4 "	
35.4 − 5+6 "	
35.2 − 7+8 "	
	139.2
	43.740
	25.664
	25.770
	25.578
	25.618
36.6 − 2 div	
37.4 − 4 div	
37.4 − 6 "	
37.6 − 8 "	
	148.0
37.4 − 2 div	
37.0 − 4 div.	
37.0 − 6 div	
36.6 − 8 div	
	148.0

1/139.2 = .007184
1/43.74 = .022883
1/25.66 = .03845
1/148 = .006757

24.388
24.612
24.182
24.276
24.254
24.274
24.314

7|2300
24.33

5:40 P.M.

1/2433 = .04110 × 1021 =
V₁ = .041963

Log = 2.62387
½ = 1.31194

a/c
-10.46136
3.5300
-7.99136
-3.91300
-4.07836
4.2206
-1.85776 = log K
.14224 = 1/K
.13877 = K
log K = 1.5885
1.5885
-1.6473
.9412

b = .000 6251
A = 87.35

a
-16.4209
3.5308
-2.6234
-14.5845
3.9139
3|12.6618
-4.2206
.9868
-3.2094
2.7901
2.7925

l
-4.8547
.9868
-5.8679
-4.2206
-1.6473
4439 = l/a
.000162
6667 = 1/fa
6202

Differences
2864 / 3845 / 3845
3164 / 2288 / 6757
2) 1556 / 2) 1617 / 4) 32693
7828 / 8056 / 8048

4110 / 2164 / 6) 48484 / .008047
4110 / 2283 / 4) 6393 / .007991
4110 / 3845 / 8005
4110 / 6757 / 6) 47857 / 7976 / 8005 / 7991 / 8056 / 8048 / 5) 40076 / 8015

Mean = .008015 × 1021 =
V₁ + V₂ = .008188
Log = −3.91309
½ log V₁ = −1.31194
−3.19876
6.42270
3.5300
10.89290
V = 3885

e₁ = 7.8109
e₂ = 7.7945 reduced for chromic conn
to e₁ = 7.7783

3|197854
−7.9285
3|19.7836
−7.9279
8470 = e^{Y/3}
e^{Y/3} = 84.83

10 March 5, 1912 – 2nd obs.

$\theta = \begin{cases} 23.00 \\ 23.05 \end{cases}$ $p = 64.69 - 54.89 = 10.10$

6.05 — no 9 — (42)

G	stop watch	F chronograph	
15.014	44.6	44.110	
15.010	44.4	44.108	
14.964	44.9	44.658	$\frac{1}{45.} = .02222$
15.030	45.4	45.008	
14.932	30.0	30.026	$\frac{1}{30.03} = .03330$
14.952			
6 | 89.900			

lost it at 6.13 P.M.

14.983

$\frac{1}{14.98} = .06675 \times 1021$

$= v_1 = 0.6815$

$\log_{10} = -2.833466$

$\frac{1}{2}\log_{10} = -1.41673$

Volts at 5.52.

833.0 + 13.6
835.5 + 13.2
839.0 + 13.8
827.0 + 14.2
3334.5 + 54.8 = 3389.3

Volts at 6.15. P.M.

817.0 + 15.0
824.5 + 14.5
827.0 + 14.3
821.0 + 14.8
3289.5 + 68.6 = 3358.1

Difference =

.0330
.0222
.0108 too small because of dropping volts

.06675
.02222
8 \| .8897
.01112

.6675
.3330
9 \| 1.0005
.01112 × 1021

$= v_1 + v_2 = .011353$ .005677

$\log = -2.055$ $\log_{10} = -3.7541$

-1.41673
-3.1963
-6.67015
3.52764
9.14255

13.8877
3
2 \| 13.8888
$e_1 = 6.944$ Error .6% in acct of volts
$e_1 = 6.936$

Volts 3370

$l = .00007087$

a

-16.4270
3.52766
-2.83335
-14.7888
-3.75541
3 \| -17.0 3440
-4.3447
1.0043
-3.3404
2.651 0

-4.8547
1.0043
-5.8504
-4.3447
-1.5057
.3205 = $\frac{l}{a}$
3273
.000221 = a
2200

$\frac{1}{4467} = \frac{1}{pa}$
4488

$e^{2/3}$

3 \| -10.8474
-4.9472
-7.84544
$e^{2/3}$ = 7.836
$e^{2/3}$ = 7.842

Mar. 6th 1912 -

First Observation

4:52

$\theta = \begin{matrix} 23.00 \\ 23.13 \end{matrix}$ begin / end

$p = \frac{6973 \text{ (Fac)}}{4861} \quad \frac{6974 \text{ (Millikan)}}{4861}$ / 9

$\frac{}{21.12} \quad \frac{}{21.13}$

Volts at 4:45

832.5 + 13.8
834.0 + 13.7
838.0 + 13.3
824.0 + 14.5
833.0 + 13.8
834.5 + 13.7
4996.0 + 82.8 = 5078.8

No 10

41

Volts at 5:55

830.0 + 14.1
832.0 + 13.9
836.0 + 13.5
821.5 + 14.7
832.5 + 13.9
832.0 + 13.9
4983.0 + 84.0 = 5067.0

Beauty

G	F	
14.302		
14.288	43.004	
14.218	(22.2) 43.198	(43.9)
14.228	43.260	(43.8)
14.298	84.504	(84.6)
14.218	46.6 – 1st division	
	47.8 – 2nd "	
	47.2 – 3rd "	
	47.0 – 4th "	
	48.0 – 5th "	
	47.4 – 6th "	
	48.0 – 7th "	
	48.0 – 8th "	
	380.0 —	
14.228		
14.204		
13.966		
14.072		
14.082		
14.118		
14.092		
14.184		
14.018		
13.944		
6)132.446		
14.06		

Worked only below here - big changes in G.

112.0 – $\frac{1}{112} = .008929$

28.254 → $\frac{1}{28.25} = .03540$

23.758

23.708 $\frac{1}{23.73} = .04214$

65.296 → $\frac{1}{65.30} = .01531$

45.616

46.028 (46.0) $\frac{1}{45.82} = .02182$

35.122 (35.4) $\frac{1}{35.28} = .02835$

35.434 (35.4)

119.0 —

119.4 — $\frac{1}{119.2} = .008389$

5:53 P.M.

Differences

3540 / 8929 / 4)026471 / 006618

.04214 / .03540 / 00674

4214 / 8929 / 5)33211 / 6642

.04214 / .01531 / 4)026683 / 006708

6708 / 6618 / 6650 / 6640 / 4)26616 / .006654 = mean of 4 pairs

2835 / 8369 / 3)19961 / 665

2162 / 1361 / 8511

.07099 / 8929 / 12)·079·8899 / .006658 / 6672

.07099 / .04214 / 17)·112·374 / .006654 / 6663

7097 / 2835 / 15)19932 / 14 / .006628 / 6633

7097 / 539 / 13)78536 / 6672 / 6633 / 6668 / 6698 / 4)26569 / 6642

Mean = .006650 × 1.021 = $r_1 + r_2 = .006762$

$\frac{1}{14.061} = .07112 \times 1.021 = r_1 = .072460$

log = −2.8601 ≡
½ " = −1.4300 ≡

a	l
−16.4270 09	−4.8547
3.7050 50	1.3247
−2.8601 01	−5.5300
−14.9931 60	−4.3871
−3.8319 00	−1.1429
3)11.1612 60	
−4.3871 3453	.1390 = l/a
1.3247	1394
−3.7118 7100	
2.2882 2000	
1950	
1944 = ½a	

Volts = 5070

e = 5.6 00
5.6 92 = e

e^½ =
3)−10.7558
−4.9882
−7.8392

68.73

8) Thursday – Mar. 7th 1912

3:35 P.M.

θ = 23.70

Volts at 3:15

		56.696
16.322	(28.6)	(57.2—)
	153.0	307.4—
16.190	174.0	349.0—
16.184	51.0	102.0—
	207.6	413.8—
16.184	—	(42.0—)
	—	42.006
15.996	—	60.314
	—	(60.6—)
16.092		

5) 30646
16.13

$\frac{1}{16.13} = .06200 \times 1021 = \nu_1 = .06328$

$\log \nu_1 = -2.7944$

$\frac{1}{2}\nu_1 = -1.3972$

$\frac{1}{57.2} = .01748$

$\frac{1}{3274} = .00032253$

$\frac{1}{349} = .002865$

$\frac{1}{102} = .009804$

$\frac{1}{414} = .002415$

$\frac{1}{42.01} = .02381$

$\frac{1}{60.31} = .01658$

p = 6993 / 4840 (48 1st vibn) = 21.53

841.5 + 13.2
841.5 + 13.2
845.0 + 13.0
814.0 + 15.3
843.5 + 13.1
843.0 + 13.1
5028.5 + 80.9 = 5109.4

Differences

.02381 .02381 .01748
.002415 .01658 .00325
3|.021395 .00723 2|.014227
.007132 .007114

.009804 9804
.002865 2415
.006939 7389
.007164 14326

.06200 .06200 6200 6200 6200
.002865 9804 2415 2381 1658
9|.064865 10|.071804 9|6441 12|8631 11|7858
.007207 .007180 .007157 .002191 .007161

mean = .007179 × 1021
= $\nu_1 + \nu_2$ = .007331 7

$\log \nu_1$ = −3.8652
−1.3972
3.1983
−6.4607
mean volts = 5090 3.7067
10.7540

$e^{2/3}$

5.676
18
e_1 = 5694

10.75503
2
3|19.51006
7.8367

$e^{\frac{2}{3}}$ = 6870

a

16.4270
3.7067
−2.7944
−14.9281
−3.8652
3|11.0629
−4.3543 .0002261 = a
1.3330
−3.6873
2.3127 2054 = $\frac{1}{na}$

l

−4.8547
1.3330
−.5217
−4.3543
−4.1674 .147

This is the best volts can
a little inaccurate
but also is bad
It comes about
known line
not plausible

Second Observation
Mar. 7th 1912.

$\theta = \frac{23.48}{23.54}$ $p = \frac{7011}{4\pm20}$ $\frac{}{21.91}$

(7)

Volts ab. 4115

834.5 + 13.7
837.0 + 13.4
839.5 + 13.2
811.5 + 15.5
839.0 + 13.2
839.0 + 13.2
50005 + 82.2 = 50087

G	F	
9.132		
9.086		42,138
	(21.2)	(42.4—)
	——	53,554
	(27.0)	(54.0—)
90.76	——	53,300
	(27.0)	(53.6—)
9,232	——	53,420
	(27.6)	(53.8—)
9.124		

6) Third Observation

March 7, 1912.

5:55

ϕ = 23.41
23.53

p = 70.50
47.77
22.73

Volts at 5:48

830.0 + 14.1
833.0 + 13.8
836.0 + 13.5
807.0 + 15.7
833.0 + 13.8
833.0 + 13.8
4972.0 + 84.7 = 5056.7

G	F
24.312	20.728
24.326	20.540
24.256	20.728
24.128	

6:10 P.M.

Fourth Obs. 3/7/12 $\theta = \frac{23.53}{23.53}$ $p = \frac{7073}{4748}$ 23.25

6:13 P.M.

Volts at 6:40

829.0 + 14.2
831.0 + 14.0
833.0 + 13.8
800.0 + 16.0
832.0 + 13.9
832.0 + 13.9

495.7.0 + 85.8 = 5042.8

6	F	
17.094		
17.234		20.872
16.996		19.734
17.064		19.566
17.220		19.562
17.314		54.066
17.134		54.288
17.172		54.280
17.144		27.496
17.094		27.506
		27.658
		46.488
	72.0	142.0—
17.118	73.0	144.5—
		6:38 P.M.

4)

Monday Mch 11th 1912 $\theta = 23.07$ $p = 71.00 - 47.14 = 23.86$

3:35

No 11

40

3 PM

660.0 + 15.6
836.5 + 13.5
834.0 + 13.3
503.0 + 04.0
837.0 + 13.5
837.0 + 13.5
4512.5 + 83.4 = 4595.9

Discard all this in result because volts must have shifted considerably in this period

G	F		
	24.3	48.3 —	$\frac{1}{48.2} = .02075$
18.074	24.0	48.2 —	
18.098	—	71.6 —	$\frac{1}{71.6} = .01397$
18.276	24.0	48.2 —	
18.312	—	48.5 —	$\frac{1}{48.35} = .02068$
18.230	37.0	—	
18.216	36.6	73.6 —	
18.352	37.0	73.6 —	$\frac{1}{73.6} = .01359$
18.238	25.0	49.4 —	$\frac{1}{49.4} = .02024$
18.218	37.0	73.8 —	$\frac{1}{73.8} = .01348$
18.212	37.2	74.3 —	
18.292	37.6	74.4 —	~~$\frac{1}{744} = .01349$~~
18.237	—	29.4	
18.206			$\frac{1}{29.4} = .03401$
13) 294 [16			
18.229		4:16 PM.	

$\frac{1}{18.273} = .05486 \times 1021 = V_1 = .05601$

$\log = 2.7483$

$\frac{1}{2}\log = 1.3742$

Differences

.02075	2068	.02024	2024
.01397	1397	.01359	1348
.00678	671	.00665	676

.03401
.01348
3) .02053
.006843

This difference most reliable as second diffs

678
671
665
676
6744
674.3
6) 4043.9
614586
.006764

.05486	5486	5486	5486
.02075	.13591	1346	.3401
11) .07561	10) 6845	10) 6834	13) 8887
.006874	.006845	.006834	.006836

most probable value = .006838 × 1021

$= V_1 + V_2 = .006915$

$\log = -3.83940$
-1.3742
-3.1983
-6.4865
$+3.6611$
-10.7554

mean volts = 4582.

$e_1 = 5.694 \times 10^{-10}$ error 3%

$e_1 = 5.687$

$e^{2/3}$

3) 10.7554
-4.9185_2
-7.8370

$68.70 = e^{2/3}$

68.64

a

-16.4270
3.6611
-2.7483
-14.8364
-3.8440
2) -18.4924
-4.3308
1.3777
-3.7085
2.2915

$.000214_2 = a$

2138

$1957 = \frac{2}{3}a$

1963

$l = .00002444$

-4.8547
1.3777
-5.4770
-4.3308
-1.1462

$.1400 = \frac{l}{a}$

1403

Second Obs. Mar. 11, 1912 (Monday)

5:28 P.M.

θ = 23.20

p = 7123 / 4690 / 24.33

Volts at 4:17

659.5 + 15.6
835.0 + 13.6
837.5 + 13.5
503.0 + 04.0
835.0 + 13.6
835.0 + 13.6
4505.0 + 73.9 = 4578.9

No 12

39

Volts at 5:15.

659.0 + 15.0
834.0 + 13.8
836.5 + 13.5
503.0 + 04.0
834.0 + 13.8
834.0 + 13.8
4500.5 + 73.9 = 4574.4

G		F	
7.874		~~23.6~~	
7.862		24.0 —	1/23.75 = .04210
7.876		23.9 —	
7.878		23.5 —	
7.792			
7.874		23.734	1/23.63 .04232
		23.522	
7.902	40.2	79.6 —	
7.918	40.2	79.6 —	1/79.5 .01257
7.852	—	79.4 —	
7.923			
7.8751			

Difference

.04232
.01257
7 | .02974
.00424

4210
1268
2942
42

1/7.875 = .1270 × 1021 = .12967

.1298

5:42 P.M.

.1270 / 4232 → 40 | .16942 → 00 4236
.1270 / 1258 → 33 | .13970 → 4233

mean = 4235 × 1021 = v1 + v2 = .004324

Log = -1.11344

½ l = -1.55670

Log v1 + v2 = -3.63548
-1.55641
3.11983
-6.39019
3.6601
-10.73301

6361
5537
1977
2905
6601
7304

V = 45.72

a

-16.4209
3.6601
-1.1134
-13.1944
-3.6366
3 | -11.5583
-4.5194 ... -3253 = a
1.3858 3309
-3.9052
2.0948

l

-4.8547
1.3858
-5.4684
-4.5194
-2.9490

.08853 = l/a 8892

1237 = 1/fw 1244

e 5395/4

e1 = 5379/12

mark

e1 = 5385 for

chron corr

e1 = 5342

e1 = 5379

e^2/3

7299/2
3 | 14598
7.8199

-10.73046
2
3 | -19.4609 = c^2/3 6606
-7.8203

e^2/3 = 66.115 — raise to 6678 for error 1% chron corr 6606

2)

Monday, Mar. 11, 1912

Third Obs.

$\theta = 23.18$ $p = \frac{77.70}{46.33}$ $\frac{}{25.37}$

Volts at 545

659.0 + 15.7
833.0 + 13.9
836.5 + 13.5
502.5 + 03.8
833.0 + 13.9
833.0 + 13.9
4497.0 + 74.7 = 4571.7

G	F	13
9.440	35.920	
(18.4)	(36.0)	
9.488	36.003	
(17.6)	(35.6)	
9.360	35.818	
—	(35.8)	
9.398	53.472	
(27.0)	(53.4)	
9.374	Balanced speed (very nearly)	
5 | 2040		
9.408		

(36)

$\frac{1}{35.91} = .02785$

$\frac{1}{53.47} = .01870$

0

Differences

.02785
.01870
.00915
.003050
.004575

4 | .01870
4675

4675
4575
9250
4630 Differences

$\frac{1}{9.41} = .1063 \times 1021 = 108.5 = V_1$

Log = -7.03543 6'10 P.M.

$\frac{1}{2}$ log = -3.51771

.1063
2785
29 | .13415
.004638

1063
1870
27 | 12500
.004629

1063
000
23 | .1063
.004622

mean = .004633 x 1021
$= V_1 + V_2 = .0047303$

Log = -3.67449
-1.51771
-3.14983
-8.34203
3.65599
-10.7310

V = 4570

a	l
-1.64270	-4.8547
3.6549	1.4043
-1.0354	-5.4504
-13.1223	-4.4825
-3.6749	-2.9679
3 | 11.4474	.092884 = l/a
-4.4825	9330
1.4043	30375 = 2a
-3.8868	3024
2.1132	3023
	129.8 = 1/pa
	130.31

$\tau_1 = 5.387$

$e_1 = 5.381$

$e^{\nu/3}$

-10.73135
2
3 | 14.46270
-7.4209

$C^{\nu/3} = 66.21$

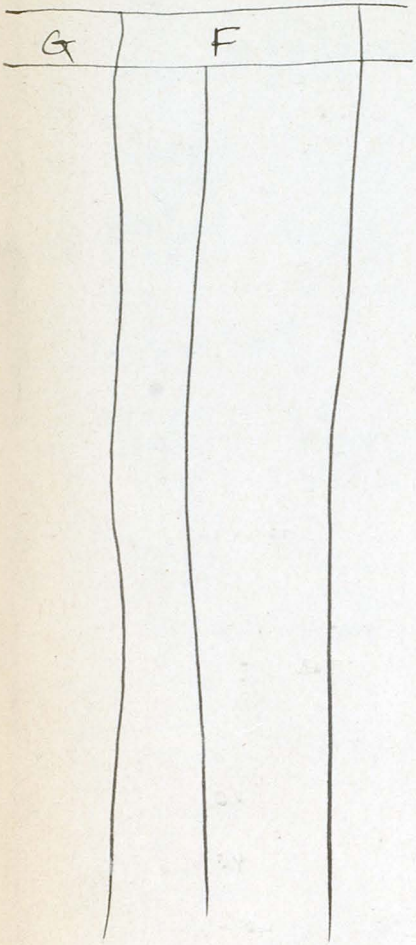
$e^{\nu/3} = 66.16$

Error .7 %

Patched
compare with
Compare data 49

Monday, Mar. 11, 1918 θ= p= 1.

Fourth Obs.



Volts at 6:11. P.M.

658.5 + 15.7
832.5 + 13.9
836.0 + 13.5
502.0 + 03.8
833.0 + 13.9
832.5 + 13.9

4494.5 + 74.7 = 4569.2

Calibration of Upp. Chronoscope Lasalle

40 second interval.

220.13 / 20.21 / 4)199.92 / 49.98

220.50 / 20.13 / 4)200.37 / 5009

220.55 / 20.50 / 4)200.05 / 5001

220.20 / 20.55 / 4)199.65 / 49.91

220 27 / 20.20 / 4)200.07 / 5002

220 27 / 20.27 / 4)200.00 / 50.00

219.92 / 20.27 / 4)199 63 / 49.91

219 53 / 19.92 / 4)199 61 / 49.90

219.50 / 19.58 / 4)199.92 / 49.98

219.60 / 19.50 / 4)200 10 / 5002

mean 49.981

10 sec interval

69.98 / 20.60 / 49.38

11 9 14 / 69.98 / 49.26

70 71 / 19.14 / 50.65

54 55 / 4.46 / 50.09

55 34 / 5.01 / 50.38

109 93 / 55.39 / 49.54

5582 / 8.44 / 50.38

109.40 / 5582 / 50.58

59 33 / 9.40 / 49.93

109.91 / 9.40 / 50.51

60 03 / 9.91 / 50.12

110 27 / 60.03 / 50.24

60.25 / 10.27 / 49.98

110 58 / 60.25 / 50.33

60 81 / 10.58 / 50.23

111 03 / 60.81 / 50.22

61.33 / 11.03 / 50.30

111.54 / 61.33 / 50.21

61.49 / 11.54 / 49.95

111 69 / 61.49 / 50.20

Mean of 15 = 50.12

4 sec interval

31.80 / 11.69 / 20.11

51 82 / 31.80 / 20.02

72.11 / 51.82 / 20.29

92.11 / 72.11 / 20.00

112 28 / 92.11 / 20.17

32 77 / 12.28 / 20.49

52 80 / 32.77 / 20.03

73 87 / 52.80 / 20.27

93 05 / 73 87 / 19.98

113 25 / 93.05 / 20.20

33 50 / 13 25 / 20.25

53.94 / 33.50 / 20.44

74 30 / 53.94 / 20.46

94 52 / 74.30 / 20.22

114.77 / 94.52 / 20.25

34.94 / 14.74 / 20.20

55.19 / 34.99 / 20.20

75 40 / 55 19 / 20.21

Mean = 20.21

Key No. 1 for 10 secs

114.04
63.71
50.33

63.94
14.04
49.90

113.75
63.94
49.81

63.88
13.75
50.13

97.86
47.65
50.21

148.12
97.86
50.26

98.09
48.12
49.97

144.87
94.66
50.21

94.75
44.87
49.88

144.86
94.75
50.11

94.94
44.86
50.08

144.88
94.94
49.94

56.49
6.01
50.48

106.63
56.49
50.14

Mean of 10 readings for 10 secs = 50.104

Key No. 1 for 4 secs

26.98
6.63
20.35

47.58
26.98
20.60

67.78
47.58
20.20

87.94
67.78
20.16

108.32
87.94
20.38

28.83
8.32
20.51

58.81
28.83
29.98
2

for 3 secs

79.02
58.81
20.21

99.48
79.02
20.46

20.21
99.48
20.73

3 | 59.96
19.99

ten readings

Mean = 20.357 for 4 secs.

2/36

Calibration of Hipp Chronoscope.

Wednes. Dec. 6, 1911

Millikan

Key No. 1

136.15
86.99
50.06

96.09
46.15
59.94 → for 50.06
12 secs.

146,15
96.09
50.06

96.36
46.15
50.21

146.46
96.36
50.10

∴ 49.95 for 10 secs.

96.56
46.46
50.10

246.51
96.56
149.95
49.98

10 secs.

New Key Key No. 2

96.25
46.51
49.74

145.88
96.25
49.63

40 | 245.94
45.88
200.06
50.00

40 secs.

258.65
58.93
4 | 199.72
49.93

245.96
45.94
4 | 200.02
50.00

245.70
45.96
4 | 199.740
49.94

258.59
58.65
4 | 199.94
49.99

258.31
58.65
4 | 199.66
49.92

257.66
58.31
4 | 199.35
49.84

Key No. 1

257.59
257.66
4 | 199.93
49.98

264.74
64.95
4 | 199.79
49.95

264.69
64.74
4 | 199.95
49.99

264.73
64.69
4 | 200.04
50.01

49.98

264.63
64.73
4 | 199.90
49.98

264.55
64.63
4 | 199.92
49.98

264.83
64.55
4 | 200.28
50.07

264.71
64.93
4 | 199.88
49.97

Mean of 10 obs. on 40 secs. at 18°C
÷ 4 = 49.975 = 10 secs.

Feb 10th 1912

Calibration of Hipps chronoscope for 5 sec intervals

1st ten readings

54.65	29.75	29.30	54.06	79.16	103.87
29.75	4.73	4.50	29.30	54.06	79.16
24.90	25.02	24.80	24.76	25.10	24.71

28.90	54.19	79.23	104.32
3.87	28.90	54.19	79.23
25.03	25.29	25.04	25.09

4.980
5.004
4.96
4.952
5.020
49.42
50.06
50.58
5.008
5.018
49.948
4.995

2nd ten readings

29.10	54.22	104.65		29.63
4.32	29.10	79.42		4.65
24.78	25.12	25.23		24.98

54.58	79.86	104.72	3003	55.21	8003
29.63	54.58	79.82	74.72	30.03	55.21
24.95	25.28	24.86	25.31	25.18	2482

4.952
5.024
5.046
49.96
49.90
5.056
49.72
5.062
5.036
4.964
5.0102
4.9948
2|100050
5.0025

This shows that I can rely on Hipp chronoscope timings down to 5 sec with no error larger than .2% — might call it .4% for safety then e would be in error only .6% at outside.