

KG
11365
343

0 12

Longitude - Campaign.
Cambridge Washington.
1867.

J. L. Fairbanks, Stationer, 135 Washington Street, Boston.

KG 11365.348

KG 11365.343

Cambridge-Washington Longi-
tude Campaign, 1867.

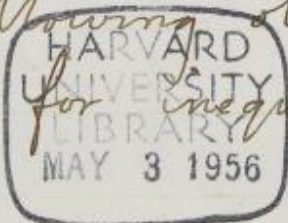
U. S. C. S. Transit No 8.

reached Cambridge May 27,
and was set up next day, and
adjusted approximately, Polaris
at L. C. being used for the azimuth
adjustment.

The instrument was put upon
the piers in the West Transit
Room;

The collimation was approximately
adjusted by means of the wires
of the small magnetic transit on
the stand immediately south.

The following obsns. were made
May 29 for inequality of pivots.



2

Lamp. West

These levellings are valueless, the

Time	Temp.	Angle from zenith	Level Readings		Level
			East	West	
<u>A. M.</u>					
11 25	63	90 N	46.2	47.3	
			46.7	47.2	
			92.9	94.5	+0.40
35	65	80 N	46.5	46.8	
50	66		46.8	44.6	
			93.3	91.4	-0.48
<u>P. M.</u>					
12 0		70 N	44.0	47.0	
			45.3	45.5	
			89.3	92.5	+0.80
		60 N	44.0	46.5	
			45.2	45.1	
			89.2	91.6	+0.60
		50 N	43.7	46.5	
			45.3	44.3	
			89.0	90.8	+0.45
12 15	66	40 N	43.8	46.0	
			43.6	45.7	
			88.4	91.7	+0.82

instrument Lamp East
not being reversed often enough

Time	Temp	Angle to zenith	Level Readings		Level
			East	West	
P. M.					
2 15	66.5	90 S	43.8 43.4	49.5 49.6	
			87.2	99.1	+2.98
		80 S	44.5 42.3	47.5 49.3	
			86.8	96.8	+2.50
		70 S	45.0 41.7	46.1 48.9	
			86.7	95.0	+2.08
2 30	66.5	60 S	44.0 40.8	46.0 48.8	
			84.8	94.8	+2.50
		50 S	43.0 40.3	45.5 48.0	
			83.3	93.5	+2.55
		40 S	42.8 40.9	44.9 46.1	
			83.7	91.0	+1.82

RH

Lamp West
 These levelings are worthless, the

Time	Temp	Angle to zenith	Level Readings		Level
			East	West	
3 30	66	40 S	39.5	45.2	
			41.5	43.5	
			81.0	88.7	
		50 S	39.8	45.2	
			41.8	43.0	
			81.6	88.2	
		60 S	39.8	45.2	
			42.0	43.0	
			81.8	88.2	
		70 S	39.8	45.5	
			42.9	42.5	
			82.7	88.0	
		80 S	39.8	46.0	
			42.8	43.1	
			82.6	89.1	
		90 S	39.2	46.8	
			43.2	43.0	
			82.4	89.8	
2 50	66.5	90 S			+1.85

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instrument Lamp East not being reversed often enough.

Time	Temp	Angle to zenith	Level Readings		Level
			East	West	
12 25	66	40 N	42.1	46.8	
			42.3	46.5	
			84.4	93.3	+2.25
		50 N	42.2	46.5	
			42.2	46.3	
			84.4	92.8	+2.10
12 40	66.5	60 N	41.6	46.8	
			43.1	45.2	
			84.7	92.0	+1.82
12 45		70 N	44.2	46.8	
			42.3	45.7	
			83.5	92.5	+2.25
2 5	66	80 N	44.2	50.2	
			45.3	49.2	
			89.5	99.2	+2.42
		90 N	44.1	50.0	
			43.8	50.0	
			87.9	100.0	+3.02

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May
31

Lamp East

Time	Temp	Angle to zenith	Level Reading		Level
			E	W	
10 ^{AM} 15	59	90 S	45.1	62.7	
			51.7	56.0	
			96.8	118.7	+ 5.48
		80 S	43.8	61.3	
			50.8	54.8	
			94.6	116.1	+ 5.38
11 15		70 S	43.8	61.3	
			50.3	55.3	
			94.1	116.6	+ 5.56
		60 S	44.2	60.1	
			48.8	55.4	
			93.0	115.5	+ 5.56
12 5	59.5	50 S	44.5	58.8	
			48.4	54.5	
			92.9	113.3	+ 5.10
		40 S	43.6	57.2	
			47.9	52.8	
			91.5	110.0	~~+ 5.62~~
Repeated	June 5	5"	41.9	40.8	
			38.1	43.5	
			80.0	84.3	+ 1.07

Lamp west

Pivots⁷

Temp	Angle to zenith	Level Reading		Level	Inequality corr. Lp. E
		E	W		
90 N		46.7	60.5		
		52.2	54.3		
		98.9	194.8	+ 3.98	- 0.38
80 N		46.1	60.2		
		51.8	54.3		
		97.9	114.5	+ 4.15	- 0.31
70 N		44.7	61.1		
		51.1	54.1		
		95.8	115.2	+ 4.85	- 0.18
60 N		45.3	59.5		
		51.1	54.1		
		96.4	113.6	+ 4.30	- 0.32
50 N		45.3	57.1		
		49.6	52.6		
		94.9	109.7	+ 3.70	- 0.35
40 N		~~44.0~~	~~56.9~~		
		~~48.0~~	~~53.2~~		
		~~92.0~~	~~110.1~~	~~+ 4.52~~	
		44.4	39.4		
		39.1	44.2		
		83.5	83.6	+ 0.02	- 0.26

June

5

Lamp East

Time	Temp	Angle to zenith	Level Reading		Level
			E	W	
P M					
3 30	71	90 N	46.2	43.2	
			38.5	49.8	
			<u>84.7</u>	<u>93.0</u>	+2.08
		80 N	41.1	40.1	
			36.9	44.3	
			<u>78.0</u>	<u>84.4</u>	+1.60
5 0	70.5	70 N	40.0	40.0	
			37.3	42.9	
			<u>77.3</u>	<u>82.9</u>	+1.40
		60 N	39.9	40.0	
			37.3	42.7	
			<u>77.2</u>	<u>82.7</u>	+1.38
5 45	70	50 N	41.0	39.8	
			37.2	43.3	
			<u>78.2</u>	<u>83.1</u>	+1.22
		40 N	40.0	40.7	
			37.1	43.5	
			<u>77.1</u>	<u>84.2</u>	+1.78

Lamp West

Pivots⁹

Temp	Angle to Zenith	Level Reading		Level	Inequality Corr. Lp. E.
		E	W		
90 S		44.7	40.7		
		<u>39.2</u>	<u>47.0</u>		
		33.9	87.7	+0.95	-0.28
80 S		42.5	38.8		
		<u>38.2</u>	<u>42.4</u>		
		80.7	81.2	+0.12	-0.37
70 S		41.3	39.2		
		<u>38.5</u>	<u>42.0</u>		
		79.8	81.2	+0.35	-0.26
60 S		40.9	39.1		
		<u>38.8</u>	<u>41.5</u>		
		79.7	80.6	+0.22	-0.29
50 S		41.3	39.0		
		<u>38.7</u>	<u>42.0</u>		
		80.0	81.0	+0.25	-0.24
40 S		41.2	39.9		
		<u>38.8</u>	<u>42.5</u>		
		80.0	82.4	+0.60	-0.30
Mean					-0.30

10

12 Jan 1867

May 31 Friday

 α Can. Ven. Lp. E

Polaris level Lp. E

Cross level E 45.1 58.8

W 49.6 54.3

97.7 113.1 + 4.60

Polaris 3 Lp. E middle thread

Reversed to Lp. W.

 α Virginis

A Cassiopea to C

 γ Virginis

Level Lp. W

L. 45.2 59.3

51.2 54.0

96.4 113.3 + 4.22

June 1. Measures for collimation of middle wire, by wire of magnetic transit.

Two measures gave for Lamp East.

Middle wire $0^{\circ} 38.4$ W of collim. wire
Lamp. W

" $0^{\circ} 64.2$ W

Coll. corr. $\Delta p \ E = + 0^{\circ} 29 = + 0^{\circ} 41$

This is however affected by inequality of pivots, the transit pointing down to the collimator at an angle $115^{\circ}.4$ S of zenith. The following measures were made for inequality in this position

$\Delta p. \ W$

40.4	46.5
40.2	46.8
80.6	93.3
	+ 3.17

$\Delta p \ E.$

35.2	45.2
36.5	43.7
71.7	88.9
	+ 4.30

.12

The approximate value of 1 rev. of
the micrometer screw is

$$3^{\text{s}}.20$$

and of 1 division of the level

$$0^{\text{s}}.067$$

The inequality $\times \sin 25^{\circ}.4 = \text{about } 0^{\text{s}}.01$

Hence the coll. corr. taking account
of diurnal aberration

$$= +0.38$$

Lp E.

$$-0.42$$

Lp W.

June 1 Saturday

β Urs Min 5 tallies

coll. adjusted

Level Lf. E

42.2 52.0

44.5 50.0

~~ζ Urs Min Lf. E.~~

η Draconis e^2 perhaps a little late.

15 Draconis 1st two tallies

Reversed to w

last tally.

Level Lf w

43.7 52.8

48.1 48.9

14

 ϵ Urs Min1st two tallies Lf wReversed to ϵ .

Last two tallies

4th wire of 1st, 3^d & 4th of 2^d
uncertain. Illumination very poor. α Herculis ϵ .Level Lf ϵ .

42.8 54.3

46.8 51.7

 β Draconis ϵ .

The collimation correction seems to
be from the reversals on 15 Draconis
& ϵ Urs. Min. - 0.15 for Lf. ϵ .

8³⁰ June 3 Monday

6^h 20^m Received telegram from S W Dean
 "Weather cloudy with showers. Cannot
 try longitudes tonight."

June 4 Tuesday

Lp. E. 13^h 40^m

42.7 47.8

42.3 48.7

95.0 96.5 +0.38

Lp. W 14^h 9^m

44.1 46.0

42.5 48.3 λ

96.6 94.3 -0.52

Lp W 14^h 32^m

44.2 47.0

44.2 47.2

98.4 94.2 -1.05

16

Lp E

14 45

45.0 46.5

42.3 49.5

 97.3 96.0 - 0.32

Lp W

15 55

44.8 48.2

 44.8 49.2

 89.6 97.4 + 1.7

Lp E

16^h 11^m

45.7 48.7

 43.0 51.3

 88.7 100.0 + 2.82

Lp W

16 32

46.8 48.8

 45.1 50.7

 91.9 99.5 + 1.90

17

Lp w

17^h 0^m

46.2 49.2

45.0 50.7

91.2 99.9

+1.92
+1.92

Lp w

18^h 0^m

46.3 51.2

46.5 51.3

92.8 102.5

+2.42

0.8

2.84

7.02

-1.51

-0.38

432

145

18

June 6th Wednesday
 Lp. W 14 4

47.0	44.1	
<u>42.4</u>	<u>49.0</u>	
89.4	93.1	+ 0.92

Lp W 14 15

47.8	43.9	
<u>42.3</u>	<u>49.1</u>	
90.1	93.0	+ 0.72

Lp E 14 30

45.7	47.1	
<u>43.5</u>	<u>50.2</u>	
89.2	97.3	+ 2.02

Lp E 15 15

48.1	47.0	
<u>44.2</u>	<u>51.0</u>	
92.3	98.0	+ 1.42

Lp W 15 25

48.9	46.2	
<u>45.6</u>	<u>50.0</u>	
94.5	96.2	+ 0.42

Lh. E. 16 0

47.8 49.1

45.0 51.5

92.8 100.6 + 0.95

Lh E 16 25

47.3 49.2

46.0 51.0

93.3 100.2 + 1.72

Lh E 17 32

48.0 49.0

45.0 52.2

93.0 101.2 + 2.05

Lh E 17 50

48.0 49.2

45.1 52.2

93.1 101.4 + 2.07

Lh W 18 15

49.2 48.0

46.2 51.1

95.4 99.1 + 0.92

20

Lp E 18 30

47.8 50.0

45.9 52.2

93.7 102.2 + 2.12

Lp E 18 40

47.8 50.3

45.7 52.5

93.5 102.8 + 2.32

Lp W 19 0

49.2 50.0

47.2 51.7

96.4 101.7 + 1.32

June 6 4 P.M.

21

Measures of diaphragm with
Therm 77°) micrometer screw. + rotation

F₅ 0.81 80 80 79 80 0.800

4 1.64 63 62 63 64 1.632

3 2.49 49 48 47 48 2.482

2 3.31 32 32 32 32 3.318

1 4.20 20 19 20 20 4.198

E₅ 5.90 89 89 90 90 5.896

4 6.74 73 74 73 74 6.736

3 7.54 54 54 55 56 7.546

2 8.40 41 41 41 41 8.408

1 9.26 25 25 26 25 9.254

D₅ 10.97 96 96 95 96 10.960

4 11.84 84 85 84 85 11.844

3 12.64 65 65 64 64 12.644

2 13.51 50 51 51 51 13.508

1 14.37 37 38 38 38 14.376

22

C ₅	16.08	07	07	08	08	16.076
4	16.90	90	91	91	91	16.906
3	17.73	71	73	72	72	17.722
2	18.60	59	59	59	60	18.594
1	19.42	44	44	44	44	19.436

B ₅	21.15	14	15	17	15	21.152
4	22.02	02	01	02	03	22.020
3	22.85	85	85	85	85	22.850
2	23.64	62	63	65	67	23.642
1	24.48	48	47	47	48	24.476

Therm 78

B ₁	24.49	49	49	48	47	24.484
2	23.62	64	64	65	65	23.640
3	22.87	86	87	86	86	22.864
4	22.03	03	04	02	03	22.030
5	21.17	18	17	18	17	21.174

C ₁	19.45	44	45	43	43	19.440
2	18.61	60	59	60	61	18.602
3	17.73	73	73	74	72	17.730
4	16.90	92	91	92	92	16.914
5	16.07	08	07	08	09	16.078

D ₁	14.39	40	39	39	39	14.392
2	13.52	52	53	52	52	13.522
3	12.67	64	65	66	65	12.654
4	11.85	85	85	86	84	11.850
5	10.95	95	96	96	96	10.956

24

9.27 26 27 28 27 9.270

8.42 43 42 43 43 8.426

7.55 56 57 56 56 7.560

6.74 74 75 74 73 6.740

5.90 91 91 91 91 5.908

4.19 21 21 21 21 4.206

3.33 32 32 34 33 3.328

2.46 49 48 48 49 2.480

1.64 63 63 63 65 1.636

0.80 80 81 81 82 0.808

Therm 79 4^h 45^m P M

June 6 Thursday 25

Lh w 13 12

42.8 35.3

35.2 42.2

78.0 77.5 - 0.12

Lh w 13^h 35^m

41.8 33.2

34.8 40.2

76.6 73.4 - 0.80

Lh w 13^h 53^m

41.5 33.0

33.8 40.7

75.3 73.7 - 0.40

Lh E 14 5

39.7 34.8

33.0 41.7

72.7 76.5 + 0.95

Lh w 14 25

39.5 35.1

36.0 39.0

75.5 74.1 - 0.35

26

Lp w 45 45

41.0 38.0

37.0 42.2

78.0 80.2 + 0.55

Lp. E

39.8 39.3

35.0 44.0

74.8 ~~74.8~~ ~~83.3~~ 83.0 + 2.12 2.05~~37.9~~ ~~41.7~~

Lp w

40.8 38.2

37.9 41.7

78.7 79.9 + 0.30

Lp. w. 16 35

42.1 37.5

37.0 42.8

79.1 80.3 + 0.30

Lp. E.

$$\begin{array}{rcl}
 40.3 & 39.5 & \\
 36.0 & 44.0 & \\
 \hline
 76.3 & 83.5 & + 9.80
 \end{array}$$

Lp. E. 17.3

$$\begin{array}{rcl}
 41.3 & 38.7 & \\
 36.0 & 44.1 & \\
 \hline
 77.3 & 82.8 & + 1.38
 \end{array}$$

28 this quantity, having generally the wrong sign, can hardly be due to backlash.

			log.
+8	0.804	+11.859	1.07404
+4	1.634	10.029	0.4254
-2	2.481	10.182	1.00783
+10	3.323	9.340	0.97035
+8	4.202	8.461	9.2742
+12	5.902	6.761	8.3001
+4	6.738	5.925	7.7269
+14	7.552	5.111	7.0851
+18	8.417	4.246	6.2798
+16	9.262	3.401	5.3161
-4	10.958	1.705	0.23172
+6	11.847	0.816	9.91169
+10	12.649	+0.014	8.14613
+14	13.515	-0.852	9.93044
+16	14.384	1.721	0.23578
+2	16.077	3.414	5.3326
+8	16.910	4.247	6.2808
+8	17.726	5.063	7.0441
+8	18.598	5.935	7.7342
+4	19.438	6.775	8.3091
+22	21.163	8.500	9.2942
+10	22.025	9.362	0.97137
+14	22.857	10.194	1.00834
-2	23.641	10.978	0.4052
+8	24.480	-11.817	1.07257
Sum	316.583	+78.850	
mean	12.663	-78.858	

Mean of middle tally

Collimation of 25 wires

0.008

0.008

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1867 June 10 Monday

Lp. W. 13 11

57.2 43.2

47.7 53.0

104.9 96.2 - 2.18

Lp. W. 13 30

57.5 44.4

48.8 53.2

106.3 97.6 - 2.18

Lp. E 13 37

56.7 45.7

48.2 54.0

104.9 99.7 - 1.30

Lp. E 13 55

57.2 46.0

48.4 55.0

- 1.12

Instr. jarred in

105.6 101.1 reversing on α Draconis

Lp. W 14 5

57.5 47.2

50.7 54.7

108.2 99.9 - 2.08

16.83

38

25.59

17.43

3.20

0.26

30

Lp w 14 15

59.3 47.2

51.8 55.2

111.1 102.4

- 2.18

Lp E 14 23

58.3 49.7

51.2 57.4

109.5 107.1

- 0.60

Lp w 14 34

59.7 50.3

53.7 56.7

113.4 107.0

- 1.60

Lp w 16 30

60.2 53.9

55.2 59.0

105.4 112.9

-0.62

~~108.8~~

Lp E 16 43

61.3 52.8

52.8 61.5

114.1 114.3

+0.05

Lp E 16 54

60.0 54.1

54.0 60.7

114.0 114.8

+0.20

Lp w 18 6

60.4 54.1

56.7 58.7

117.1 112.8

-1.08

Lp E 18 16

60.0 55.2

54.8 60.7

114.8 115.9

+0.28

32

Lh w 17 23

60.9 54.5

55.5 59.7

116.4 114.2 - 0.55

Lh w 17 34

61.8 53.2

55.6 59.7

117.4 112.9 - 1.12

Lh E 17 44

60.2 54.8

55.0 60.0

115.2 114.8 + 0.10

Lh E 17 58

60.1 55.2

54.8 60.6

114.9 115.8 + 0.22

June 11 Tuesday

Lp E 12 57

48.8 40.1

40.5 48.2

89.3 88.3

-0.85

-0.25

Lp W 13 25

49.8 39.0

42.5 46.3

-1.15

92.3 85.3

-1.75

Lp W 13 35

49.7 39.5

42.2 47.0

-0.75

91.9 86.5

-1.35

Lp E 13 52

48.7 40.7

41.0 48.7

-0.52

89.7 89.4

+0.08

Lp W 14 5

49.5 40.3

42.6 47.6

-0.45

92.1 87.9

-1.05

34

Lp E 14 13

48.3 42.0

42.0 48.5

-0.55

90.3 90.5 +0.05

Lp E 14 30

48.6 42.7

43.2 48.3

-0.85

91.8 91.0 -0.20

Lp E 16 0

49.7 47.7

46.5 50.9

-0.00

96.2 98.6 +0.60

Lp W 16 10

49.9 47.7

48.0 49.8

+0.50

97.9 97.5 -0.10

Lp W 16 27

51.4 46.5

48.1 50.2

+0.20

99.5 96.7 -0.80

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35

Lh ϵ 16 35

51.2 47.1

47.8 50.8

-0.98

99.0 97.9

-0.38

Lh ϵ 16 46

50.7 48.1

47.7 51.3

-0.35

98.4 99.4

+0.25

Lh W 17 0

51.7 47.1

49.7 49.2

-0.68

101.4 96.3

-1.28

36

June 13 Thursday

Lp w 13 25

45.8 35.8

37.9 43.3

Lp w 13 35

45.8 34.1

37.1 42.3

Lp E 13 40

44.1 35.1

34.1 44.7

Lp E 13 52

42.2 34.8

34.0 42.8

Lp 8 14 30

41.3 34.3

33.4 42.2

June 14 Friday

37

Lp E 13 18

37.8 43.8

44.3 37.3

82.1 81.1 - 0.25

Lp E 13 35

39.0 45.0

45.1 38.7

84.1 83.7 - 0.10

Lp W 13 55

40.2 44.6

47.3 37.9

87.5 82.5 - 1.25

Lp E 14 5

39.8 46.0

46.4 39.4

86.2 85.4 - 0.20

Lp W 14 15

41.2 45.1

47.9 38.4

89.1 83.5 - 1.40

Lh E 14 26

40.2 46.3

46.3 40.4

86.5 86.7 + 0.05

Lh W 14 35

41.9 45.0

48.0 39.2

89.9 84.2 - 1.42

Lh W 16 45

44.8 48.8

50.1 43.4

94.9 92.2 - 0.68

Lh W 16 55

45.2 48.4

49.1 44.6

94.3 93.0 - 0.32

Lp E 17 15
 43.7 49.9
 49.0 44.7
 92.7 94.6 + 0.72

Lp E 17 35
 44.0 49.2
 48.2 45.0
 92.2 94.2 + 0.50

Lp W 17 43
 45.5 47.8
 49.4 43.7
 94.9 91.5 - 0.85

40

Value of division of Level of Transit
Instrument No. 8 W.S.G.S.

Level locked to Transit-Circle
cross level North.

N	S
~~28.1~~	~~36.9~~
20.1	~~44.5~~
25.0	39.9
24.5	39.9

- 7".575-

micrometer A 1".10

1.099

9.1

69.78

10.1

N

S

16.3

- 15".8

47.9

A

1".20 18.2 18.3 18.5

78".75

N S
33.2 + 1" 15" 30.9

A 1" 0" 1.0" 0.8 0.2
60" 38

N S
45.0 19.0
45.2 + 13" 05" 19.0

A 0" 50.0 47.3 47.3 48.3 48.5
48" 28

N S
52.3 11.5
52.3 + 20" 32 11.8

A 0" 40.0 41.0 39.2 39.5 40.0
40" 04

N S
63.5 0" 30" 0 28" 2 28.5 0.0
63.6 28.7 28.6 0.0
31" 77 28" 80

42

Level

Micrometer A

Read	5 ind	0" 40" 39.5- 39.0
------	-------	-------------------

52.9	10.5-	38.7 39.3
------	-------	-----------

53.0	10.5-	mean 0" 39.3
------	-------	--------------

+ 21".22

43.3	19.6	0.50.0 49.5- 50.1
------	------	-------------------

43.2	19.5-	50.2 50.5- 50.6
------	-------	-----------------

+ 11".85-

50".15-

35.0	27.5-	0 60".0 59.5- 59.5
------	-------	--------------------

35.0	27.8	59.8 59.2 59.6
------	------	----------------

+ 3".72

59".60

25.3	36.9	0 70".0 68.9 68.9
------	------	-------------------

- 5".80

6.9.0 69.5- 68.9

69".2

16.0	46.0	0 80" 79.5 79.2
------	------	-----------------

- 15".0

79.0 78.5 79.5

79.28

Level Micrometer A
 Read S End or 90^s.0 89.5 89.9
 4.3 57.1 90.3 89.2
 - 26".4 89".78
 For value of revolution of screw
 or 0^s.0
 0 0"

value of level division = 1".074

mic	level	e-o		
28".8	+ 31.77	-28.89	+27.38	+5.2
39.3	21.22	18.39	16.83	-3.2
40.04	20.32	17.65	15.93	-5.4
48.28	13.05	9.41	8.66	-11
50.15	11.85	-7.54	+7.46	+47
59.60	3.72	+1.91	-0.67	+1.19
60.38	+1.15	2.69	-3.24	-0.78
69.20	-5.80	11.51	+10.19	+5.7
69.78	-7.57	12.09	-11.96	-75
79.28	-15.00	21.59	-19.39	+76
89.78	-26.40	+32.09	-30.79	-.98
57.69	+4.39	163.76	152.50	

44

Lamp E 13^h 25^m

W?

45.7

(42° 17)

E?

35.9

33.5

46.7

79.2

82.6

- 0.85

14^h 16^m

45.0

E

36.1

35.0

46.5

80.0

82.6

- 0.65

15 16 Lamp W

W

44.8

E

41.2

35.5

51.2

80.3

92.4

- 3.02

21st~~21st~~ 42nd

next ind

13^h

44.0

38.0

E

33.2

48.5

77.2

86.5

- 2.32

$$\begin{array}{rcl}
 17^{\circ} 27'' & & \\
 39.0 & 50.5 & \varepsilon \\
 48.0 & 42.0 & \\
 \hline
 87.0 & 92.5 & -1.38
 \end{array}$$

46

mean

	80.52	80.16	80.38	80.358
η Bootis				
~~α Bootis~~				
κ Ophi	76.64	77.05	77.11	76.93
γ Dra	121.76	122.36	121.77	121.89
α Bootis	80.66	80.45	80.93	80.68
δ Ophi	~~75.81~~			
τ Herc	110.67	110.42	110.73	110.61
~~α Lyrae~~	~~97.16~~			
α Virg	76.98	77.13	77.13	77.08
ζ Virg	75.74	75.67	75.88	75.76
η Urs Maj	118.08	117.61	118.28	117.99

90499 97550
~~97332~~ 88049

88610 99389 87999

08597 79408 88005

90677 97332 88009

04379 83675 88054

88694 99271 87965

87944 00000 87944

07185 80825 88010

88004

23.676 37431

3.2043 50573

48

Copy in p. 1 as far as "immediately south."

~~Record of campaign.~~

1867 May 31 Friday. Obs. SMS

 α Cen. Zen. Lp E

Level Lp E at 13 ^h 0 ^m	w	E
	58.8	45.1
	54.3	49.6

Polaris Lp E middle thread

Reversed to Lp w.

 ~~α Virginis Lp w~~A. Ceresio p. to C Lp w D₄ - D₁ ~~γ Virginis "~~

Level Lp w at 13 30	w	E
	59.3	45.2
	54.0	51.2

 η Urs. Maj. Lp w D₁ - D₅

June 1 Saturday

Collimation^{Core.} of middle thread determined
by obsns. on wire of magnetic transit
as +0.40 Lp. E.

June 1 Saturday Obs. G.M.S.
 B Mrs. Min. 5 J.
Coll. adjusted. Clock put forward ^{4^m}

Level Lp E at 15^h 0^m?

W 52.0 E 42.2

50.0 44.5

New sheet.

η Draconis Lp E 5 J.

15 Draconis " 7 E

Reversed to W. F.

Level Lp W at 16 30

W 52.8 E 43.7

48.9 48.1

E Mrs. Min. Lp W B C

Reversed to E C B

C₂ B₃ & B₂ uncertain. IM. very poor

α' Herculis Lp E. 5 J. C₅ lost

Level Lp E at 17 15

W 54.3 E 42.8

51.7 46.8

50 Pen taken up.

β Draconis Lp. E... $F_5 - B_1$

1867 June 4 Tuesday, Obs. G.M.S.

Level Lp E at $13^h 40^m$ W 47.8 E 42.7

η Bootis Lp E $F_5 - B_1$ 48.7 42.3

α Draconis E F_5 E

Reversed to W $\frac{F_2 - F_5}{B_4 - B_1}$

Level Lp W. at 14 9

W 46.0 E 44.1

48.3 42.5

α Bootis Lp W $B_3 - F_5$

ι Cassiopeiæ W F_5 E

Reversed to E $\frac{E_4 - F_5}{E_3 - B_1}$

5 Urs. Min E F_5

Reversed to W $E_3 - F_5$

Level Lp W at 14 32

47.0 44.2
47.2 44.2

Cambridge clock on. at 15

First min. break $15^h 3^m$

Seaton's clock on. at 15 12 58
 off " 15 17 10

Naval clock on at 15 23 20
 off 15 29 6

Sheet No 2.

ζ Urs. Min. Gr. 2320, τ Herculis
 η Draconis, 15 Draconis, η Herculis
 observed, but all lost, owing to the
 transit having been switched out of
 the circuit.

Level Lp W at 16 32

W 48.8 E 46.8

50.7 45.1

κ Ophiuchi Lp W 5 J.

Level Lp W at 17 0

W 49.2 E 46.2

50.7 45.0

52

Cambridge clock on.

First min break 17 19 ?

Seaton clock on at 17 25 24

off 17 30 14

Naval clock on at 17 31 44

17 36 18

γ Draconis Lp W 5 J.

very well obsd.

Level Lp W 18^h 0^m

W 51.2 E 46.3

51.3 46.5

22 Camelopard. L C. Lp W E tally

Reversed to E. but lost 1st

star.

Chronograph here broke down
and no further obsns. could be made.

1867 June 5 Wednesday
 Sheet no 1. Obsr. G.M.S.

12 Can. Ven. }
 & Virginis }
 Polaris } observed with East Transit
 & Virginis }
 & Urs Maj. }

Level Lp W 14^h 4^m

W 44.1 E 47.0

49.0 42.4

& Bootis W 5 J.

Level Lp W at 14 15

W 43.9 E 47.8

49.1 42.3

5 Urs. Min Lp W B C

Reversed to E C B

s. Level Lp. E at 14 30

W 47.1 E 45.7

50.2 43.5

54

Cambridge clock on.

First min. break 14 36

Seaton clock on at 14 53 0

off at 14 57 50

Level Lp E at 15 15

W 47.0 E 48.1

51.0 44.2

 γ^2 Urs. Min. Lp E $F_2 - E_1$ Rev. to W $E_3 - F_5$

Level Lp W at 15 25

W 46.2 E 48.9

50.0 45.6

Sheet no 2,

 γ Urs. Min Lp W $C_1 - C_5$ Rev. to E $C_5 - B_1$ Level Lp E at 16^h 0^m

W 49.1 E 47.8

51.5 45.0

δ Ophiuchi Lp E $7_5 - B_1$
 τ Herculis " "

Level Lp E at $16^h 25^m$

W 49.2 E 47.3

51.0 46.0

Cambridge clock on. ~~at~~
 1st min. break. $17^h 5^m$

Seaton clock on at 17 13 34

off at 17 19 6

Albany clock on at 17 38 28

off at 17 40 2

Level Lp E at $17^h 32^m$

W 49.0 E 48.0

52.2 45.0

μ Herculis Lp E. $D_1 - B_1$

γ^1 Draconis (pr) " $E_3 - B_1$

Level Lp E at $17^h 50^m$

W 49.2 E 48.0

52.2 45.1

56

22 Camelopardalis L C Lp E C₄-D₅

Level Lp W at 18 15

S Lp 48.0 E 49.2

51.1 46.2

S Urs. Min Lp W C₁-C₅

Reversed to E

Sheet No 3

S Urs. Min. Lp E. C₄-C₁

Level Lp E at 18 30

W 50.0 E 47.8

52.2 45.9

α Lyrae Lp E 5 J.

Level Lp E at 18 40

W 50.3 E 47.8

52.5 45.7

β Lyrae Lp E D₁-B₁50 Draconis Lp E ~~B₁~~ F E

Reversed to W E F

Level Lp W at 19 0

W 50.0 E 49.2

51.7 47.2

~~Insert measures of diaphragm with
micrometer screw. p 21~~

Insert

1867 June 6 Thursday

Sheet no 3 of last night Obs. GMS

Level Δ w 13 12

W 35.3 E 42.8

42.2 35.2

 α Virginis Δ w $B_1 - F_5$ ζ Virginis " "Level Δ w 13 35

W 33.2 E 41.8

40.2 34.8

 η Urs. Maj w $B_1 - F_5$ Level Δ w 13 53

W 33.0 E 41.5

40.7 33.8

 α Draconis $B_1 - C_5$ Δ wReversed to E $C_3 - B_1$ Level Δ E 14 5

W 34.8 E 39.7

41.7 33.0

 α Bootis Δ E $F_5 - B_1$

$\frac{1}{2} \text{ h } \epsilon$
 i. bass w/ 2 C $B_1 - C_5$
 Reversed to w $B_5 - B_1$
 Level $\frac{1}{2} \text{ h}$ w at 14 25
 W 35.1 ϵ 39.5
 39.0 36.0

Sheet no 2.
 Cambridge clock on
 1st min 14 57 ?

Albany clock on at 15 8 32
 off at 15 13 46

Seaton clock on at 15 17 24
 off at 15 22 20

Naval clock on at 15 24 42
 15 29 22

Level Δp w at 15 45

w 38.0 E 41.0

42.2 37.0

[Mrs Min Δp w $C_3 - D_5$

Reversed to E $C_1 - B_1$

Level Δp E at

w 39.3 E 39.8

44.0 35.0

Groomb. 2320 Δp E $F_5 - E$

Reversed to w $F_1 - F_5$

Level Δp w at

w 38.2 E 40.8

41.7 37.9

τ Herculis w $B_1 - F_5$

η Draconis w $B_1 - F_5$

15 Draconis w $D_2 - F_5$

Level Δp w at 16 35

w 37.5 E 42.1

42.8 37.0

η Herculis Δp w $B_1 - F_5$

Level Sp E at

W 39.5 E 40.3

44.0 36.0

K Ophiuchi Sp E 75-B,

d Herculis " "

Level Sp E at 17^h 3^m

W 38.7 E 41.3

44.1 36.0

Cambridge clock on.

1st min. break. 17 21

Albany clock on at 17 27 24
off at 17 32 46

Seaton clock on at 17 37 18
off at 17 42 38

Naval clock on at 17 44 52
17 49 26

Naval mean time clock on

at 17 49 50

17 52 12

1867 June 9 Sunday

Same sheet. Obsr. G.M.S

Stars observed for equatorial
intervals. Seeing rather poor. —

β Urs. Min. δ E $F_5 - B_1$

β Bootis " " "

New sheet

γ^2 Urs. Min. δ E $F_5 - B_1$

α Cor. Bor " "

α Serpentiis δ W $B_1 - F_5$

ϵ Serpentiis " "

ζ Urs. Min " $C_1 - E_5$

June 10 Monday Obs. S.M.S.

Level Lp W at 13^h 11^m

W 43.2 E 57.2

53.0 47.7

α Virginis Lp W $\beta_1 - \gamma_5$

γ " " " " "

Level Lp W at 13 30

W 44.4 E 57.5

53.2 48.8

Reversed to ϵ Level Lp ϵ at 13 37

45.7 56.7
54.0 48.2

η Urs Maj. Lp ϵ $\gamma_5 - \beta_1$

η Bootis " "

Level Lp ϵ at 13 55

W 46.0 E 57.2

55.0 48.4

α Draconis Lp ϵ $\gamma_5 - \epsilon$,

Reversed to α . Instrument received a jar in reversing by the clamp catching as it was lowered; the collimation appears to have been changed by it.

α Draconis Lp W $\gamma_4 \gamma_5$

Level Lp W at 14 5
 W 47.2 E 57.5

54.7 50.7

α Bootis Lp W B₁ - F₅

~~v bass. L C. W F₄ - E₁~~

~~Reversed to E E₅ - F₅~~

Level Lp W at 14 15

W 47.2 E 59.3

55.2 51.8

v bass. L C W F₄ - E₁

Reversed to E E₅ - F₅

Level Lp E at 14 23

W 49.7 E 58.3

57.4 51.2

5 hrs Min Lp E F₅ - E₁

Reversed to W E₁ - F₅

Level Lp W at 14 34

W 50.3 E 59.7

56.7 53.7

Sheet no. 2.

Albany clock on at 15 6 30
off at 15 7 34
on at 15 9 38
off at 15 10 36

Cambridge clock on . 1st min break 15 24

Albany clock on at 15 37 40
off at 15 42 46

Seaton clock on at 16 2 12
off at 16 7 8

Naval clock on at 16 10 46
off at 16 16 10

Sheet no. 3

Level Lp W at 16 30

W 53.9 E 60.2

59.0 55.2

η Herculis Lp W B₁ - F₅

Reversed to E.

Level Lp E at 16 43

W 52.8 E 61.3

61.5 52.8

κ Ophiuchi Lp E F₅ - B₁

Level Lp E at 16 54

W 54.1 E 60.0

60.7 54.0

δ Herculis Lp E E₅ - B₁

ϵ Urs Min Lp E D₄ - C₃

Reversed to W F₁ - F₅

Level Lp W at 17 6

W 54.1 E 60.4

58.7 56.7

Reversed to E.

Level Lp $\overset{E}{\text{XXX}}$ at 17 16
 W 55.2 E 60.0

60.7 54.8

Reversed to W
 Level Lp W at 17 23
 W 54.5 E 60.9

59.7 55.5

β Draconis Lp W $B_5 - E_5$

α Ophiuchi " $D_1 - F_5$

Level Lp W at 17^h 34^m

W 53.2 E 61.8

Cambridge 59.7 55.6
 clock on. 1st min break 17 34
 W Draconis Lp W $C_3 - D_5$

Reversed to E $B_5 - B_1$

μ Herculis Lp E $F_5 - B_1$

Seaton clock on at 17 40 22

off at 17 44 52

Level Lp E at 17 44

W 54.8 E 60.2

60.8 55.0

Naval clock on at 17 47 12

17 51 28

γ Draconis 2μ E $F_5 - B_1$

Albany clock on at 17 6 8

off at 17 7 8

on at 17 8 26

off at 17 9 34

on at 17 10 30

off at 17 11 32

1867 June 11 Tuesday Obs. GMS

12 Can. Ven. Lp E $F_5 - B_1$

Level Lp E at 12 57

W 40.1 E 48.8

48.2 40.5

Polaris L C Lp E $C_5 D_2 D_3$

Reversed to W $D_2 D_1$

α Virginis Lp W $B_1 - F_5$

Polaris L C " $C_4 C_3$

Level Lp W at 13 25

W 39.0 E 49.8

46.3 42.5

ζ Virginis Lp W $B_1 - F_5$

Level Lp W at 13 35

W 39.5 E 49.7

47.0 42.2

η Urs Maj Lp W $B_1 - F_5$

η Bootis Lp E. $F_5 - B_1$

Level Lp E at 13 52

W 40.7 E 48.7

48.7 41.0

α Draconis 1p E $F_5 - E_1$

Reversed to W $F_2 - F_5$

Level 1p W at 14 5

W 40.3 E 49.5

47.6

42.6

Reversed to E

α Bootis 1p. E $F_5 - B_1$

Level 1p E at 14 13

W 42.0 E 48.3

48.5

42.0

η Bootis 1p E $F_5 - B_1$

Level 1p E at 14 30

W 42.7 E 48.6

48.3

43.2

Sheet no 2.

Cambridge clock on. 1st min break
15^h 19^m

Albany clock on 15 35 12

off 15 39 18

occasionally taken off between
these times, it coinciding very
nearly with the Camb. clock.

Seaton clock on at 15 42 38

off at 15 47 38

Naval clock on at 15 49 16

off at 15 54 12

Level Lp E at 16 0

W 47.7 E 49.7

50.9 46.5

Groomb. 2320 Lp E $F_5 - E_1$

Reversed to W $E_4 - F_5$

Level Δp w at 16 10

w 47.7 ε 49.9

49.8 48.0

τ Herculis Δp w $B_1 - F_5$

η Draconis " "

Level Δp w at 16 27

w 46.5 ε 51.4

50.2 48.1

15 Draconis Δp w $C_2 - C_5$

Reversed to ε $C_5 - B_1$

Level Δp ε at 16 35

w 47.1 ε 51.2

50.8 47.8

η Herculis Δp ε $F_5 - B_1$

Sheet no 3.

Level Δp ε at 16 46

w 48.1 ε 50.7

51.3 47.7

κ Ophiuchi Δp ε $F_5 - B_1$

Reversed to w

d Herculis Sp W B₁ - F₅
 Level Sp W at 17 0
 W 47.1 E 51.7
 49.2 49.7

Cambridge clock on
 First min break 17 9

Mbang clock on at 17 17 54
 off at 17 22 50

Seaton clock on at 17 24 16
 off at 17 29 2

Naval clock on at 17 31 8
 off at 17 36 8

1867 June 13. Thursday
Obsr. G.M.S. Same sheet.

I Virginis Lp W (4 thds. only)

α " " B₁ - F₅

Level Lp W at 13 25

W 35.8 E 45.8

43.3 37.9

ζ Virg. Lp W B₁ - B₄ D₁ - F₅

Level Lp W at 13 35

W 34.1 E 45.8

Revised to 42.3 37.1
Level Lp ~~W~~ E at 13 40

W 35.1 E 44.1

44.7 34.1

Level Lp E at 13 52

W 34.8 E 42.2

42.8 34.0

Level Lp E at 14 3

W 34.3 E 41.3

42.2 33.4

Clouds prevented further obsns.

1867 June 14 Friday
Obsr. G.M.S.

Level Lp E at 13 18

W 43.8 E 37.8

37.3 44.3

α Virginis Lp E $F_5 - B_1$
 ζ " " "

Level Lp E at 13 35

W 45.0 E 39.0

38.7 45.1

η Urs Maj Lp E $F_5 - B_1$
 Reversed to W

η Bootis Lp W $B_1 - F_5$

Level Lp W at 13 55

W 44.6 E 40.2

37.9 47.3

α Draconis Lp W $B_1 - C_5$

Reversed to E $C_5 - B_1$

Level Lp E at 14 5

W 46.0 E 39.8

39.4 46.4

Reversed to W

α Bootis Lp W B₁ - F₅

Level Lp W at 14 15

W 45.1 E 41.2

38.4 47.9

γ Bootis Lp W B₁ - F₅

Reversed to E.

Level Lp ~~W~~ ^E at 14 26

W 46.3 E 40.2

40.4 46.3

5 Hrs.. Min Lp ~~W~~ ^E E₅ - E₁

Reversed to W E₁ - F₅

Level Lp W at 14 35

W 45.0 E 41.9

39.2 48.0

Sheet no 2.

Albany clock on at 15 5 3
off at 15 6 54

Cambridge clock on.
1st min. break 16^h 2^m

~~Scaton~~ Albany clock on at 16 14 56
off at 16 19 49

Scaton clock on at 16 21 17
off at 16 26 14

η Herculis 2p w B, - F₅
Level 2p w at 16 45
W 48.8 E 44.8

43.4 50.1

κ Ophiuchi 2p w B, - F₅
Level 2p w at 16 55
W 48.4 E 45.2
44.6 49.1

d Herculis $\text{Sp } w \quad B_1 - F_5$

ϵ Urs Min " $D_1 - E_2$

Reversed to $\epsilon \quad B_5 - B_1$

Level $\text{Sp } \epsilon$ at 17 15

$w \quad 49.9 \quad \epsilon \quad 43.7$

44.7 $\quad$ 49.0

Sheet no 3.

β Draconis $\epsilon \quad F_5 - D_1$

α Ophiuchi $\epsilon \quad F_5 - B_1$

Level $\text{Sp } \epsilon$ at 17 35

$w \quad 49.2 \quad \epsilon \quad 44.0$

45.0 $\quad$ 48.2

w Draconis $\text{Sp } \epsilon \quad F_5 - E_1$

Reversed to $w \quad E_1 - F_5$

Level $\text{Sp } w$ at 17 43

$w \quad 47.8 \quad \epsilon \quad 45.5$

43.7 $\quad$ 49.4

Cambridge clock on.

1st min. break 17^h 50^m

Albany clock on at 17 56 28
off at 18 1 50

Seaton clock on at 18 2 52
off at 18 8 23

1867 June 19 Wednesday

Obs. J. V.

Level Lp E at 13 25

W 45.7 E 35.9

33.5 46.7

η Bootis Lp E G-A

α Bootis Lp E G-A

Level Lp E at 14 16

W 45.0 E 36.1

35.0 46.5

β Urs. Min. ^{thw} G-F₁

Reversed to E F₁-G

Level Lp E at 15 16

W 44.8 E 41.2

35.5 51.2

d 035

1867 June 21 Friday
Obsr. J.W.

Level Lp E ?

44.0 38.0

33.2 48.5
Albany clock on at 16 59 9 off at 17 3 47
Seaton " " 17 5 42 " " 17 10 50
Naval " " 17 12 24 " " 17 18 16

Instrument received a severe jar
in reversing.

Level Lp w? at 17 27

39.0 50.5

48.0 42.0

μ Herculis Lp w B₁ - F₅

γ Draconis " "

Weather very cloudy. Only
a star to be seen occasionally.

Camb. clock on. 1st min. 18 29

Albany clock on at 18 34 59 off 18 38 56

Seaton " " 18 39 34 " 18 44 36

Naval " " 18 45 46 " 18 50 6

1867 June 28 Friday
obsr. J.W.

Level Lp E at 12^h 28^m

W 27.4 E 43.9

37.2 31.5

Repeated

W 25.0 E 42.0

36.5 29.0

Lp E at 13 15

W 37.0 E 32.0

27.0 42.0

5 Urs. Min Lp E $\mathcal{F}_5 - \mathcal{F}_1$

Reversed to W $\mathcal{F}_1 - \mathcal{F}_5$

E Bootis Lp W $C_1 - \mathcal{F}_5$ (C_2 lost)

α^2 Librae " $D_1 - \mathcal{F}_5$ (E, lost)

~~β Urs Min " $B_1 - B_5$~~

~~Reversed to E $B_5 - B_1$~~

Level Sp W at 14 50
W 28.5 E 43.2

38.5 33.3
^{67.0} ^{76.5} - 2.38
 B Urs Min Sp W B₁ - B₅
 Reversed to E B₅ - B₁,
 B librae Sp E G-A lost from
 Chronograph running down.

μ Bootis Sp E G-A
 α Coronae " "
 Level Sp E

W 28.0 E 45.0

37.0 36.1

Reversed to W - 4.02
 α Serpentis Sp W A-G
 Level Sp W at 16 0

W 37.1 E 36.5

46.8 26.7

Set for Ground 223205 but did
 not see it.

τ Herculis Sp w A-G.
 α Scorpii " " "

Sheet no 2. Obsr. W.M. Davis
 α Herculis C, - ~~A~~^{E₅} Sp w
 β Draconis A-G " "
w Draconis " "
 γ Draconis B, - F₅ " "

1867 June 29 Saturday
Obsr. J. W.

Level of E at 14 20

32.1 45.9

42.1 36.0

5 Mrs. Min of E 9 - F

Reversed to W F, - 9

Level of W at 14 30

42.1 41.5

34.3 49.6

μ' Bootis of W A-9

α Coronae of E 9-A

α Serpentis " "

ϵ Serpentis " "

ζ Mrs. Min " E 4 wires of C tally

Reversed to W F, 9.

Groomb. 2320 of W A-B₅

Reversed to E C₅-B₁

Sheet No. 2.

Camb. clock on. ~~at~~ First min 16^h 19^m
 on again " " 16 32

Albany clock on at 16 42 27
 off at 43 2
 on at 45 57
 off at 46 48
 on at 50 44
 off at 53 33

Scaton " on at 17 0 26 off 17 5 32

Naval " " " 17 8 30 " 17 13 45

~~β Draconis Lp E~~

Level Lp E at 16 45

38.5 48.2

46.0 42.0

Reversed to W

β Draconis Lp W A-G

w Draconis " C₁-C₅

Reversed to E.

δ 'Drac. pr δ E $C_5 - C,$

δ Urs. Min δ E $D_3 - C,$

Reversed to W $F_2 - F_5$

Level δ W at 18 25

46.2 45.0

39.5 51.9

α Lyrae δ W A - G

Sheet No 3.

Camb. clock on 1st min 18 53?

Army clock on at 18 57 55? off at 19 2 50?

Seaton " " 19 3 59? " " 19 8 42?

Naval " " 19 10 11 " " 19 15 7

α Aquilae δ W A - G

τ Aquilae Lp W A-G

Level Lp W at 20 5'

47.5 47.5

41.0 54.6

Reversed to E

α Cygni Lp E G-A

μ Aquarii " "

~~8 hrs Maj~~

Level Lp E at 20 55'

48.1 47.0

40.8 54.3

Repeated

48.5 46.0

38.9 55.0

σ^2 Urs Maj L C Lp E C₁-E₅

Reversed to W

Level Lp W at 21 21

37.8 55.0

47.5 44.5

Repeated

36.5 54.6

46.5 43.5

The following statements of
the condition of the atmosphere
and of the observer were made
from memory some time afterward
those of S.M.S. about June 20
" " ^{JW} Observer July 20 Atmosphere

June 4	Tolerable	} Seeing fair	
5	"		
6	Excellent		" very good
10	Good		
11	Fair		
14	Good	" Tolerable	

29 Good " Good

The following statements of
the condition of the atmosphere
and of the barometer were made
from memory some time after sunset
about 5 P.M. about June 20

Location: Philadelphia

Time	Temperature	Barometer
5 P.M.	75°	30.00
6 P.M.	74°	30.00
7 P.M.	73°	30.00
8 P.M.	72°	30.00
9 P.M.	71°	30.00
10 P.M.	70°	30.00
11 P.M.	69°	30.00
12 P.M.	68°	30.00
1 P.M.	67°	30.00
2 P.M.	66°	30.00
3 P.M.	65°	30.00
4 P.M.	64°	30.00
5 P.M.	63°	30.00
6 P.M.	62°	30.00
7 P.M.	61°	30.00
8 P.M.	60°	30.00
9 P.M.	59°	30.00
10 P.M.	58°	30.00
11 P.M.	57°	30.00
12 P.M.	56°	30.00
1 P.M.	55°	30.00
2 P.M.	54°	30.00
3 P.M.	53°	30.00
4 P.M.	52°	30.00
5 P.M.	51°	30.00
6 P.M.	50°	30.00
7 P.M.	49°	30.00
8 P.M.	48°	30.00
9 P.M.	47°	30.00
10 P.M.	46°	30.00
11 P.M.	45°	30.00
12 P.M.	44°	30.00
1 P.M.	43°	30.00
2 P.M.	42°	30.00
3 P.M.	41°	30.00
4 P.M.	40°	30.00
5 P.M.	39°	30.00
6 P.M.	38°	30.00
7 P.M.	37°	30.00
8 P.M.	36°	30.00
9 P.M.	35°	30.00
10 P.M.	34°	30.00
11 P.M.	33°	30.00
12 P.M.	32°	30.00
1 P.M.	31°	30.00
2 P.M.	30°	30.00
3 P.M.	29°	30.00
4 P.M.	28°	30.00
5 P.M.	27°	30.00
6 P.M.	26°	30.00
7 P.M.	25°	30.00
8 P.M.	24°	30.00
9 P.M.	23°	30.00
10 P.M.	22°	30.00
11 P.M.	21°	30.00
12 P.M.	20°	30.00
1 P.M.	19°	30.00
2 P.M.	18°	30.00
3 P.M.	17°	30.00
4 P.M.	16°	30.00
5 P.M.	15°	30.00
6 P.M.	14°	30.00
7 P.M.	13°	30.00
8 P.M.	12°	30.00
9 P.M.	11°	30.00
10 P.M.	10°	30.00
11 P.M.	9°	30.00
12 P.M.	8°	30.00
1 P.M.	7°	30.00
2 P.M.	6°	30.00
3 P.M.	5°	30.00
4 P.M.	4°	30.00
5 P.M.	3°	30.00
6 P.M.	2°	30.00
7 P.M.	1°	30.00
8 P.M.	0°	30.00
9 P.M.	-1°	30.00
10 P.M.	-2°	30.00
11 P.M.	-3°	30.00
12 P.M.	-4°	30.00
1 P.M.	-5°	30.00
2 P.M.	-6°	30.00
3 P.M.	-7°	30.00
4 P.M.	-8°	30.00
5 P.M.	-9°	30.00
6 P.M.	-10°	30.00
7 P.M.	-11°	30.00
8 P.M.	-12°	30.00
9 P.M.	-13°	30.00
10 P.M.	-14°	30.00
11 P.M.	-15°	30.00
12 P.M.	-16°	30.00
1 P.M.	-17°	30.00
2 P.M.	-18°	30.00
3 P.M.	-19°	30.00
4 P.M.	-20°	30.00
5 P.M.	-21°	30.00
6 P.M.	-22°	30.00
7 P.M.	-23°	30.00
8 P.M.	-24°	30.00
9 P.M.	-25°	30.00
10 P.M.	-26°	30.00
11 P.M.	-27°	30.00
12 P.M.	-28°	30.00
1 P.M.	-29°	30.00
2 P.M.	-30°	30.00

$2\mu. \varepsilon$

$\phi - (\delta + \tau)$ South of zenith

Subtract
270 from
circle readings

$90 + \phi - (\delta - \tau)$ North

180

$2\mu. w$

$90 + (\delta + \tau) \phi$ South of zenith

Subtract
circle readings
from 360

$(\delta - \tau) \phi$ north.

270

Circle reads

$270 + \phi - (\delta + \tau)$ south of zenith

$270 + \phi - (\delta - \tau)$ north

