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ROYAL OBSERVATORY, GREENWICH.

REDUCTION

OF

THE OBSERVATIONS

OF THE

DEEP-SUNK THERMOMETERS

AT THE

ROYAL OBSERVATORY, GREENWICH,

FROM 1846 TO 1859.

BY

PROFESSOR J. D. EVERETT,

OF KING'S COLLEGE, WINDSOR, NOVA SCOTIA.

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MY first operation was to take the means of the readings of each thermometer for each Calendar Month, year by year. For 1846, 7, and for 1856, 7, 8, the means were already given in the *Greenwich Observations*, and in these instances I have simply copied them, not considering it necessary to revise the calculation. The only exceptions to this statement are the means for the 6 ft. and 3 ft. thermometers for March 1858, in which month a number of observations are wanting (the fluid having sunk below the scale); and as the means printed in the *Observations*, being derived only from the recorded readings, were of necessity too high, I adopted in their stead lower values obtained by a rough estimation. I should also state that wherever erroneous readings were pointed out in the *Observations*, I adopted the corrections there suggested; but these corrections were, in all cases, too insignificant to have any appreciable influence on my ultimate results.

The monthly means are given on pages (cci) and (ccii) of the subjoined tabular statement of results; those values which, from the fluid having risen above or fallen below the scale, are doubtful, being enclosed in brackets. These doubtful cases are almost confined to the 6 ft. thermometer. The mean values for the entire year, given in the last column of each page, are simply the arithmetical means of the 12 monthly values; no allowance being made for the unequal lengths of the months.

The observations extend over 13 years and 9 months, commencing with April 1846 and coming down to the end of December 1859. My second operation was to find the mean monthly values for the 13 years which are entire; viz., 1847–1859. They are given on page (cciii), and were derived from the values for each year in the usual manner.

The next operation was to find the co-efficients of the terms in harmonic expressions which should represent the temperature of each thermometer, in terms of the time of year. For an explanation of the process by which they are obtained, I may refer to my Paper in the *Transactions of the Royal Society of Edinburgh*, Vol. xxii, Part II. The process is identical with that described by Sir John Herschel, art. Meteorology, *Enclyclopædia Britannica*, pp. 664, 665. I adopt the notation employed in my own Paper, except that I write,

$$t \text{ instead of } 2\,\pi\,\frac{t}{T}$$

that is to say, I adopt the convention that time shall be represented by degrees at the rate of 360° to the year. I should also state that the two forms

$$\sqrt{\frac{\pi\,c}{T\,k}} \text{ and } \sqrt{\frac{\pi\,c}{k}}$$

the former of which is used in my paper above referred to, and the latter in Professor Thomson's, which immediately precedes it in the *Transactions*, stand for one and the same function; the latter form (which will be here used) implying the convention that a year is the unit of time. For a full discussion of the units employed, see Professor Thomson's Paper, pp. 424–427.

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The values of the coefficients A_1, B_1, A_2, B_2, were found by the process exhibited on p. 433 of my Paper in the *Transactions;* but in the present instance the work was carried to one and sometimes two more places of decimals. The values of E_1 and P_1 were calculated by the formulæ

$$\log \tan E_1 = \log A_1 - \log B_1 + 10$$
$$\log P_1 = \log B_1 + \log \sec E_1 - 10$$

the value of E_1 being taken to the nearest 10 seconds. The tabular logarithm of P_1 being thus found, the Napierian logarithm was derived from it by a Table. The value of E_1 in circular measure was obtained by a Table of "Lengths of Circular Arcs to Radius Unity." The logarithms were carried to 5 places of decimals; but the correctness of the 5th decimal place in the values of $\log_e P_1$ and E_1 is not to be depended on.

The next operation was to find the differences in the values of $\log_e P_1$, obtained by comparing the thermometers two and two. The number of thermometers being 4, the number of comparisons is of course 6. The differences in the corresponding values of E_1 (in circular measure) were also found. These latter differences ought to be equal to the former, each to each, if the conditions which theory supposes were exactly fulfilled; and any one of them divided by the corresponding difference of depth should give the value of the thermal coefficient $\sqrt{\frac{\pi c}{k}}$ for the stratum of soil intervening betweeen the two thermometers compared, k being the conductivity, c the capacity for heat (or specific heat), both referred to the unit of volume, and π the ratio of circumference of circle to diameter. If the surface of the soil is uneven, or if buildings or other objects in the immediate neighbourhood prevent uniformity in the distribution of the surface-temperature, the values of the thermal coefficients derived from P_1 cannot be expected to agree exactly with those derived from E_1. On the other hand, differences in the thermal qualities of the strata of soil intervening between the bulbs of the thermometers would have no tendency to produce discrepancy between the results from P_1 and those from E_1, provided that each stratum is uniform horizontally; but would merely bring out differences between results for different depths.

In the present instance, the values of $\sqrt{\frac{\pi c}{k}}$ derived from E_1 agree remarkably well among themselves, but differ considerably from the values derived from P_1, which latter differ also among themselves. On taking the means of the 6 determinations furnished by each element, it appears, however, that the discrepancies nearly counterbalance each other; the mean value of $\sqrt{\frac{\pi c}{k}}$ derived from P_1 (amplitude) being ·09158, and that derived from E_1 (epoch) being ·09192. The mean of these two numbers is ·09175.

The values of the same function found for the three stations at Edinburgh were—

Calton Hill, Trap Rock	·1156
Experimental Garden, Sand	·1098
Craigleith Quarry, Sandstone	·06744

The less the value of this function is, the more sensible will the changes of temperature be at any given depth, and the more rapidly will they be felt.

The values of the half-yearly coefficients P_2 and E_2 were derived from those of A_2 and B_2 by a process similar to that already described for P_1 and E_1, and the differences of $\log_e P_2$ and also of E_2, in circular measure, were divided by the corresponding differences of depth. The quotients thus obtained are determinations of the value of $\sqrt{\frac{2\pi c}{k}}$, and have accordingly been divided by $\sqrt{2}$, in order to obtain values of $\sqrt{\frac{\pi c}{k}}$. These latter ought, if the conditions supposed by theory were fulfilled, to agree with those previously obtained from the annual term; and the 6 values derived from P_2 ought to be equal respectively to the corresponding values derived from E_2. The agreement is much closer in the present instance than in the case of the thermometers at Calton Hill.

Thus far, only the means of the actual readings have been employed; but in order to ascertain the exact temperatures of the bulbs of the thermometers, it is necessary to apply small corrections for temperature of stem. In applying these corrections, I have adopted the method described by Professor (now Principal) Forbes, *Transactions R. S. E.*, Vol. xvi, Part II., except that, instead of correcting each individual reading, I have corrected the monthly means. In correcting for the temperature of that portion of the stem which is exposed to the air, I made use of the Table on page 203 of Professor Forbes' Paper. The mode of obtaining this correction is sufficiently obvious, bearing in mind that alcohol expands, at ordinary temperatures, by ·000555 of its volume for each degree Fahrenheit. The correction for the temperature of the underground portion of the stem is based upon an approximate formula for the mean temperature of the stem, which, though not pretending to great accuracy, is sufficient for the purpose required. In order to apply this

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correction, it is of course necessary to know the ratio of the quantity of fluid in the underground portion of the stem to the quantity in the bulb; or, what amounts to the same thing, the number of degrees of the scale that are equivalent to the quantity of fluid in the underground portion of the stem. Respecting this datum I have not been able to obtain direct information; and the analogy of the Edinburgh thermometers does not afford very definite grounds for estimation; for by the Table, p. 198, of Professor Forbes' Paper, it appears that the thermometers at three stations, "Observatory," "Experimental Garden," and "Craigleith," differ considerably, as regards the element in question. I have assumed that the values of "Observatory" are applicable to the Greenwich thermometers; that is to say, that the quantities of fluid in the underground portions of the stems are equivalent respectively to,

13°·7	for the	24 ft.	thermometer.
4°·5	,,	12	,,
4°·8	,,	6	,,

I have also applied corrections for the inequality of the Calendar Months. It would scarcely be practicable to do this completely, and I have therefore contented myself with making January, February, and March, of equal length, each containing 30 days, except in leap year, when I give February 31 days. The mode of effecting this correction was, to find, from the *Observations*, the mean temperature of January 31st, also of March 1st, and hence to calculate what the mean temperature would have been for each of the three months, if these two days had been reckoned as belonging to February.

The results obtained by applying the sum of the three several corrections just described, are given in p. (ccv), under the designation of "Corrected Means for the Period 1847–59." Making these corrected means the basis of calculation, I have repeated the operations already described for finding the value of $\sqrt{\frac{\pi c}{k}}$. The results from the half-yearly term are improved by the application of the corrections; but in the case of the annual term (which is far more important) the discrepancies are increased.

I may remark that I have tried the effect of omitting the second of the above-mentioned corrections and applying the other two; also the effect of applying the first only, and the first two only. These experiments were confined to the annual term, and the results were in each case more discrepant than those obtained from the uncorrected temperatures. I have therefore thought it unnecessary to give them.

With the view of ascertaining whether the values of the coefficients have continued uniform throughout the whole period of observation, I have divided it into three shorter periods; the first containing 4 years and 9 months, the second 5 years, and the third 4 years. The monthly means for each of these periods (uncorrected) are given on p. (ccvi), together with the values of A_0, P_1, $\log_e P_1$ and E_1, derived from them, and on p. (ccvii), the resulting values of $\sqrt{\frac{\pi c}{k}}$ are shown. On inspecting these last results, it will be observed that the values diminish from each period to the next; and also that the agreement between results from amplitude and those from epoch improves. Both these facts are very singular; and I can offer no satisfactory explanation of them. The *primâ facie* inference is, that some change has taken place in the soil, probably as regards moisture. Drainage, building, planting, or clearing may be suggested as possible causes. The diminution of $\sqrt{\frac{\pi c}{k}}$ indicates either a decrease in capacity for heat, or an increase in conductivity.

Another singular fact appears on inspecting the values of A_0 (mean temperature of the year) given on p. (ccvi), viz., that the mean temperature at 6 ft. has, in each of the three periods, been greater than at any other depth. I do not think this circumstance can be due to errors in the estimated readings of the 6 ft. thermometer. On the contrary, these readings appear to have been rather under-estimated; for it will be observed, that in deriving values of $\sqrt{\frac{\pi c}{k}}$ from comparison of the values of the $\log_e P_1$ for every pair of thermometers, the least values have been obtained from comparison of those at 12 ft. and 6 ft., and the greatest from those at 6 ft. and 3 ft.; whereas no such difference is observable in the values derived from E_1. Hence it appears that the value which we have given to P_1 for the 6 ft. thermometer is too small; and therefore the range (which is approximately double of P_1) is too small; and since the estimated readings have been taken at the time of maximum temperature, the inference is that they also are too small.

As matter of curiosity rather than use, I have given, on p. (ccvii) the values of the coefficients, and the resulting values of $\sqrt{\frac{\pi c}{k}}$, for the terms whose periods are respectively one-third and one-fourth of a year. These terms are of the form

$$P_3 \,.\, \sin(3t + E_3) + P_4 \,.\, \sin(4t + E_4)$$

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and are to be appended to the annual and half-yearly terms whose coefficients have already been found. The values for these two additional terms have been derived from the "Corrected Means," by a process analogous to that which was used for the two preceding terms.

On p. (ccviii) are given the "Corrections necessary to reduce Calculated to Actual Temperatures;" that is to say, the differences between the observed monthly temperatures and the values of v furnished by each of the expressions

$$v = A_0 + P_1 . \sin(t + E_1)$$
$$v = A_0 + P_1 . \sin(t + E_1) + P_2 . \sin(2t + E_2)$$

the sign + being used to denote excess of observed above calculated temperature. In the construction of this Table the "Corrected Means" and "Corrected Values of Coefficients," p. (ccv), have been employed. In the first set of corrections the occurrence of double maxima and minima in the year is very marked. The corrections here given in no way affect the accuracy of the results previously deduced, since each term in the series for v is independent of the rest.

The relation between results derived (as ours have been) from monthly means, and those which would be furnished by daily means, is as follows:—

Let the monthly mean temperature be represented by the expression—

$$A_0 + P_1 . \sin(t + E_1) + P_2 . \sin(2t + E_2)$$

(t being the time for the centre of the month),

then the daily, or more strictly, the instantaneous temperature will be

$$A_0 + P_1 \frac{\text{arc } 15^\circ}{\sin 15^\circ} \sin(t + E_1) + P_2 \frac{\text{arc } 30^\circ}{\sin 30^\circ} \sin(2t + E_2).$$

Hence the only alteration necessary for rendering our results applicable to daily mean temperatures, is to multiply the values found for P_1 and P_2 by the under-mentioned factors:—

P_1 must be multiplied by $\frac{\text{arc } 15^\circ}{\sin 15^\circ}$ that is by 1·0115

P_2 ,, ,, $\frac{\text{arc } 30^\circ}{\sin 30^\circ}$,, 1·0472

Similarly—

P_3 ,, ,, $\frac{\text{arc } 45^\circ}{\sin 45^\circ}$,, 1·1107

P_4 ,, ,, $\frac{\text{arc } 60^\circ}{\sin 60^\circ}$,, 1·2092

Since these factors are the same for all the thermometers, the difference of $\log_e P_1$, obtained by comparing any two thermometers, will remain unchanged. Hence the mode, in which we have derived $\sqrt{\frac{\pi c}{k}}$ from the values of $\log_e P_1$, requires no correction; and the same remark applies to $\log_e P_2$, $\log_e P_3$, $\log_e P_4$. It is evident that the values of E_1, E_2, E_3, E_4 require no correction.

It appears from the foregoing investigation, that the value of $\sqrt{\frac{\pi c}{k}}$ for the soil in which the Greenwich thermometers are sunk is about ·092.

If it be required to find approximately the effect, at any given depth, of the daily range of temperature at the surface, we may proceed as follows:—Assume the daily variation at the surface to follow a simple harmonic law, which is the same for every day in the year: employing the same units as we have hitherto used, the term expressing daily variation will be of the form

$$P . \sin(365 t + E)$$

and the diminution of $\log_e P$ for each foot of depth will be,

$$\sqrt{\frac{365 \pi c}{k}} = \sqrt{365} \times \cdot 092 = 1 \cdot 758,$$

which is the Napierian logarithm of 5·80. Hence the amplitude P diminishes in the ratio of 1 : 5·8 for each foot of depth; and the daily range at the depth of 3 feet will be only $\left(\frac{1}{5 \cdot 8}\right)^3$, or about $\frac{1}{195}$th of that at the surface.

The corresponding retardation of phase for each foot of descent will be 1·758 in circular measure, which is equivalent to about 102 days; and the retardation for three feet will be 306 days.

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It is quite obvious then that the daily range at the surface is altogether inappreciable at 3 feet, and *à fortiori* at greater depths. Hence the daily variation in the readings of the deep-sunk thermometers, as recorded in the *Observations* for 1846–7, must be owing to changes of temperature in their stems. As an approximate verification of this assertion, we will take two instances from the *Observations* for 1847; and to obviate the necessity of applying the correction mentioned in *Introduction to Greenwich Meteorological Observations*, page lxxi, we shall, in each instance, select the month in which the maximum occurs.

In September of that year the highest and lowest mean readings at even hours of Göttingen time, were—

For Thermometer in Air (Table xxxii),

Highest.............	62·3	at 4^h
Lowest	48·8	,, 18^h
Showing a difference of....................	13·5	

For 12 ft. Thermometer (Table xxiv),

Highest.............	55·16	at 2^h
Lowest	55·06	,, 16^h and 18^h
Showing a difference of	·10	

The mean reading of the 12 ft. thermometer for the month was 55·11; and as the lowest degree on its scale is 42·0, the mean length of the column exposed to air was 13·11. Since the expansion of alcohol for 1° Fahrenheit is ·000555, we have

$$13 \cdot 11 \times 13 \cdot 5 \times \cdot 000555 = \cdot 098$$

for the daily range due to the temperature of the portion of stem exposed to air; which agrees with the difference ·10, shown by the observations.

Again, in August of the same year, we have—

For Thermometer in Air,

Highest.............	72·6	at 4^h
Lowest	56·2	,, 18^h
Difference........	16·4	

For 3 ft. Thermometer,

Highest.............	62·50	at 4^h
Lowest	62·22	,, 18
Difference........	·28	

Length of column exposed to air 62·34 − 34·2 = 28·14, and 28·14 × 16·4 × ·000555 = ·26, which nearly agrees with the difference ·28 found above.

The values of P_1, P_2, E_1, E_2, for any depth other than 3, 6, 12, or 24 feet, may be found by taking the values of these coefficients for the nearest of the 4 thermometers, and using the equations

$$\text{Difference of } \log_e P_1 = \text{difference of } E_1 = \cdot 092 \times \text{difference of depth.}$$
$$\text{Difference of } \log_e P_2 = \text{difference of } E_2 = \cdot 092 \times \sqrt{2} \times \text{difference of depth.}$$

The mean temperature of a horizontal stratum of given thickness may be derived from the expression for the temperature of its centre, by the following rule. Let the product of ·092 or $\sqrt{\frac{\pi c}{k}}$ by half the thickness of the stratum be denoted by z, and let the values of P_1, P_2, E_1, E_2, for the centre of the stratum be given; then

P_1 must be multiplied by $1 + \frac{1}{45} z^4 - \frac{1}{5670} z^8$ nearly.

P_2 ,, ,, $1 + \frac{4}{45} z^4 - \frac{16}{5670} z^8$,,

E_1 must be increased by $\tan^{-1}\left(\frac{1}{3} z + \frac{1}{105} z^6\right)$,,

E_2 ,, ,, $\tan^{-1}\left(\frac{2}{3} z^2 + \frac{8}{105} z^6\right)$,,

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When the stratum is 1 French foot in thickness, it will be found that the multiplier for P_1 is 1·0000001, and the correction for E_1 is 2′. 25″. Hence we may form some idea of the corrections due to the lengths of the bulbs (10 or 12 inches). It is obvious that these corrections will be very small; and they will be the same for all the thermometers, except in so far as the bulbs differ in length.

The Tables on the latter half of p. (ccviii) have been derived from graphical projection in the following manner:— The monthly means of each thermometer p. (cciii) were made the ordinates of a curve at 12 equidistant points in the line of abscissæ, the curve itself being carefully drawn by hand through the 12 points thus determined. The two points at which the curve intersected the line of mean annual temperature were marked, and are entered in the first Table under the names (derived from an obvious analogy) of vernal and autumnal means. The days midway between these were taken as the centres of warm and cold halves of the year; this part of the calculation being checked by comparison with the values of E_1 (p. (cciii)), which in no case differed by more than a day from the values found graphically. The "highest" and "lowest" temperatures, in the last Table on the same page, were determined graphically, and the numbers in the remaining columns (except "Mean of Year") were derived from them. It will be observed that in every instance the temperature rises higher above the mean than it falls below; but the number of days below the mean is greater than the number above.

I have inadvertently omitted above to call attention to the decrease of temperature, with increase of depth, which the thermometers exhibit. This is especially evident from the values of A_0, p. (ccvi), which show that in each of the periods the temperature has been higher at 3 than at 12 feet, and higher at 12 than at 24 feet. As, however, the mean temperature of Greenwich (49°·27, I believe,) is less than the lowest of these, it may be that the years which our observations cover have been exceptionally warm.

J. D. EVERETT.

NOTE BY THE ASTRONOMER ROYAL.

From the establishment of the thermometers to the middle of the year 1857, the excess of fluid in the 6-feet and 3-feet thermometers was such that, when the temperature shown by the 6-feet thermometer rose above 57°·5, or that of the 3-feet thermometer rose above 64°·5, a portion of the fluid passed into the upper bulb.

On 1857, June 22, Mr. Negretti removed from each of these thermometers a quantity of fluid, corresponding to the extent of 5° on its scale; and the scales of the two thermometers were lowered by that quantity, making the readings the same as before.

It appears now that the amount of fluid removed was a little too great. When the temperature of the 6-feet thermometer falls below 43°·5, or that of the 3-feet thermometer below 39°·7, the fluid sinks into the capillary tube.

It appears probable that the observations of the thermometers in their present state will ultimately give material assistance for the completion of the defective higher readings in their former state, and that the readings of the thermometers in their former state enable us to supply the lower readings which are wanting in their present state.

I am unable to suggest any conjectural explanation of the change of mean annual temperature and of law of annual temperature pointed out in page (cxcvii), line 31.

G. B. AIRY.

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TABULAR STATEMENT OF RESULTS.

MEAN READINGS of THERMOMETER 24 French feet deep.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1846	..	..	..	48.95	48.78	48.86	49.39	50.30	51.24	52.19	52.60	52.53	..
1847	52.05	51.18	50.19	49.34	48.83	48.69	49.09	49.81	50.64	51.34	51.72	51.79	50.39
1848	51.47	50.92	50.08	49.39	49.07	49.15	49.68	50.41	51.19	51.81	52.16	52.04	50.61
1849	51.54	50.89	50.15	49.57	49.14	49.01	49.42	50.22	50.97	51.67	52.04	52.03	50.55
1850	51.57	50.83	49.99	49.32	48.87	48.79	49.10	49.81	50.65	51.29	51.63	51.54	50.28
1851	51.16	50.55	49.86	49.18	48.76	48.74	49.07	49.78	50.60	51.34	51.72	51.71	50.21
1852	51.16	50.46	49.79	49.15	48.71	48.69	49.04	49.77	50.77	51.68	52.20	52.09	50.29
1853	51.66	51.11	50.46	49.62	48.94	48.78	49.12	49.88	50.73	51.48	51.83	51.70	50.44
1854	51.09	50.22	49.38	48.74	48.42	48.49	48.88	49.57	50.40	51.16	51.61	51.57	49.96
1855	51.02	50.32	49.48	48.53	47.95	47.85	48.21	49.01	49.93	50.77	51.40	51.38	49.65
1856	50.75	49.93	49.13	48.53	48.10	48.08	48.53	49.32	50.32	51.15	51.58	51.60	49.75
1857	51.05	50.26	49.37	48.65	48.24	48.23	48.72	49.64	50.68	51.69	52.29	52.34	50.10
1858	51.97	51.36	50.50	49.54	48.92	48.85	49.30	50.22	51.12	51.91	52.27	52.23	50.68
1859	51.71	51.02	50.29	49.71	49.43	49.41	49.82	50.71	51.70	52.51	(52.94)	52.76	51.00

MEAN READINGS of THERMOMETER 12 French feet deep.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1846	..	..	..	47.17	48.06	50.49	53.68	55.55	56.57	56.55	54.71	52.21	..
1847	48.98	46.73	45.78	45.81	46.81	49.50	51.92	54.22	55.11	54.58	53.61	51.82	50.41
1848	49.64	47.39	46.57	46.92	48.28	50.90	53.01	54.70	55.28	55.07	53.43	51.19	51.03
1849	49.20	47.89	47.11	46.92	47.46	49.92	52.63	54.51	55.50	55.20	53.73	51.52	50.97
1850	48.80	46.68	46.37	46.17	47.19	49.26	51.96	54.06	54.88	54.38	52.67	50.87	50.27
1851	48.84	47.50	46.35	46.29	47.29	49.24	51.88	54.02	55.30	54.98	53.46	50.55	50.47
1852	48.43	47.21	46.23	46.15	47.34	49.32	51.85	54.90	56.07	55.39	53.48	51.90	50.69
1853	50.40	48.68	46.65	45.99	46.85	49.20	51.97	53.97	55.00	54.57	53.23	50.56	50.59
1854	47.56	46.22	45.59	46.07	47.56	49.31	51.45	53.71	55.11	55.08	53.22	50.61	50.12
1855	48.53	46.44	44.61	44.50	46.06	48.04	50.91	53.40	54.75	54.78	53.26	50.63	49.66
1856	47.69	46.39	45.87	45.76	46.89	48.87	51.64	54.12	55.33	54.89	53.49	50.87	50.15
1857	48.50	46.49	45.62	45.82	46.84	49.46	52.58	55.08	56.44	56.26	54.88	52.80	50.90
1858	50.62	48.22	46.16	46.00	47.41	49.91	53.29	55.22	56.21	56.03	54.24	51.35	51.22
1859	49.27	47.87	47.43	47.67	48.43	50.67	53.69	56.35	(57.07)	56.51	54.66	51.48	51.76

MEAN READINGS of THERMOMETER 6 French feet deep.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1846	..	..	..	47.46	49.94	(55.87)	(58.25)	(58.99)	(59.23)	(56.99)	52.79	47.97	..
1847	43.98	42.85	43.27	45.12	48.64	53.94	(57.08)	(58.91)	(57.83)	55.36	52.76	49.48	50.77
1848	45.80	44.26	44.93	47.45	51.09	55.28	(57.99)	(58.87)	(57.78)	55.78	51.07	48.73	51.59
1849	45.99	45.67	45.56	46.09	49.14	54.50	(57.67)	(58.31)	(58.06)	55.75	52.64	48.15	51.46
1850	44.22	43.96	44.79	45.85	48.54	53.61	(57.06)	(58.92)	(57.59)	54.69	51.16	48.08	50.71
1851	46.27	44.79	44.33	46.19	48.86	53.22	57.14	(58.87)	(58.48)	56.08	51.35	47.10	51.06
1852	45.43	44.97	43.98	46.30	49.53	52.73	(57.72)	(59.29)	(59.17)	55.24	52.26	49.98	51.38
1853	48.21	45.21	43.53	45.18	48.45	53.46	(57.11)	(58.86)	(58.00)	55.11	51.78	46.79	50.97
1854	43.30	43.95	44.22	47.13	49.80	52.91	56.22	(58.91)	(58.59)	56.12	51.29	47.31	50.81
1855	45.46	42.17	41.79	44.47	48.07	51.98	56.86	(58.83)	(58.31)	56.42	51.57	46.84	50.23
1856	44.38	44.22	44.42	46.12	48.60	53.29	57.05	(58.84)	(58.61)	56.09	51.88	47.79	50.94
1857	45.08	43.15	44.14	46.14	49.00	54.82	58.95	61.27	60.94	57.86	54.42	50.76	52.21
1858	47.47	44.46	(43.00)	46.22	49.76	55.88	59.32	60.69	60.03	57.65	52.24	48.38	52.09
1859	46.39	45.91	46.86	48.06	50.42	55.82	60.43	(62.38)	60.25	58.04	52.17	47.49	52.85

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MEAN READINGS of THERMOMETER 3 French feet deep.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1846	..	..	..	47·66	52·15	61·72	62·95	63·61	62·45	55·44	50·22	42·71	..
1847	39·35	39·65	41·17	44·46	51·17	57·24	61·56	62·34	57·82	54·73	50·63	46·46	50·55
1848	41·28	42·00	43·30	47·72	54·34	58·36	61·21	60·15	58·45	54·75	47·53	45·88	51·25
1849	42·55	43·28	43·56	44·86	51·15	58·36	61·69	61·44	60·11	54·42	49·75	44·08	51·27
1850	39·13	41·87	42·36	46·04	49·50	57·84	60·65	61·26	57·97	52·98	48·85	44·21	50·22
1851	43·62	41·80	42·26	45·84	49·97	56·63	60·73	62·76	59·52	55·32	46·63	43·39	50·71
1852	42·17	42·21	41·49	46·33	51·24	55·07	(63·70)	(63·41)	60·60	52·84	50·59	47·55	51·43
1853	45·16	40·50	40·35	44·57	50·16	56·59	60·10	61·51	58·49	53·94	48·14	41·92	50·12
1854	39·25	41·15	42·61	48·09	51·08	55·52	59·90	61·63	61·17	54·51	47·48	43·38	50·48
1855	41·48	36·94	39·05	44·64	49·25	55·12	61·43	62·03	60·05	55·66	47·97	41·52	49·60
1856	41·39	41·66	42·22	46·26	49·57	56·85	61·01	(63·90)	59·32	55·37	48·24	44·13	50·83
1857	41·33	40·22	42·67	46·23	51·19	59·16	62·82	64·76	61·76	56·45	51·46	47·21	52·11
1858	42·23	39·84	(40·00)	46·29	51·03	61·65	62·73	63·82	61·28	56·52	47·37	44·57	51·46
1859	42·76	43·53	45·69	47·22	51·89	60·07	65·72	65·32	60·28	56·80	47·74	42·24	52·44

MEAN READINGS of THERMOMETER 1 inch deep.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1846	..	..	..	..	..	64·2	64·8	64·7	62·2	52·2	47·7	36·2	..
1847	37·9	38·0	42·3	46·4	56·7	59·8	66·8	63·9	56·0	53·7	48·4	44·0	51·16
1848	37·4	44·1	44·6	49·5	61·6	61·7	65·0	60·8	58·8	53·5	45·5	45·5	52·33
1849	41·5	43·6	44·3	46·3	56·5	63·3	65·0	65·2	61·8	53·0	46·5	41·1	52·34
1850	36·7	44·4	41·9	50·4	53·0	64·1	65·2	63·0	58·7	49·5	48·7	42·7	51·52
1851	44·2	42·7	44·0	48·5	54·8	62·2	63·8	65·5	60·0	54·7	41·2	42·2	51·98
1852	42·8	42·0	43·0	49·9	55·1	59·4	71·0	65·2	61·1	50·2	50·4	48·0	53·18
1853	44·3	37·0	41·8	47·4	55·7	62·3	63·2	64·1	60·3	55·1	44·9	38·0	51·18
1854	40·6	41·6	45·3	52·7	54·2	59·8	64·4	64·6	61·6	52·9	44·1	42·9	52·06
1855	38·4	33·4	41·0	48·9	52·9	61·3	65·6	66·0	60·9	54·7	44·3	38·3	50·48
1856	41·5	43·3	41·7	50·4	52·6	63·0	64·8	66·7	59·0	54·5	43·9	41·9	51·94
1857	38·9	40·7	43·7	48·3	57·6	65·6	67·0	67·9	62·5	55·2	48·8	46·6	53·57
1858	39·6	37·8	42·2	49·6	54·3	68·6	64·5	66·0	62·7	54·2	42·2	42·4	52·01
1859	42·4	43·5	47·3	49·3	55·8	64·4	70·7	66·7	59·7	54·4	44·3	39·3	53·15

MEAN READINGS of THERMOMETER in Air.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1846	..	..	..	..	..	..	65·4	64·4	61·4	50·9	46·5	33·4	..
1847	36·4	36·4	42·0	46·0	57·4	59·2	66·9	63·4	55·0	53·2	47·3	42·9	50·51
1848	36·3	45·8	46·2	52·1	68·0	63·9	68·7	63·0	63·3	55·3	46·7	46·5	54·65
1849	41·9	45·8	46·8	49·1	60·6	68·5	68·8	69·4	65·3	55·8	47·5	40·6	55·01
1850	35·9	47·3	45·0	54·0	56·3	69·7	68·7	67·0	63·4	52·2	49·5	42·5	54·29
1851	45·5	44·3	46·8	51·5	59·1	68·2	67·8	70·6	64·7	57·3	41·6	41·7	54·92
1852	44·1	44·2	47·3	55·5	59·1	62·4	77·4	68·5	63·3	52·5	51·6	49·0	56·24
1853	44·8	37·2	43·7	50·3	61·4	66·9	67·5	68·7	62·2	55·9	45·6	36·4	53·38
1854	41·7	44·4	50·1	59·4	58·9	63·5	68·8	69·1	68·0	56·7	43·9	43·1	55·63
1855	38·4	34·0	43·7	54·6	56·3	66·3	69·1	70·6	65·2	57·1	44·3	37·8	53·12
1856	41·8	45·1	43·1	55·3	55·5	68·3	69·0	71·4	63·3	57·2	43·7	42·3	54·67
1857	38·6	44·6	47·3	51·3	63·7	72·6	73·3	73·5	66·7	58·4	49·1	48·0	57·26
1858	41·0	39·4	46·6	55·6	60·0	76·4	68·3	73·5	67·6	56·9	43·0	42·7	55·92
1859	43·9	47·2	51·0	53·9	62·4	70·3	77·6	74·2	63·9	56·5	46·5	39·8	57·27

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MEAN READINGS for the PERIOD 1847–1859 (13 Years).

Thermometer.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
24 ft.	51°·40	50°·70	49°·90	49°·17	48°·72	48°·67	49°·08	49°·86	50°·75	51°·52	51°·95	51°·91	50°·30
12 ft.	48·96	47·21	46·18	46·16	47·26	49·51	52·21	54·48	55·54	55·21	53·64	51·24	50·63
6 ft.	45·54	44·27	44·22	46·18	49·22	53·96	57·74	59·46	58·74	56·17	52·05	48·22	51·31
3 ft.	41·67	41·13	42·06	46·04	50·89	57·57	61·79	62·64	59·76	54·95	48·64	44·35	50·96
Inch..	40·48	40·93	43·32	49·05	55·45	62·73	65·92	65·05	60·24	53·51	45·63	42·53	52·07
Air ..	40·78	42·75	46·12	52·97	59·90	67·40	70·15	69·45	63·99	55·77	46·18	42·56	54·84

VALUES of the COEFFICIENTS in the EXPRESSIONS—

$$v = A_0 + A_1 \,.\, \cos t + B_1 \,.\, \sin t + A_2 \,.\, \cos 2t + B_2 \,.\, \cos 2t. \qquad (1)$$

$$v = A_0 + P_1 \,.\, \sin (t + E_1) + P_2 \,.\, \sin (2t + E_2). \qquad (2)$$

Thermometer.	A_0	A_1	B_1	A_2	B_2	P_1	E_1	P_2	E_2
24 ft..........	50°·30	+ 1°·1738	− 1°·1805	− 0°·05	− 0°·0058	1°·6647	135° 10′	0°·0503	263° 25′
12 ft..........	50·63	− 1·5897	− 4·5302	− 0·0483	+ 0·254	4·8010	199 20	0·259	349 14
6 ft..........	51·31	− 6·0285	− 4·9568	+ 0·295	+ 0·468	7·8047	230 34	0·553	392 15
3 ft..........	50·96	− 10·029	− 4·4058	+ 0·773	+ 0·598	10·954	246 17	0·977	412 18
Inch..........	52·07	− 12·865	− 2·095			13·033	260 45		
Air..........	54·84	− 14·966	− 1·221			15·013	265 20		

NAPIERIAN LOGARITHMS of P_1 and P_2, and VALUES of E_1 and E_2 in circular measure $\left(\frac{\text{arc}}{\text{radius}}\right)$.

Thermometer.	$\log_e P_1$	E_1	$\log_e P_2$	E_2
24 ft......	0·50966	2·35905	− 2·989	4·597
12 ft......	1·56883	3·47907	− 1·353	6·095
6 ft......	2·05473	4·02424	− 0·593	6·846
3 ft......	2·39369	4·29846	− 0·023	7·196
Inch......	2·56750	4·55094		
Air	2·70890	4·63099		

Taking the differences of the values of $\log_e P_1$ for each pair of thermometers, also the differences of the values of E_1, and dividing in each case by the difference of depth, we obtain the following quotients, which are determinations of the value of $\sqrt{\frac{\pi c}{k}}$, c being the capacity for heat, and k the conductivity.

Thermometers compared.	Difference of $\log_e P_1$ divided by Difference of depth.	Difference of E_1 divided by Difference of depth.
24 ft. and 12 ft.	·0883	·0933
24 ,, 6 ,,	·0858	·0925
24 ,, 3 ,,	·0897	·0924
12 ,, 6 ,,	·0810	·0909
12 ,, 3 ,,	·0917	·0910
6 ,, 3 ,,	·1130	·0914
Means	·09158	·09192

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To obtain determinations of the value of $\sqrt{\frac{\pi c}{k}}$ from the values of $\log_e A_2$ and E_2, we must first proceed as above, and divide the results by $\sqrt{2}$, as shown below :—

Thermometers compared.	Diff. of $\log_e P_2$ divided by Diff. of depth.	Quotients by $\sqrt{2}$.	Diff. of E_2 divided by Diff. of depth.	Quotients by $\sqrt{2}$.
24 ft. and 12 ft.	·1364	·0964	·1248	·0882
24 ,, 6 ,,	·1331	·0941	·1249	·0883
24 ,, 3 ,,	·1412	·0998	·1237	·0875
12 ,, 6 ,,	·1267	·0896	·1251	·0885
12 ,, 3 ,,	·1477	·1044	·1223	·0865
6 ,, 3 ,,	·1899	·1343	·1166	·0824
Means	....	·1031	....	·0869

The mean of ·09158 and ·09192 is ·09175,
The mean of ·1031 and ·0869 is ·0950,
and the former of these means is entitled to much more weight than the latter, the coefficients of the half-yearly term being too small, and too variable from year to year, to furnish accurate determinations.

CORRECTIONS for TEMPERATURE of that portion of STEM which is above the bottom of the scale, or above the capillary tube.

Argument, $(v - V) \times (v - v') \times \cdot 000555$; v being the temperature of bulb, or the actual reading ; V the temperature of air ; and v' the degree of the bottom of the scale. The values of v' are—

For the 24 ft. thermometer, 43°
,, 12 ,, 42°

For the 6 ft. thermometer, 39°
,, 3 ,, 34°

Thermometers.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
24 ft.	+ °·05	+ °·03	+ °·01	− °·01	− °·04	− °·06	− °·07	− °·07	− °·06	− °·02	+ °·03	+ °·05
12 ,, ...	+ ·03	+ ·01	·00	− ·02	− ·04	− ·08	− ·11	− ·10	− ·06	·00	+ ·05	+ ·05
6 ,, ...	+ ·02	·00	− ·01	− ·03	− ·06	− ·11	− ·13	− ·11	− ·06	·00	+ ·04	+ ·03
3 ,, ...	·00	·00	− ·02	− ·04	− ·09	− ·12	− ·13	− ·10	− ·06	− ·01	+ ·02	+ ·01

The sign + denotes that the correction is to be added to the observed reading.
[In strictness, these numbers do not apply after 1857, June.—G. B. A.]

ASSUMED CORRECTIONS for TEMPERATURE of that portion of STEM (capillary tube) which is below ground.

Thermometers.	January.	February.	March.	April.	May	June.	July.	August.	September.	October.	November.	December.
24 ft.	+ °·03	+ °·04	+ °·03	+ °·02	°·00	− °·02	− °·04	− °·05	− °·04	− °·02	°·00	− °·02
12 ,, ...	+ ·02	+ ·02	+ ·01	·00	− ·01	− ·03	− ·04	− ·03	− ·02	·00	+ ·01	+ ·02
6 ,, ...	+ ·01	+ ·01	+ ·01	·00	− ·01	− ·01	− ·01	− ·01	·00	·00	+ ·01	+ ·01
3 ,, ...	·00	·00	·00	·00	·00	·00	·00	·00	·00	·00	·00	·00

CORRECTIONS for INEQUALITY of CALENDAR MONTHS, obtained by reckoning the 31st of January and the 1st of March as part of February.

Thermometers.	January.	February.	March.
24 ft.......	+ °·01	°·00	+ °·01
12 ,, ...	+ ·04	·00	− ·02
6 ,, ...	+ ·03	·00	+ ·01
3 ,, ...	+ ·02	·00	+ ·04

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CORRECTED MEANS for the PERIOD 1847–1859.

Thermometers.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Means.
	°	°	°	°	°	°	°	°	°	°	°	°	°
24 ft.	51·49	50·77	49·95	49·18	48·68	48·59	48·97	49·74	50·65	51·48	51·98	51·94	50·28
12 ,,	49·05	47·24	46·17	46·14	47·21	49·40	52·06	54·35	55·46	55·21	53·70	51·31	50·61
6 ,,	45·60	44·28	44·23	46·15	49·15	53·84	57·60	59·34	58·68	56·17	52·10	48·26	51·28
3 ,,	41·69	41·13	42·08	46·00	50·80	57·45	61·66	62·54	59·70	54·94	48·66	44·36	50·92

CORRECTED VALUES of COEFFICIENTS.

Thermometers.	A_0.	A_1.	B_1.	A_2.	B_2.	P_1.	E_1.	P_2.	E_2.
	°	°	°	°	°	°	° ′	°	° ′
24 feet...	50·28	+1·2688	−1·1540	−0·0517	−0·01154	1·7151	132. 17	0·0530	257. 25
12 ,, .	50·61	−1·4856	−4·5410	−0·060	+0·231	4·7778	198. 7	0·239	345. 26
6 ,, .	51·28	−5·9375	−4·9715	+0·277	+0·459	7·7443	230. 4	0·536	391. 7
3 ,, .	50·92	−9·9547	−4·4176	+0·755	+0·603	10·891	246. 4	0·966	411. 23

CORRECTED VALUES of $\log_e P_1$, $\log_e P_2$, and of E_1 and E_2, in CIRCULAR MEASURE.

Thermometers.	$\log_e P_1$.	E_1.	$\log_e P_2$.	E_2.
24 feet..........	·53947	2·30885	− 2·9381	4·4928
12 ,, ...	1·56398	3·45779	− 1·4327	6·0289
6 ,, ...	2·04694	4·01531	− ·6235	6·8263
3 ,, ...	2·38794	4·29472	− ·0343	7·1800

Thermometers compared.	Diff. of $\log_e P_1$ divided by Diff. of Depth.	Diff. of E_1 divided by Diff. of Depth.
24 feet and 12 feet	·0854	·0957
24 ,, 6 ,, ...	·0838	·0948
24 ,, 3 ,, ...	·0880	·0946
12 ,, 6 ,, ...	·0805	·0929
12 ,, 3 ,, ...	·0915	·0930
6 ,, 3 ,, ...	·1137	·0931
Means	·09048	·09402

The mean of ·09048 and ·09402 is ·09225.

Thermometers compared.	Diff. of $\log_e P_2$ divided by Diff. of Depth.	Quotients by $\sqrt{2}$.	Diff. of E_2 divided by Diff. of Depth.	Quotients by $\sqrt{2}$.
24 feet and 12 feet	·1254	·0887	·1280	·0905
24 ,, 6 ,, ...	·1286	·0909	·1297	·0917
24 ,, 3 ,, ...	·1383	·0978	·1280	·0905
12 ,, 6 ,, ...	·1349	·0954	·1329	·0940
12 ,, 3 ,, ...	·1554	·1099	·1279	·0904
6 ,, 3 ,, ...	·1964	·1389	·1179	·0834
Means	....	·1036	....	·0901

The mean of ·1036 and ·0901 is ·09685.

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MEANS of UNCORRECTED READINGS for the THREE PERIODS—(1) April 1846–December 1850; (2) January 1851–December 1855; (3) January 1856–December 1859.

Periods.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
24-feet Thermometer.												
1st period ……	°51·66	°50·96	50·10	°49·31	°48·94	°48·90	°49·34	°50·11	50·94	°51·66	°52·03	°51·99
2nd ,, ……	51·22	50·53	49·79	49·04	48·56	48·51	48·86	49·60	50·49	51·29	51·75	51·69
3rd ,, ……	51·37	50·64	49·82	49·11	48·67	48·64	49·09	49·97	50·96	51·82	52·27	52·23
12-feet Thermometer.												
1st period ……	°49·16	°47·17	°46·46	°46·60	°47·56	°50·01	°52·64	°54·61	°55·47	°55·16	°53·63	°51·52
2nd ,, ……	48·75	47·21	45·89	45·80	47·02	49·02	51·61	54·00	55·25	54·96	53·33	50·85
3rd ,, ……	49·02	47·24	46·27	46·31	47·39	49·73	52·80	55·19	56·26	55·92	54·32	51·62
6-feet Thermometer.												
1st period ……	°45·00	°44·18	°44·64	°46·39	°49·47	°54·64	°57·61	°58·80	°58·10	°55·71	°52·08	°48·48
2nd ,, ……	45·73	44·22	43·57	45·85	48·94	52·86	57·01	58·95	58·51	55·79	51·65	47·60
3rd ,, ……	45·83	44·44	44·92	46·64	49·44	54·95	58·94	60·80	59·96	57·41	52·68	48·60
3-feet Thermometer.												
1st period ……	°40·58	°41·70	°42·60	°46·15	°51·66	°58·70	°61·61	°61·76	°59·36	°54·46	°49·40	°44·67
2nd ,, ……	42·34	40·52	41·15	45·89	50·34	55·79	61·17	62·27	59·97	54·45	48·16	43·55
3rd ,, ……	41·93	41·31	42·64	46·50	50·92	59·43	63·07	64·45	60·66	56·28	48·70	44·54

VALUES of COEFFICIENTS derived from the above.

Thermometers and Periods.		A_0.	P_1.	$\mathrm{Log}_e\, P_1$.	E_1 in degrees.	E_1 in Circular Measure.
		°	°	°	° ′	
24 feet	1st period …………	50·50	1·6186	0·48154	135. 4	2·35750
	2nd ,, …………	50·11	1·6399	0·49461	133. 16	2·32599
	3rd ,, …………	50·38	1·8280	0·60322	138. 58	2·42547
12 feet	1st period …………	50·83	4·6626	1·53958	201. 8	3·51044
	2nd ,, …………	50·31	5·7336	1·55468	197. 48	3·45226
	3rd ,, …………	51·01	5·1726	1·64338	199. 54	3·48877
6 feet	1st period …………	51·26	7·5509	2·02167	232. 41	4·06099
	2nd ,, …………	50·89	7·6413	2·03357	229. 12	4·00029
	3rd ,, …………	52·05	8·3247	2·11923	230. 45	4·02720
3 feet	1st period …………	51·05	10·773	2·37701	248. 19	4·33394
	2nd ,, …………	50·47	10·830	2·38231	244. 45	4·27155
	3rd ,, …………	51·70	11·646	2·45493	246. 45	4·30650

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Thermometers compared.	Difference of log P_1 divided by Difference of Depth.			Difference of E_1 divided by Difference of Depth.		
	1st Period.	2nd Period.	3rd Period.	1st Period.	2nd Period.	3rd Period.
24 feet and 12 feet	·08817	·08834	·08668	·09608	·09386	·08861
24 ,, 6 ,, ...	·08556	·08550	·08422	·09464	·09302	·08898
24 ,, 3 ,, ...	·09026	·08989	·08818	·09412	·09265	·08957
12 ,, 6 ,, ...	·08035	·07982	·07931	·09176	·09134	·08974
12 ,, 3 ,, ...	·09305	·09196	·09017	·09150	·09103	·09086
6 ,, 3 ,, ...	·11845	·11625	·11190	·09098	·09042	·09310
Means..................	·09264	·09196	·09008	·09318	·09205	·09014

The Mean of ·09264 and ·09318 is ·09291.
,, ·09196 ,, ·09205 ,, ·09200.
,, ·09008 ,, ·09014 ,, ·09011.

COEFFICIENTS of the TERM whose PERIOD is ONE-THIRD of a YEAR.

Thermometers.	A_3.	B_3.	P_3.	$\log_e P_3$.	E_3 in Degrees.	E_3 in Circular Measure.
	°	°	°		° ′	
24 feet......................	− 0·0133	− 0·0333	0·0359	− 3·3281	201. 47	3·5218
12 ,, ...	− 0·035	+ 0·00833	0·0360	− 3·3247	283. 23	4·9460
6 ,, ...	− 0·0833	+ 0·09	0·1226	− 2·0988	317. 13	5·5365
3 ,, ...	− 0·035	+ 0·1033	0·1091	− 2·2158	341. 17	5·9565

Thermometers compared.	Diff. of $\log_e P_3$ divided by Diff. of Depth.	Quotients by $\sqrt{3}$ or Values of $\sqrt{\frac{\pi c}{k}}$.	Diff. of E_3 divided by Diff. of Depth.	Quotients by $\sqrt{3}$ or Values of $\sqrt{\frac{\pi c}{k}}$.
24 feet and 12 feet................	·0003	·0002	·1187	·0685
24 ,, 6 ,, ...	·0683	·0394	·1119	·0646
24 ,, 3 ,, ...	·0530	·0306	·1159	·0669
12 ,, 6 ,, ...	·2043	·1180	·0984	·0568
12 ,, 3 ,, ...	·1232	·0711	·1123	·0648
6 ,, 3 ,, ...	− ·0390	− ·0225	·1400	·0808
Means......................	....	·0395	....	·0671

The Mean of ·0395 and ·0671 is ·0533.

COEFFICIENTS of the TERM whose PERIOD is ONE-FOURTH of a YEAR.

Thermometers.	A_4.	B_4.	P_4.	$\log_e P_4$.	E_4 in Degrees.	E_4 in Circular Measure.
	°	°	°		° ′	
24 feet......................	− 0·005	+ 0·00577	0·00764	− 4·8747	− 40. 55	− 0·7141
12 ,, ...	+ 0·0667	+ 0·0231	0·0706	− 2·6507	+ 70. 54	+ 1·2374
6 ,, ...	+ 0·0967	− 0·0202	0·0988	− 2·3148	101. 48	1·7764
3 ,, ...	+ 0·155	− 0·0663	0·1685	− 1·7806	173. 10	3·0223

Thermometers compared.	Diff. of $\log_e P_4$ divided by Diff. of Depth.	Quotients by 2 or Values of $\sqrt{\frac{\pi c}{k}}$.	Diff. of E_4 divided by Diff. of Depth.	Quotients by 2 or values of $\sqrt{\frac{\pi c}{k}}$.
24 feet and 12 feet................	·1853	·0926	·1626	·0813
24 ,, 6 ,, ...	·1422	·0711	·1384	·0692
24 ,, 3 ,, ...	·1473	·0737	·1779	·0890
12 ,, 6 ,, ...	·0560	·0280	·0898	·0449
12 ,, 3 ,, ...	·0967	·0484	·1983	·0992
6 ,, 3 ,, ...	·1781	·0890	·4153	·2076
Means......................	....	·0671	....	·0985

The Mean of ·0671 and ·0985 is ·0828.

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CORRECTIONS necessary to reduce CALCULATED to ACTUAL TEMPERATURES (corrected).

I. When only the Annual Term is employed.

Thermometers.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
24 feet.........	−°·06	+°·03	+°·03	+°·05	+°·03	−°·01	−°·04	−°·02	+°·01	+°·05	+°·07	−°·02
12 ,, ...	−·07	+·19	+·24	+·07	−·21	−·23	−·04	+·18	+·17	+·06	−·10	−·28
6 ,, ...	+·26	+·62	+·22	−·16	−·79	−·09	+·38	+·44	+·13	−·08	−·52	−·37
3 ,, ...	+·72	+1·04	−·03	−·50	−1·27	+·12	+·79	+·79	−·03	−·40	−1·11	−·15

II. When the Annual and Half-yearly Terms are employed.

Thermometers.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
24 feet.........	−°·01	+°·01	+°·01	°·00	−°·01	+°·01	+°·01	+°·02	−°·01	°·00	+°·03	°·00
12 ,, ...	−·01	+·02	+·01	+·01	−·04	·00	+·02	+·01	−·06	·00	+·07	−·05
6 ,, ...	−·02	+·08	−·04	+·12	−·25	+·17	+·10	−·10	−·13	+·20	+·02	−·11
3 ,, ...	−·03	+·44	−·16	+·25	−·67	+·25	+·04	+·19	−·16	+·35	−·51	−·02

DATES of the CENTRES of the WARM and COLD HALVES of the YEAR, for each THERMOMETER, and DAYS whose TEMPERATURE is equal to the MEAN of the YEAR (for uncorrected readings).

Thermometers.	Centre of Warm.	Centre of Cold.	Vernal Mean.	Autumnal Mean.	Days from Vernal to Autumnal.	Days from Autumnal to Vernal.
Air........................	July 21	January 20	April 24	October 18	177	188
Inch........................	,, 26	,, 24	,, 30	,, 21	174	191
3 feet........................	August 9	February 8	May 15	November 3	172	193
6 ,, ...	,, 25	,, 24	,, 30	,, 21	175	190
12 ,, ...	September 25	March 27	June 28	December 23	178	187
24 ,, ...	November 30	June 1	September 1	February 28	180	185

The application of the corrections (p. (cciv)) will produce a retardation of 3 days for the 24-feet Thermometer, and of 1 day for the 12-feet Thermometer.

TABLE showing the RANGE of the ANNUAL CURVE of TEMPERATURE for each THERMOMETER (uncorrected).

Thermometers.	Highest.	Lowest.	Mean of Year.	Highest above Mean.	Lowest below Mean.	Range.
Air........................	70°·2	40°·4	54°·8	15°·4	14°·4	29°·8
Inch........................	66·2	40·8	52·1	14·1	11·3	25·4
3 feet........................	62·8	41·1	51·0	11·7	9·9	21·7
6 ,, ...	59·5	44·1	51·3	8·2	7·2	15·4
12 ,, ...	55·5	46·0	50·6	4·9	4·6	9·5
24 ,, ...	52·0	48·6	50·3	1·7	1·7	3·4

The numbers in this Table are for monthly means, understanding by a month any period of 30 or 31 days. The ranges, and departures, above and below mean of year, will be greater for daily means, by about 1 per cent.

The effect of the corrections (p. (cciv)) will be to increase the range by a tenth of a degree for the 24-feet Thermometer, and diminish it by the same amount for the 3-feet, 6-feet, and 12-feet Thermometers.

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