

XV. *Observations for ascertaining the length of the Pendulum at Madras in the East Indies, latitude $13^{\circ} 4' 9''$,¹ N. with the conclusions drawn from the same.* By JOHN GOLDINGHAM, Esq. F. R. S.

Read January 31, 1822.

THE object of the enquiry in this paper has been considered at all times one of interest and importance, and is particularly so at present, when investigations have been completed in Europe, by order of some of the governments there; such as, with reference to their accuracy, had never before been made in any quarter of the globe, so far as comes within my recollection. I had seen the details of Captain KATER's experiments in the Philosophical Transactions, and he also did me the favour to send me out a copy of his Paper. The simplicity and accuracy of the apparatus induced me to write to that Gentleman, requesting he would have the goodness to order a similar one to be sent to me. This request he not only most readily complied with, but made the experiments requisite for enabling me to draw the conclusions; and thence to form the comparison with the results obtained in Europe. The apparatus arrived in March, and I immediately set about fixing it; which, notwithstanding the little solid assistance to be obtained in an operation of this nature from workmen in this country, I was enabled to effect in a most satisfactory manner; and I am led to hope, these observations will not be deemed unworthy the attention of the learned in Europe.

The clock used in these experiments has a gridiron pendulum, the motion being given by a spring; the maker's name is HASWELL, and the works are of the best description: it was fixed to the north wall of the Observatory, which is of solid masonry two feet in thickness: the rate was ascertained by comparisons with the transit clock each day, at the commencement and conclusion of the experiments: the transit of the noon before the comparison, and that after, were used in finding this rate; so that four results were obtained from the two comparisons: the transit clock, which is an excellent time keeper, was regulated by transits of the sun and stars; the weather fortunately having been clear, both at noon and at night, during the time the experiments were making.

The first operation performed was that of making the weight of the clock pendulum black, and fixing the disc on the centre. This having been done, five blocks of seasoned teak-wood, each $\frac{1}{4}$ inches in diameter and 7 in length, were prepared; the place above the clock for the frame, which was to support the pendulum, was then marked. This I did with great care and precaution: intersecting lines were drawn upon the wall to show the exact position of the centres of the blocks and of the screws for fastening the frame; holes $\frac{1}{4}$ inches in diameter and $10\frac{1}{2}$ in depth, (it being necessary to let the outer part of the blocks $3\frac{1}{2}$ inches within the surface of the wall, to bring the pendulum sufficiently near the clock case) were then made in the wall, and the blocks, coated with tar to preserve them from the white ants, were let in and firmly secured. The outer surfaces of the whole, which had previously been made smooth and level, being in

one plane. The frame, its two parts being firmly screwed together, was then placed, levelled by means of a spirit level, and fixed to the blocks in the firmest manner: the frame enclosing the agates was next put up, levelled, and screwed in its place, the Y's elevated, and the pendulum hung; the knife edges were then lowered upon the agates; when I had the satisfaction to find, from the precautions which I had taken, that the pendulum was most correctly in its place. In this distant part of the globe, there is an anxiety in handling and fixing any new apparatus which is not felt in England, where the maker of it is ready to give assistance, as well as to repair any damage that may chance to have been done: here, little or no assistance can be obtained; and if the use of any part of the apparatus should be mistaken, and the part forced into a wrong place, the injury may be fatal to the experiments, as it cannot be repaired here; it therefore affords no small gratification when an instrument is firmly secured, uninjured, in its proper position.

The pendulum is precisely the same, in all its parts, as that used by Captain KATER at the different stations of the Trigonometrical Survey of England, and which he has fully described in the *Philosophical Transactions* for 1819. Any farther description therefore of its construction, will here be unnecessary.

The next operation was to fix the arc for measuring the vibrations. The clock-case was of handsome mahogany enriched with projecting mouldings, with the door in front of plate glass. The mouldings kept the pendulum at too great a distance from the part of the case where the arc could otherwise have been fastened, and it became necessary to

have a support in front of the case. I therefore had a solid stand of teak wood made, similar to that for supporting the telescope, the inner part cut out to the form of the mouldings of the clock-case, so that it fitted perfectly close to it; in this position it was screwed to the floor; the ends for the supports of the arc were then let in, and secured to the top of the stand, and the arc fixed in its proper place, with reference to the extreme point of the pendulum. The floor outside of this apparatus was then separated from the part of the floor which supported it, to prevent any shake by persons moving about within the building.

The small telescope containing the diaphragm was now fixed upon its stand, and screwed to the floor at the proper distance from the pendulum: this was about $9\frac{1}{2}$ feet. The telescope, and every other part of the apparatus, have been so fully described by Captain KATER in the paper published in the Philosophical Transactions, that I feel it unnecessary to be more particular here.*

While making the holes in the wall above the clock for the insertion of the blocks for supporting the frame, a great deal of dust would necessarily fall upon the clock-case; every part of the case where dust could penetrate was therefore filled up with wax, and several folds of cloth were afterwards secured over the whole of the case, so that it was hardly possible that any dust could penetrate to the works of the clock. After the frame was fixed, the cloth and wax were removed, and fresh oil applied to the works.

* The drawing [Pl. XIV] shows the inside of a part of the Observatory, the pendulum up, and the adjustment of the diaphragm making, preparatory to commencing the observations.

The clock was then set in motion. This was on the 22d of March, and the observations commenced two days afterwards.

The following is the mode pursued in making the observations.

The pendulum was lifted up from the Y's by myself and an assistant, and the knife edges wiped with a cloth saturated with oil. The pendulum was then replaced, and the Y's lowered, so that the knife edges rested upon the agates. The telescope was then adjusted (care being taken that the O on the arc of vibration coincided with the point of the slip), so that the edges of the slip were exactly embraced by the edges of the diaphragm. The height of the barometer, of the thermometer fixed near the middle of the pendulum, and that of the hygrometer, were taken and registered. The point of the slip at the end of the pendulum was then brought and kept by the hand to about $1^{\circ},8$ upon the arc; and an instant before the pendulum of the clock was at its highest point on the same side, the hand was withdrawn, and the pendulum thereby allowed to vibrate freely. I stationed the head Bramin assistant* to take down the time, and the youngest Bramin assistant to count the clock, which he does with the greatest correctness. Having placed myself at the telescope, I found there was a sensible portion of time, more or less, as the arc of vibration was greater or smaller, between the disappearance of the disc behind the slip, and its reappearance; I therefore noticed the seconds, and parts of a second, when the disc disappeared, and also the instant when it

* The name of the head assistant is Senavassaehary, and that of the other Teroo-
vencatachary.

again appeared, both which the Bramin put down; the mean of these I took as the true time of the coincidence, and registered it accordingly. These times I found could be accurately noted; and it is probable the mean of the two observations is generally correct to less than half a second. In this manner the times of the coincidences were observed. The thermometer often varying a good deal in a short time, I thought it right to take its height three times, at the third observation of each set, as well as the first and fifth. The barometer was observed at the end of each set, as well as at the beginning; and also the hygrometer, as mentioned above, at the beginning of the observations, and likewise at the end of those of each day; being desirous of seeing how much the atmosphere had changed in dryness, as well as in heat and weight; not that this was material, but it is satisfactory to know what change there actually was in the atmosphere during the time the observations were making. I now proceed to detail the observations.

Every observation taken is here given. As although in this as in similar cases, one feels better pleased with some observations than with others, yet I do not recollect more than two of these observations, which I felt dissatisfied with at the time, and that not in a sufficient degree to induce me to think of rejecting them.

The results, I trust, will prove how unnecessary it would have been to have rejected any of the observations.

OBSERVATIONS.

FIRST SERIES.

March 24th A. M.

h.	m.	Inch.
6	24	30,085
7	12	30,101

Rate of the Clock — 0",39. } Hygrometer 11°,5 dry. }	Mean	-	30,093
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Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Tem-perature.	Vibrations in 24 hours.
81	h. m. s. 6 23 44	° 1,15	° 1, 10	" 721,25			+	+	
	35 45,25	1,05	1, 01	722,75	719,25	86160,42	1,983	4,687	86167,090
81,3	47 48	0,97	0,935	724	720,75	86160,91	1,671	4,750	86167,331
	59 52	0,88	0,835	723, 8	721, 8	86161,33	1,432	4,793	86167,555
81,4	7 11 55,8	0,79				86161,26	1,102	4,814	86167,216
81,23	Mean						Rate of the Clock		86167,298 — 0,390 86166,908
Rate of the Clock — 0",39						Barometer { 30,105 30,123			
						Mean - 30,114			
81,5	h. m. s. 7 24 50,5	° 1,13	° 1,065	" 722, 4			+	+	
	36 52,9	1,00	0, 95	722, 4	720, 4	86160,80	1,858	4,809	86167,467
82	48 58,6	0,90	0, 87	725, 7	723, 7	86161,88	1,479	4,915	86168,274
	8 1 2,25	0,84	0,795	723,65	721,65	86161,21	1,240	5,152	86167,602
82,7	13 6,0	0,75		723,75	721,75	86161,24	1,036	5,300	86167,576
81,73	Mean						Rate of the Clock		86167,729 —,390 86167,339

Barometer $\left\{ \begin{array}{l} 30,137 \\ 30,134 \end{array} \right.$
 Mean - 30,135

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Tempe-rature.	Vibrations in 24 hours.
82,9	h. m. s. 8 29 26,5	° 1,15	°	"			+	+	
	41 27,1	1,05	1,10	720, 6	718, 6	86160,20	1,983	5,512	86167,692
83,4	53 32,1	0,95	1,00	725, 0	723, 0	86161,66	1,638	5,592	86168,888
	9 5 34,75	0,87	0,91	722,65	720,65	86160,88	1,357	5,765	86167,995
84,3	17 37,4	0,79	0,83	722,65	720,65	86160,88	1,129	5,956	86167,996
83,53	Mean						Rate of the Clock		86168,135 - 0,390 86167,745
<p>Barometer $\left\{ \begin{array}{l} 30,129 \\ 30,140 \end{array} \right.$ Mean - <u>30,135</u></p>									
84,5	h. m. s. 9 33 39,25	° 1,11	°	"			+	+	
	45 38,6	1,03	1, 07	719,35	717,35	86159,78	1,876	6,188	86167,844
85	57 36,75	0,95	0, 99	718,15	716,15	86159,38	1,605	6,290	86167,275
	10 9 35,5	0,88	0,915	718,75	716,75	86159,58	1,372	6,345	86167,297
85	21 35,0	0,80	0, 84	719, 5	717, 5	86159,83	1,156	6,345	86167,331
84,83	Mean						Rate of the Clock		86167,437 - ,390 86167,047

End of the Experiments.

Barometer { 30,147
30,161

Hygrometer 12^o $\frac{1}{8}$ dry.

Mean - 30,154

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibrations in 24 hours.	
81,2	h. m. s. 7 10 19,5	o 1,28	o	"			+	+		
	22 18,6	1,18	1, 23	719,1	717,1	86159,70	2,479	4,780	86166,959	
81,6	34 20,6	1,07	1,125	722	720	86160,66	2,073	4,864	86167,597	
	46 23,6	0,97	1, 02	723	721	86160,99	1,705	4,949	86167,644	
82	58 28,1	0,85	0, 91	724,5	722,5	86161,49	1,357	5,245	86168,092	
81,6	Mean	Rate of the Clock						86167,573 - 1,490		86166,083
March 26, P. M.										
Clock losing 1",91 } Hygrometer 15 ^o ,6 dry }						Barometer { 30,132 30,133		Mean - 30,133		
84	h. m. s. 4 58 37,1	o 1,20	o	"			+	+		
	10 33,6	1,10	1,15	716, 5	714, 5	86158,83	2,167	5,913	86166,910	
83,9	22 31,45	1,04	1,07	717,85	715,85	86159,28	1,876	5,888	86167,044	
	34 30,5	0,98	1,01	719,05	717,05	86159,68	1,671	5,837	86167,188	
83,5	46 30,5	0,90	0,94	720,	718, 0	86160,00	1,448	5,753	86167,201	
83,8	Mean	Rate of the Clock						86167,086 - 1,910		86165,176

March 26, A. M.

Clock losing 2",08
Hygrometer 14°, dry. }
}

Barometer { 30,149
30,150
Mean - 30,149

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
79.3	h. m. s. 5 58 58,1	° 1,19	°	"			+	+	
	11 1,37	1,09	1, 14	723,27	721,27	86161,08	2,129	3,955	86167,164
79.5	23 6,75	1,00	1,045	725,38	723,38	86161,70	1,789	3,997	86167,466
	35 12,25	0,93	0,965	725, 5	723, 5	86161,81	1,526	4,048	86167,384
79.8	47 19,45	0,87	0, 90	727, 2	725, 2	86162,37	1,327	4,116	86167,813
79.53	Mean							Rate of the Clock	86167,457 — 2,080 86165,377
<p>Hygrometer 13°,6 dry. Barometer { 30,150 30,173 Mean - 30,162</p>									
79.8	h. m. s. 6 56 30,62	° 1,29	°	"			+	+	
	7 8 32,5	1,19	1, 24	721,88	719,88	86161,63	2,519	4,264	86168,413
80.9	20 36,5	1,09	1, 14	724, 0	722, 0	86161,32	2,129	4,496	86167,945
	32 40,67	1,00	1,045	724,17	722,17	86161,38	1,789	4,653	86167,822
81.3	44 46,	0,93	0,965	725,33	723,33	86161,76	1,526	4,738	86168,024
80.67	Mean							Rate of the Clock	86168,031 — 2, 08 86165,971

March 27, P. M. Barometer $\left\{ \begin{array}{l} 30,116 \\ 30,131 \end{array} \right.$
 Clock losing 2",06 }
 Hygrometer 20° dry. } Mean - 30,123

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Temperature.	Vibrations in 24 hours.
84, 7	h. m. s. 4 13 44,25	° 1,24	° 1, 20	" 715,87	713,87	86158,62	+	+	
	25 40,12	1,16	1, 12	716,51	714,51	86158,83	2,055	6,176	86167,155
84, 3	37 36,63	1,08	1,035	717,87	715,87	86159,29	1,755	6,028	86167,070
	49 34, 5	0,99	0,955	717,87	715,87	86159,28	1,494	5,985	86166,759
84, 1	5 1 32,37	0,92							
84,37	Mean					Mean of the Clock			86166,990 — 2,060 86164,930
Hygrometer 19°,3 dry.						Barometer $\left\{ \begin{array}{l} 30,131 \\ 30,087 \end{array} \right.$ Mean - 30,109			
84,1	h. m. s. 5 10 14,75	° 1,28	° 1,235	" 716,50	714,50	86158,83	+	+	
	22 11,25	1,19	1, 14	718,50	716,50	86159,50	2,129	5,901	86167,530
83,9	34 9,75	1,09	1,045	718,87	716,87	86159,62	1,789	5,837	86167,246
	46 8,62	1,00	0, 96	720,63	718,63	86160,21	1, 51	5,753	86167,473
83,5	58 9,25	0,92							
83,83	Mean					Rate of the Clock			86167,380 — 2,060 86165,320

March 29, P. M.

Clock losing 1",46
Hygrometer 17°,7 dry. }

Barometer { 30,084
30,113
Mean - 30,098

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Tempe-rature.	Vibrations. in 24 hours.	
84,5	h. m. s. 2 59 8	°	°	"			+	+		
		1,23	1,19	719,12	717,12	86159,71	2,320	6,112	86168,142	
	3 11 7,12	1,15	1,11	720,88	718,88	86160,29	2,019	6,070	86168,389	
84,3	23 8,0	1,07	1,02	723, 0	721, 0	86160,99	1,705	6,028	86168,723	
	35 11,0	0,97	0,93	723,63	721,63	86161,20	1,417	5,985	86168,602	
84,1	47 14,63	0,89								
84,3	Mean	Rate of the Clock							86168,464 - 1,460	86167,004
<p>Hygrometer 17°,7 dry. Barometer { 30,113 30,087 Mean - 30,100</p>										
84,1	h. m. s. 3 56 44,75	°	°	"			+	+		
		1,26	1,215	721, 0	719, 0	86160,33	2,418	5,956	86168,704	
	48 45,75	1,17	1,115	721,75	719,75	86160,58	2,037	5,930	86168,447	
84	20 47,50	1,06	1,015	723,62	721,62	86161,20	1,688	5,922	86168,810	
	32 51,12	0,97	0, 93	723,13	721,13	86161,04	1,417	5,922	86168,379	
84	44 54,25	0,89								
84,03	Mean	Rate of the Clock							86168,585 - 1, 46	86167,121

March 30, P. M.

Barometer $\left\{ \begin{array}{l} 30,136 \\ 30,117 \end{array} \right.$ Clock losing $1''.96$
Hygrometer $16^{\circ}.2$ dry. }Mean - $30,126$

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibration in 24 hours.
84.4	h. m. s.	°	°	"			+	+	
	2 57 1, 5	1,27	1,225	721, 0	719, 0	86160,33	2,459	6,083	86168,872
	3 9 2, 5	1,18	1,135	721,25	719,25	86160,42	2,111	6,057	86168,588
84.3	21 3,75	1,09	1,045	722, 5	720, 5	86160,83	1,789	6,049	86168,668
	33 6,25	1,00	0, 96	723,37	721,37	86161,12	1,510	6,049	86168,679
84.3	45 9,62	0,92							
84.33	Mean						Rate of the Clock		86168,702 - 1,960 86166,742
Hygrometer $16^{\circ}.5$ dry.						Barometer $\left\{ \begin{array}{l} 30,117 \\ 30,115 \end{array} \right.$ Mean - $30,116$			
84.3	h. m. s.	°	°	"			+	+	
	3 52 18,25	1,24	1, 19	720,62	718,62	86160,21	2,320	6,028	86168,558
	4 4 18,87	1,14	1,095	722,13	720,13	86160,71	1,965	5,985	86168,660
84.1	16 21	1,05	1,005	723,75	721,75	86161,24	1,655	6,008	86168,903
	28 24,75	1,96	0,925	723,63	721,63	86161,20	1,402	5,977	86 68,579
84	40 38,28	0,89							
84.13	Mean						Rate of the Clock		86168,675 - 1,960 86166,715

the length of the pendulum at Madras.

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March 30, A. M.

Barometer { 30,124
30,144

Clock losing 2'',23 }
Hygrometer 13°,7 dry. }

Mean - 30,134

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Tempe-rature.	Vibrations in 24 hours.
80,1	h. m. s. 6 0 30	° 1,29	°	'			+	+	
	12 30,5	1,20	1,245	720,5	718,5	86160,17	2,539	4,327	86167,036
80,6	24 31,75	1,12	1,16	721,25	719,25	86160,41	2,205	4,433	86167,048
	36 33,62	1,04	1,08	721,87	719,87	86160,62	1,911	4,518	86167,049
80,9	48 37,12	0,96	1,0	723,50	721,50	86161,16	1,639	4,577	86167,376
80,53	Mean						Rate of the Clock		86167,127 - 2, 23 86164,897
Hygrometer 13°,3 dry.						Barometer { 30,144 30,162			
						Mean - 30,153			
81	h. m. s. 6 59 7,12	° 1,19	°	"			+	+	
	7 11 9,87	1,10	1,145	722,75	720,75	86160,91	2,148	4,695	86167,753
81,4	23 13,5	1,0	1,05	723,63	721,63	86161,20	1,806	4,780	86167,786
	35 17,5	0,93	0,965	724,0	722,0	86161,33	1,526	4,843	86167,699
81,6	47 22,0	0,88	0,905	724,5	722,5	86161,49	1,341	4,886	86167,717
81,33	Mean						Rate of the Clock		86167,739 - 2,230 86165,509

March 31, P. M.

Clock losing 2^{''},24
 Hygrometer 16°₂ dry. }

Barometer { 30,07
 30,066
 Mean - 30,068

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibrations in 24 hours.
85,1	h. m. s.	°	°	"			+	+	
	3 8 27,5	1,24	1, 19	718,25	716,25	86159,42	2,320	6,366	86168,106
84,9	20 25,75	1,14	1,095	719,37	717,37	86159,78	1,965	6,324	86168,069
	32 25,12	1,05	1,005	720,38	718,38	86160,13	1,656	6,273	86168,059
84,6	44 25, 5	0,96	0,940	719,75	717,75	86159,92	1,448	6,210	86167,578
	56 25,25	0,88							
84,87	Mean						Rate of the Clock		86167,953 — 2,240 86165,713
Hygrometer 16° ₃ dry.						Barometer { 30,066 30,061 Mean - 30,064			
84,6	h. m. s.	°	°	"			+	+	
	4 6 55, 5	1,37	1,32	716,62	714,62	86158,87	2,855	6,155	86167,880
84,4	18 52,12	1,27	1,22	717,75	715,75	86159,24	2,439	6,112	86167, 79
	30 49,87	1,17	1,12	720,00	718,00	86160,00	2,055	6,074	86168,129
84,26	42 49,87	1,07	1,02	719,75	717,75	86159,67	1,705	6,049	86167,424
	54 49,62	0,97							
84,42	Mean						Rate of the Clock		86167,806 — 2,240 86165,566

March 31, P. M.

Clock losing 2'' 10
Hygrometer 14° 6 dry. }

Barometer { 30,098
30,114
Mean - 30,106

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
81,3	h. m. s. 5 59 27, 5	° 1,21	°	"			+	+	
	6 11 28, 5	1,13	1, 17	721, 5	719, 5	86160,50	2,243	4,763	86167,506
81,15	23 31,62	1,06	1,095	723,12	721,12	86161,03	1,964	4,733	86167,727
	35 35, 5	0,99	1,025	723,88	721,88	86161,29	1,721	4,725	86167,736
81,25	47 40,37	0,92	0,955	724,87	722,87	86161,61	1,494	4,750	86167,854
81,23	Mean						Rate of the Clock		86167,706 — 2,100 86165,606
Hygrometer 13° 5 dry.						Barometer { 30,114 30,130 Mean - 30,122			
81,35	h. m. s. 6 59 59, 5	° 1,20	°	"			+	+	
	12 2,25	1,12	1, 16	722,75	720,75	86160,91	2,205	4,822	86167,937
81,55	24 6,62	1,04	1, 08	724,37	722,37	86161,45	1,911	4,864	86168,225
	36 12,37	0,95	0,995	725,75	723,75	86161,90	1,622	4,941	86168,463
81,95	48 19,00	0,87	0, 91	726,63	724,63	86162,19	1,357	5,021	86168,568
81,62	Mean						Rate of the Clock		86168,298 — 2,100 86166,198

April 1, P. M.

Clock losing 1''85
Hygrometer 16°8 dry. }

Barometer { 30,100
30,087
Mean - 30,094

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
85,3	h. m. s.	°	°	"			+	+	
	2 23 30,62	1, 18	1,137	717,52	715,52	86159,17	2,118	6,473	86167,761
85,3	35 28,12	1,095	1,048	720,13	718,13	86160,04	1,799	6,473	86168,312
	47 28,25	1,000	0, 96	720,75	718,75	86160,25	1,510	6,455	86168,215
85,15	59 29	0, 92	0,883	721, 5	719, 5	86160,50	1,278	6,425	86168,203
	3 11 30, 5	0,845							
85,25	Mean						Rate of the Clock		86168,123 - 1,850 86166,273
Hygrometer 16°8 dry.						Barometer { 30,087 30,083 Mean - 30,085			
85,15	h. m. s.	°	°	"			+	+	
	3 19 39,75	1,27	1,21	719,25	717,25	86159,75	2,399	6,404	86168,553
85,10	31 39	1,15	1,10	719,62	717,62	86159,87	1,983	6,396	86168,249
	43 38,62	1,05	1,01	720,63	718,63	86160,21	1,671	6,383	86168,264
85,06	55 39,25	0,97	0,93	722,00	720,00	86160,66	1,417	6,375	86168,452
	4 7 41,25	0,89							
85,10	Mean						Rate of the Clock		86168,379 - 1,850 86166,529

April 1, P. M.

Clock losing 1",86
Hygrometer 48° dry. }

Barometer { 30,126
30,134
Mean - 30,130

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Contraction for Arc.	For Temperature.	Vibrations in 24 hours.
81,95	h. m. s. 6 16 49,75	° 1, 19	° 1,145	" 722,25	720,25	86160,83	+	+	86168,092
	28 52,0	1, 10	1,055	723,13	721,13	86161,04	1,824	5,233	86168,097
82,5	40 55,13	1, 01	0,978	723,37	721,37	86161,12	1,567	5,300	86167,987
	52 58,5	0,945	0,912	723,62	721,62	86161,20	1,363	5,321	86167,884
82,6	7 5 2,12	0, 88							
82,35	Mean						Rate of the Clock		86168,015 — 1,860 86166,155
Hygrometer 13°,8 dry.						Barometer { 30,134 30,172 Mean - 30,153			
82,6	h. m. s. 7 13 12,62	° 1,195	° 1,148	" 722	720	86161,00	+	+	86168,514
	25 14,62	1, 10	1, 06	723,88	721,88	86161,28	1,841	5,410	86168,531
82,85	37 18,5	1, 02	0, 98	725,12	723,12	86161,69	1,574	5,444	86868,708
	49 23,62	0, 94	0, 89	725,63	723,63	86161,86	1,321	5,469	86168,650
82,95	8 1 29,25	0,855							
82,80	Mean						Rate of the Clock		86168,601 — 1,860 86166,741

The correction for the arc of vibration was ascertained by multiplying the square of the mean arc by 1,6385. The correction for temperature was found as follows: the mean of the thermometer at the beginning and middle of the observations was taken, and that of the middle and end; which gave five heights, one for each observation; the mean of the first and second, of the second and third, and so on in succession was taken, which gave four mean heights; the difference between each of these and 70° was multiplied by 0,423, the part of a vibration due to each degree of the thermometer, as furnished by Captain KATER, and the required correction was obtained.

The rate of the clock was found as before mentioned. The following shows the daily rate of the transit clock, in the interval during which the observations were taken; and furnishes a satisfactory example of the good performance of this standard for finding the rate of the other clock.

Rate of the Transit Clock.

March 22	-	-	- 0,25	March 29	-	-	+ 0,09
23	-	-	+ 0,13	30	-	-	+ 0,05
24	-	-	- 0,05	31	-	-	- 0,03
25	-	-	+ 0,23	April 1	-	-	+ 0,02
26	-	-	+ 0,10	2	-	-	- 0,08
27	-	-	+ 0,15	3	-	-	+ 0,05
28	-	-	+ 0,20	4	-	-	- 0,04

Table of the Results of the foregoing Experiments.

Day. 1821.	Time of the Experiment.	Mean Height of the			Number of Vibrations in 24 hours, at the temperature of 70° of Farenheit.
		Thermo- meter.	Barometer.	Hygrome- ter.	
March 24	A. M.	81,23	Inch. 30,093	dry.	85166,908
		81,73	30,114		86167,339
25	A. M.	83,53	30,135		86166,275
		84,83	30,135	12,25	86167,047
		84,97	30,141		86166,218
		80,83	30,145		86165,111
		81, 6	30,154	12,22	86166,083
		83, 8	30,133		86165,176
26	P. M.	79,53	30,149		86165,377
	A. M.	80,67	30,162	14, 4	86165,971
27	P. M.	84,37	30,123		86164,930
		83,83	30,109	19, 6	86165,320
29	P. M.	84, 3	30,098		86167,004
		84,03	30,100	17, 7	86167,121
30	P. M.	84,33	30,126		86166,742
		84,13	30,116		86166,715
		80,53	30,134	14,92	86164,897
31	P. M.	81,33	30,153		86165,509
		84,87	30,068		86165,713
		84,42	30,064	15,15	86165,566
April 1	P. M.	81,23	30,106		86165,606
		81,62	30,122		86166,198
		85,25	30,094		86166,273
		85,10	30,085		86166,529
2	A. M.	82,35	30,130	15,65	86166,155
		82,80	30,153		86166,741
		85,37	30,131		86166,254
		84,87	30,123	16, 7	86166,241
Mean		83,48	30,121	15,38	86166,108

*Second Series of Experiments for ascertaining the length of the
Pendulum at Madras.*

Thinking it possible that these Observations might be referred to by future observers in other parts of the world, and wishing to have as accurate results as I could obtain, I deter-

mined to take a second series; having made what I considered some improvement in detaching the clock and apparatus from the floor of the building. In this series, besides comparisons for the rate of the clock used in the experiments, with the transit clock at the time of making the experiments, transits of stars were taken with this clock for the purpose. The result of this series, however, seems to prove, that every necessary precaution had been used in the first, the difference of the two being only 0,06 of a vibration in 24 hours.*

The following are the Observations of the Second Series.

OBSERVATIONS.

SECOND SERIES.

April 18th A. M.

Barometer $\left\{ \begin{array}{l} 30,018 \\ 30,029 \\ \hline \end{array} \right.$
 Mean - 30,025

Rate of Clock $+ 0'',97$ }
 Hygrometer $12^{\circ},6$ dry. }

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For tempe- rature.	Vibrations. in 24 hours.
82.7	h. m. s. 18 14 21,75	0,275	0	"			+	+	
	26 12,87	1, 17	1,122	711,12	709,12	86157,00	2,447	5,402	86164,849
83	38 5,50	1, 08	1,125	712,63	710,63	86157,52	2,074	5,469	86165,063
	49 58,50	0, 99	1,035	713, 0	711, 0	86157,64	1,755	5,550	86164,945
83,45	19 1 52,12	0,915	0,953	713,62	711,62	86157,86	1,488	5,643	86164,691
83,05	Mean								86164,887 + 0,970 86165,857

* By rejecting the 4 in each series, which differs most from the mean, we obtain a mean 0,03 of a vibration less than that from which the conclusions have been drawn.

Barometer { 30,029
 30,044
 Mean - 30,037

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Tempe-rature.	Vibrations in 24 hours.
83,45	h. m. s.	°	°	"			+	+	
	19 11 27,12	1, 30	1, 25	708,63	706,63	86156,15	2,560	5,748	86164,478
84,0	23 15,75	1, 20	1,155	711,38	709,38	86157,09	2,186	5,863	86165,539
	35 7,13	1, 11	1,067	711,12	709,12	86157,00	1,865	5,985	86164,850
84,6	46 58,25	1,025	0,990	712,12	710,12	86157,34	1,606	6,112	86165,058
	58 50,37	0,955							
84,02	Mean						Rate of the Clock		86164,981 + ,970 86165,951
Hygrometer 15° dry.						Barometer { 30,044 30,045 Mean - 30,044			
84,6	h. m. s.	°	°	"			+	+	
	20 13 1, 5	1, 39	1,337	709, 0	707, 0	86156,28	2,929	6,218	86165,424
85	24 50, 5	1,285	1,233	708,75	706,75	86156,19	2,491	6,303	86164,984
	36 39,25	1, 18	1,132	710, 0	708	86156,66	2,100	6,396	86165,156
85,5	48 29,25	1,085	1,043	709,37	707,37	86156,40	1,782	6,502	86164,684
	21 0 18,62	1, 00							
85,04	Mean						Rate of the Clock		86165,062 + ,970 86166,032

the length of the pendulum at Madras.

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April 19, P. M.

Barometer $\left\{ \begin{array}{l} 29,983 \\ 29,961 \end{array} \right.$
 Mean - $\underline{29,972}$

Rate of Clock $0''88$ }
 Hygrometer $16^{\circ}5$ dry. }

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
87,5	h. m. s.	o	o	"			+	+	
	2 21 17,62	1,275	1.223	707,50	705,50	86155,76	2,451	7,386	86165,597
87,35	33 5,12	1,170	1,112	708,50	706,50	86156,01	2,026	7,356	86165,392
	44 53,62	1,055	1,015	710,88	708,88	86157,06	1,688	7,318	86166,066
87,15	56 44, 5	0,975	0,933	709,62	707,62	86156,49	1,426	7,276	86165,192
	3 8 34,12	0,890							
87,33	Mean						Rate of the Clock		86165,562 + ,880 <hr/> 86166,442
Barometer $\left\{ \begin{array}{l} 29,961 \\ 29,952 \end{array} \right.$ Mean - $\underline{29,956}$									
87,1	h. m. s.	o	o	"			+	+	
	3 17 0,12	1, 26	1, 20	708,50	706,50	86156,01	2,359	7,212	86165,461
86,9	28 48,62	1, 14	1,093	707,88	705,88	86155,89	1,958	7,170	86165,018
	40 36, 5	1,045	1,013	710,62	708,62	86156,83	1,681	7,136	86165,647
86,8	52 27,12	0, 98	0,935	710,50	708,50	86156,79	1,432	7,115	86165,337
	4 4 17,62	0, 89							
86,93	Mean						Rate of the Clock		86165,366 + ,880 <hr/> 86166,246

Hygrometer 16°5 dry.

Barometer { 29,952
29,948

Mean - 29,950

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Contraction for Arc.	For Temperature.	Vibrations in 24 hours.
86,8	h. m. s. 4 11 57,4	° 1,19	°	"			+	+	
	23 46,62	1,09	1, 14	709,22	707,22	86156,35	2,129	7,064	86165,543
86,4	35 36,62	1,00	1,045	710, 0	708, 0	86156,62	1,789	6,679	86165,388
	47 28,37	0,91	0,955	711,75	709,75	86157,22	1,491	6,908	86165,619
86,1	59 20,62	0,82	0,865	712,25	710,25	86157,39	1,226	6,840	86165,456
86,43	Mean						Rate of the Clock		86165,52 + ,880 86166,382

April 19, A. M. 18^h 20 Civil.

Barometer { 30,046
30,041

Rate of Clock + 0''70
Hygrometer 13°4 dry. }

Mean - 30,044

83	h. m. s. 17 54 47,62	° 1, 29	°	"			+	+	
	18 6 37,87	1,195	1,243	710,25	708,25	86156,705	2,532	5,562	86164,799
83,6	18 29,37	1,105	1,150	711,50	709, 5	86157,132	2,167	5,689	86164,988
	30 20,87	1,030	1,067	711,50	709,50	86157,132	1,865	5,753	86164,750
83,6	42 14, 5	0, 96	0,995	713,63	711,63	86157,843	1,622	5,753	86165,218
83,4	Mean						Rate of the Clock		86164,939 +0,700 86165,639

Barometer { 30,041
30,050

Mean - 30,045

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibrations in 24 hours.	
83,6	h. m. s. 18 49 21	° 1,305	°	"			+	+		
	19 1 10,75	1, 21	1,257	709,75	707,75	86156,533	2,589	5,795	86164,917	
84	13 3,12	1, 11	1, 16	712,37	710,37	86157,429	2,205	5,880	86165,514	
	24 54, 5	1, 03	1, 07	711,38	709,38	86157,091	1,876	5,951	86164,918	
84,25	36 48	0, 97	1, 00	713, 5	711, 5	86157,813	1,638	6,002	86165,453	
83,95	Mean	Rate of the Clock						86165,200		
								+ ,700		
									86165,900	
Hygrometer 13°,6.						Barometer { 30,050 30,036				
						Mean - 30,043				
84,25	h. m. s. 19 44 11, 5	° 1, 25	°	"			+	+		
	56 1,75	1, 17	1, 21	710,25	708,25	86156,705	2,399	6,104	86165,208	
84,95	20 7 53,12	1, 08	1,125	711,37	709,37	86157,088	2,074	6,252	86165,414	
	19 44,62	0,995	1,038	711,50	709,50	86157,132	1,765	6,341	86165,238	
85,1	31 36,75	0,920	0,958	712,13	710,13	86157,347	1,504	6,370	86165,221	
84,77	Mean	Rate of the Clock						86165,270		
								+ ,700		
									86165,700	

April 20, P. M.

Barometer $\left\{ \begin{array}{l} 30,008 \\ 29,982 \end{array} \right.$

Rate of Clock $+ 0'' ,46$
 Hygrometer $16^{\circ} 7$ dry. }
 Mean - 29,995

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibrations in 24 hours.
87,5	h. m. s. 2 11 25, 5	0 1,195	0	"			+	+	
	23 12, 5	1, 10	1,148	707, 0	705, 0	86155,586	2,159	7,360	86165,105
87,1	35 0, 5	1, 01	1,055	708	706	86155,932	1,824	7,276	86165,032
	46 49,75	0, 94	0,975	709,25	707,25	86156,362	1,557	7,233	86165,152
87,1	58 58, 5	0, 87	0,905	708,75	706,75	86156,190	1,342	7,233	86164,765
87,23	Mean	Rate of the Clock							86165,013 + ,460
									86165,473
Barometer						29,982			
Mean -						29,977			
Mean -						29,979			
87,0	h. m. s. 3 5 32,62	0 1,205	0	"			+	+	
	17 19,62	1, 11	1,158	707, 0	705	86155,586	2,197	7,191	86164,974
87,0	29 8,25	1, 02	1,065	708,63	706,63	86156,149	1,858	7,191	86165,198
	40 57, 0	0, 95	0,985	708,75	706,75	86156,190	1,590	7,191	86164,971
87	52 47,62	0, 89	0, 92	710,62	708,62	86156,832	1,387	7,191	86165,410
87,0	Mean	Rate of the Clock							86165,138 + ,460
									86165,598

Barometer $\left\{ \begin{array}{l} 30,062 \\ 30,068 \end{array} \right.$

Mean - $\underline{30,065}$

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibrations. in 24 hours.
83,7	h. m. s. 18 45 38, 5	° 1,205	°	"			+	+	
	57 28,37	1,110	1,157	709,87	707,87	86156,575	2,193	5,808	86164,576
83,8	19 9 19,63	1,055	1,083	711,26	709,26	86157,050	1,922	5,829	86164,801
	21 11,37	0,990	1,022	711,74	709,74	86157,214	1,711	5,858	86164,783
84	33 3,87	0,915	0,953	712,50	710,50	86157,473	1,488	5,901	86164,862
83,83	Mean						Rate of the Clock		86164,755 + ,630 <hr/> 86165,385
Hygrometer 14° dry.					Barometer $\left\{ \begin{array}{l} 30,068 \\ 30,072 \end{array} \right.$				
					Mean - $\underline{30,070}$				
84,1	h. m. s. 19 40 10	° 1, 19	°	"			+	+	
	51 59,63	1, 11	1, 15	709,63	707,63	86156,492	2,167	5,985	86164,644
84,3	20 3 52,75	1, 02	1,065	713,12	711,12	86157,684	1,858	6,028	86165,570
	15 44,75	0, 94	0, 98	712, 0	710, 0	86157,303	1,574	6,104	86164,981
84,8	27 38,63	0, 87	0,905	713,88	711,88	86157,942	1,342	6,209	86165,493
84,4	Mean						Rate of the Clock		86165,175 + ,630 <hr/> 86165,805

Hygrometer 16°,2 dry.

Barometer $\left\{ \begin{array}{l} 29.977 \\ 29.977 \end{array} \right.$
 Mean - 29.977

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	For Tempe-rature.	Vibrations in 24 hours.
87	h. m. s. 4 0 4, 5	° 1, 30	° 1, 25	" 707,87			+	+	
	11 51,37	1, 20	1,155	708	705,87	86155,887	2,560	7,161	86165,608
86,7	23 39,37	1, 11	1,067	709,13	706	86155,932	2,186	7,094	86165,212
	35 28, 5	1,025	0,993	709,87	707,13	86156,321	1,865	7,043	86165,229
86,5	47 18,37	0, 96			707,87	86156,575	1,516	7, 0	86165,091
86,73	Mean							Rate of the Clock	86165,285 + ,160 86165,745
April 20, A. M.									
Rate of Clock 0'',22 + Hygrometer 13°,4						Barometer $\left\{ \begin{array}{l} 30.047 \\ 30.071 \end{array} \right.$ Mean - 30,059			
83,3	h. m. s. 17 5 11, 5	° 1,275	° 1,233	" 711,37			+	+	
	18 5 2,87	1, 19	1, 15	710,75	709,37	86157,088	2,491	5,647	86165,226
83,5	16 53,62	1, 11	1,065	712,13	708,75	86156,876	2,167	5,689	86164,732
	28 45,75	1,020	0,990	711,00	710,13	86157,347	1,858	5,732	86164,937
83,7	40 36,75	0, 96			709,00	86156,962	1,606	5,774	86164,342
83,5	Mean							Rate of the Clock	86164,809 + 0,220 86165,029

Barometer $\left\{ \begin{array}{l} 30,071 \\ 30,088 \end{array} \right.$
 Mean $\underline{30,079}$

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	For Tempe- rature.	Vibrations in 24 hours.
83.7	h. m. s.	°	°	"			+	+	
	18 47 47.75	1, 36	1, 31	709,37	707,37	86156,403	2,812	5,829	86165,044
84	59 37,12	1, 26	1,215	710,51	708,51	86156,794	2,418	5,888	86165,100
	19 11 27,63	1, 17	1, 13	711,87	709,87	86157,259	2,092	5,956	86164,842
84.3	23 19, 5	1, 09	1,043	713,25	711,25	86157,728	1,782	6,015	86165,525
	35 12,75	0,995							
84.0	Mean						Rate of the Clock		86165,128 + ,022 86165,150
Hygrometer 13°,4 dry.						Barometer $\left\{ \begin{array}{l} 30,088 \\ 30,082 \end{array} \right.$ Mean - $\underline{30,085}$			
84.35	h. m. s.	°	°	"			+	+	
	19 42 26	1, 39	1,337	710, 0	708	86156,619	2,929	6,112	86165,660
84.75	54 16	1,285	1,233	710, 5	708, 5	86156,790	2,491	6,197	86165,478
	20 6 65	1,180	1,135	711,13	709,13	86157,006	2,111	6,281	86165,398
85.15	17 57,63	1,090	1,045	713,24	711,24	86157,725	1,789	6,366	86165,880
	29 50,87	1, 00							
84.75	Mean						Rate of the Clock		86165,604 + ,022 86165,626

Hygrometer 17°, 5.

Barometer { 30,017
30,007

Mean - 30,012

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.	
87	h. m. s. 3 56 31,37	° 1,14	°	"			+	+		
	4 8 21,25	1,03	1,085	709,88	707,88	86156,584	1,929	7,170	86165,683	
86,8	20 12,62	0,95	0, 99	711,37	709,37	86157,088	1,606	7,127	86165,821	
	32 4,13	0,87	0, 91	711,51	709,51	86157,136	1,357	7,106	86165,599	
86,8	43 56,88	0,79	0, 83	712,75	710,75	86157,558	1,128	7,106	86165,792	
86,87	Mean								Rate of the Clock	86165,724 + ,760 86166,484
<p>April 22, A. M.</p> <p>Rate of Clock + 0''98</p> <p>Hygrometer 15° dry (beginning.)</p> <p>Barometer { 30,022 30,016</p> <p>Mean - 30,019</p>										
83,2	h. m. s. 17 45 46	° 1,26	°	"			+	+		
	57 40	1,18	1, 22	714	712	86157,983	2,439	5,596	86166,018	
83,3	18 9 35,62	1,09	1,135	715,62	713,62	86158,531	2,110	5,617	86166,258	
	21 32, 5	1, 0	1,045	716,88	714,88	86158,955	1,789	5,626	86166,370	
83,3	33 31	0,93	0,965	718, 5	716, 5	86159,498	1,526	5,626	86166,650	
83,27	Mean								Rate of the Clock	86166,324 + ,980 86167,304

Hygrometer 14°, 2 dry (end.)

Barometer { 30,016
30,040
Mean - 30,028

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
83,4	h. m. s. 18 43 3,87	° 1, 21	° 1, 16	" 715,63	713,63	86158,534	+	+	86166,441
	54 59, 5	1,111	1,076	717,25	715,25	86159,079	1,897	5,765	86166,741
83,7	19 6 56,75	1, 04	1, 00	717,75	715,75	86159,247	1,638	5,829	86166,714
	18 54, 5	0, 96	0, 92	718,50	716,50	86159,498	1,387	5,888	86166,773
84	30 53, 0	0, 88							
83,7	Mean						Rate of the Clock		86166,667 + ,980 86167,647

April 23, P. M.

Rate of Clock + 0",99
Hygrometer 18°, 3 dry. }

Barometer { 30,017
30,008
Mean - 30,012

Temp.	h. m. s.	°	°	"			+	+	
87,6	2 26 10,12	1,25	1, 20	707,50	705,50	86155,759	2,359	7,424	86165,542
	37 57,62	1,15	1, 10	709,76	707,76	86156,527	1,983	7,381	86165,891
87,4	49 47,38	1,05	1,015	709,12	707,12	86156,317	1,688	7,352	86165,357
	3 1 36, 5	0,98	0, 94	710, 5	708, 5	86156,790	1,448	7,326	86165,564
87,3	13 27	0,90							
87,43	Mean						Rate of the Clock		86165,588 + 0, 99 86166,578

Hygrometer 18° 6.

Barometer $\left\{ \begin{array}{l} 30,008 \\ 30,000 \end{array} \right.$

Mean - 30,004

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correction for Arc.	For Temperature.	Vibrations in 24 hours.
87.3	h. m. s. 3 20 31	° 1,21	° "	"			+	+	
	32 18,37	1,11	1, 16	717,37	715,37	86155,714	2,205	7,297	86165,216
	44 08,37	1,03	1, 07	710,00	708,00	86156,619	1,876	7,254	86165,749
87,1	55 57,75	0,93	0, 98	709,38	707,38	86156,407	1,574	7,225	86166,143
87,05	4 7 49,87	0,86	0,895	712,12	710,12	86157,344	1,312	7,216	86165,872
87,15	Mean						Rate of the Clock		86165,745 + ,990 86166,735

Table of the Results of the foregoing Experiments.

SECOND SERIES.

Day. 1821.	Time of the Experiment.	Mean Height of the			Number of Vibrations in 24 hours, at the temperature of 70° of Farenheit.
		Thermo- meter.	Barometer.	Hygrome- ter.	
April 18	A. M.	83,05	30,023	dry.	86165,857
		84,02	30,037	13,8	86165,951
		85,04	30,044		86166,032
19	P. M.	87,33	29,972		86166,442
		86,93	29,956	16,5	86166,246
		86,43	29,950		86166,382
20	A. M.	83, 4	30,044		86165,639
		83,95	30,045	13,5	86165,900
		84,77	30,043		86165,970
20	P. M.	87,23	29,995		86165,473
		87, 0	29,979	17,1	86165,598
		86,73	29,977		86165,745
21	A. M.	83, 5	30,059		86165,029
		84, 0	30,079	13,4	86165,150
		84,75	30,085		86165,626
21	P. M.	87,23	30,042		86166,140
		86,93	30,034	14	86166,151
		86,73	30,031		86166,179
22	A. M.	83,53	30,063		86165,253
		83,83	30,065	17,4	86165,385
		84, 4	30,070		86165,805
22	P. M.	87,37	30,032		86166,318
		87, 1	30,021	17,3	86166,315
		86,87	30,012		86166,484
23	A. M.	83,27	30,019	14,6	86167,304
		83, 7	30,028		86167,647
		87,43	30,012		86166,578
23	P. M.	87,15	30,004	18,4	86166,735
Mean		85,49	30,258	15,6	86166,048

The height of the pendulum above the level of the sea was 27 feet; the distance in a direct line to the sea being about 4900 yards, or 2,784 miles. The country is flat; the nearest elevation being St. Thomas's Mount, which is 9950 yards, or 5,654 miles off, and rises but little above the ordinary level.* There is a range of low hills a short distance beyond St. Thomas's Mount; and the Pulicat Mountains, which are of considerable elevation, are 39 miles off. The soil about Madras is composed of sand and blue mud, and this to as great depths as the wells have been sunk. I do not recollect any rock having been found. I have therefore used 0,66 as a multiplier to 0,095, the correction for 27 feet, which gives 0,06 to be added to the number of beats in 24 hours.

The last correction required was for the buoyancy of the atmosphere. Having no information relative to the specific gravity of the pendulum, I was obliged to determine it in the best way the limited means in this country afforded. This was done with a balance at a dispensary, and with the aid of Mr. BRUCE, the proprietor of the establishment. The Madras water drawn from wells in the Black town here, and conducted into the cisterns in the fort, is considered among the purest in the world. This was boiled, and strained into a tin trough prepared for the purpose; the pendulum also was securely and properly slung by means of brass wire, with the assistance of Mr. GORDON, jeweller, of this place. The water was at the same temperature with the atmosphere, and the experiments were made with every care. It may be unnecessary to detail them here; I shall therefore proceed to the result, which was as follows:

* About 150 feet above the level of the sea.

Thermometer 88° , barometer 30,064 inches, specific gravity of the pendulum 8,1085. Hence the specific gravity of the pendulum for the mean of the first series of observations, the thermometer being $83^{\circ},48$, and barometer 30,121, was 8,02096, and the correction for the buoyancy of the atmosphere is +6,2075 vibrations. For the second series, the thermometer having been $85^{\circ},49$, and barometer 30,258 inches, this correction is 6,220 vibrations. These corrections being applied to the number of vibrations before found, will give the true number of vibrations of the pendulum in 24 hours in vacuo at the level of the sea, the thermometer being 70° , and are as follow:—

By the first series of observations, 86172,3755. By the second series, 86172,328. The mean being 86172,352.

The length of the seconds pendulum in London, (latitude $51^{\circ} 31' 8'',4$ N.) at the temperature of 70° , according to Captain KATER, is 39,142213 inches. Now, the pendulum of experiment used at Madras, made 86293,44 vibrations in 24 hours in London, latitude as before, and 83 feet above the level of the sea, the mean height of the thermometer being $67^{\circ},6$, of the barometer 29,97 inches (vide Appendix). The correction for the height above the sea is 0,22, and that for the buoyancy of the atmosphere 6,566, both to be added: these corrections being applied, will give 86300,226 for the number of vibrations of the pendulum of experiment in 24 hours in vacuo at the level of the sea, the temperature being 70° . Now, $86300,226^2 : 86400^2 :: 39,142213 : 39,232772$ the length of the pendulum of experiment.

Then $86172,375^2 : 86400^2 :: 39,232772 : 39,026323087$, the length of the seconds pendulum at Madras by the first series of observations.

Also, $86172,328^a : 86400^a :: 39,232772 : 39,026280447$,
the length of the seconds pendulum at Madras by the second
series.

The mean of both is $39,026302$ inches, being, according
to Sir GEORGE SHUCKBURGH'S scale, the length of the seconds
pendulum by these experiments at Madras in lat. $13^\circ 4' 9'',1$
N. at the level of the sea, in vacuo, and at a temperature of
 70° of FAHRENHEIT.

Then comparing this length with $39,142213$ inches, the
length in latitude $51^\circ 31' 8'',4$ N. as before stated, the dimi-
nution of gravity from the pole to the equator will be $,0052894$,
and the ellipticity $\frac{1}{297,56}$ nearly.

J. GOLDINGHAM.

Madras,
May, 1821.

APPENDIX.

The following are the Observations made by Captain KATER in England, before the Pendulum was sent out.

July 25, 1820, in lat. $51^{\circ} 31' 8''$,4.

Clock losing $1^s, 20$ in a mean solar day. Barometer $29,83$ ^{Inches.}

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc- tion for Arc.	Vibrations in 24 hours.
$67,4$	h. m. s. 1 5 25	$1,17$	$1,70$	1629			s. 1,88	
	32 34	$0,97$	$0,90$	1634			1,33	
	59 48	$0,84$	$0,77$	1639			$0,97$	
	2 27 7	$0,71$	$0,65$	1642			$0,69$	
	54 29	$0,60$						
67,8								
67,6	Mean			1636	1634	86293,18	1,22	86294,40
<p>July 26.</p> <p>Clock losing $1^s, 22$. Barometer $30,01$ inch.</p>								
$66,2$	h. m. s. 1 37 28	$1,28$	$1,18$	1621			2,28	
	2 4 29	$1,08$	$0,99$	1632			1,60	
	31 41	$0,91$	$0,84$	1637			1,16	
	58 58	$0,77$	$0,71$	1646			$0,83$	
	3 26 24	$0,65$						
66,8								
66,5	Mean			1634	1632	86293,03	1,47	86294,50

July 27.

Clock losing 1^s.15.

Barometer 30,01 inches.

Temp.	Time of coincidence.	Arc of vibration.	Mean Arc.	Interval in seconds.	Number of vibrations.	Observed vibrations in 24 hours.	Correc-tion for Arc.	Vibrations in 24 hours.
67,2	h. m. s.	°	°				s.	
	1 2 27	1,22	1,12	1622			2,06	
	29 29	1,02	0,94	1630			1,45	
	56 39	0,86	0,79	1633			1,02	
	2 33 52	0,73	0,67	1638			0,73	
67,8	51 10	0,62						
67,5	Mean			1630,75	1628,75	86292,89	1,32	86294,21

July 28.

Clock losing 1,05.

Barometer 30,01 inches.

67,8	h. m. s.	°	°					
	0 50 41	1,19	1,09	1614			1,95	
	1 17 35	1,00	0,92	1624			1,39	
	44 39	0,84	0,78	1630			1,00	
	2 11 49	0,73	0,67	1627			0,73	
68,4	38 56	0,62						
68,1	Mean			1623,75	1621,75	86292,53	1,27	86293,80

July 29.

Clock losing 1^s.07.

Barometer 30,01 inches.

67,9	h. m. s.	°	°					
	0 47 1	1,21	1,11	1616			2,02	
	1 13 57	1,02	0,94	1620			1,45	
	40 57	0,86	0,79	1625			1,03	
	2 8 2	0,73	0,68	1630			0,76	
68,8	35 12	0,63						
68,3	Mean			1622,75	1620,75	86292,45	1,31	86293,76

Vibrations of the Pendulum at London.					
Date 1820.	Barometer.	Thermometer.	Vibrations in 24 hours.	Correction for Temperature.	Correct vibrations in a mean solar day at 70°
July 25	Inch. 29,83	° 67,6	86294,40	1,02	86293,38
26	30,01	66,5	86294,50	1,48	86293,02
27	30,01	67,5	86294,21	1,06	86293,15
28	30,01	68,1	86293,80	0,70	86293,10
29	30,01	68,3	86293,76	0,72	86293,04
Mean	29,97	67,6			86293,14

From the above table it appears, that the pendulum makes 86293,14 vibrations in a mean solar day, in latitude $51^{\circ} 31' 8'' ,4$, the temperature being 70° , and the height above the level of the sea 83 feet. The correction employed for temperature is 0,423 of a vibration for one degree. In computing the correction for the buoyancy of the atmosphere during the experiments, the temperature of $67^{\circ},6$ must be used, the barometer being at 29,97 inches.

J. GOLDINGHAM.





