PHILOSOPHICAL

TRANSACTIONS.

XIV. *An account of experiments to determine the acceleration of the Pendulum in different latitudes. By Captain* EDWARD SABINE, *of the Royal Regiment of Artillery, F. R. S. and F. L. S.*

Read March 8, 1821.

THE clocks and pendulums used in these experiments are the property of the Royal Society, and were prepared by their direction under the immediate superintendance of Captain KATER; who, in a manuscript account presented to the Society, of the instruments furnished to the Expeditions on Northern discovery, has described them as follows:

"The clocks were made by SHELTON, and are the same which accompanied Captain COOK round the world: for each clock a pendulum was cast in one piece of solid brass: this was furnished with a knife edge of hard steel perfectly strait, and finished by drawing the edge longitudinally two or three times on a soft hone, so as to take from its sharpness, and thus preclude any alteration from wear; the back of the knife edge bore firmly against a stout cross piece, and the

heads of the screws securing it, were sunk below the surface, and concealed by brass pins, to prevent their being removed: the knife edge was carefully adjusted, so as to be at right angles to the direction of gravity: a very firm support of brass was screwed to the thick plank which forms the back of the clock case; in this were imbedded two pieces of agate, which were ground into portions of hollow cylinders, finished in their places to receive the knife edge of the pendulum: parallel to the agates a small level was fixed in the direction of the cylinders, by means of which they could be placed truly horizontal: an arc divided into degrees and tenths, but which might be read off by estimation to hundredths, was attached to the back of the clock case at the bottom of the pendulum, to give the arc of vibration.

"Each clock was furnished with a triangular support of wood contrived by Dr. WOLLASTON, and so firmly arranged, that there appears no reason to apprehend any motion in the point of suspension; and it is sufficiently obvious that no change can take place in the length of the pendulum, but such as may arise from a variation in temperature. For the purpose of distinction, the two clocks and the two pendulums, are marked respectively No. 1 and No. 2."

To this description it may be added, that the clocks were cleaned and oiled by Mr. ARNOLD, in March 1818, previous to the commencement of the experiments, and that these operations have not been needed subsequently. The oil which was used was prepared by Dr. WOLLASTON. The preparation consisted in submitting it to a low temperature, when the part which remained fluid was separated by a gentle pressure from that which had become solid; the

oil had undergone this process in the year 1803, and had been laid by since that time.

The experiments, of which the account is now presented to the Society, were made in the course of two voyages of discovery in search of a North-west passage; one in the summer of 1818, and the second in the years 1819 and 1820.

In the first of these voyages, the clock and pendulum marked No. 2, were alone employed, No. 1, being sent at the same time to Spitzbergen with Mr. G. FISHER; but both the clocks being disposable when the second expedition was fitted out, they were both embarked, with a view of obtaining double and corresponding results.

It is designed to detail, in succession, the proceedings at each station, where an opportunity was afforded of landing and setting up the clocks; and to conclude, by recapitulating the number of vibrations made by each pendulum in the different latitudes in which it was tried; and by stating the deductions regarding the figure of the earth, which follow from the accelerations which were thus determined.

FIRST VOYAGE.

Island of Brassa, Shetland.

The ships having anchored in Brassa Sound on the 30th of April 1818, for the purpose of procuring a supply of fresh provision, and their stay, although designed to be very short, being understood to depend in some measure on the wind, the clock was landed, and, by the kindness of WILLIAM MOUATT, Esq. was set up in a lower room at Gardie House,

on the Island of Brassa. It happened unfortunately, that in the interval between the 30th of April and the 3d of May, on which morning the clocks were re-embarked to proceed on the voyage, the state of the weather was such as to prevent the use of the transit instrument. The rate of the clock was therefore ascertained at this station by comparison with a chronometer, the accuracy of the result being of course dependent on the steadiness with which the chronometer maintained its accustomed rate. No. 1024 of EARNSHAW, selected on this occasion, had been received on board on the 15th of April, with an assigned rate of gaining one second daily, founded on a trial of several weeks. The longitude of Brassa is not ascertained with sufficient correctness to determine, by a knowledge of the error of the watch on mean time whilst there, the rate since the 15th; but on the 9th of June, being the first good opportunity of lunar observation which occurred subsequently, the Greenwich time obtained by the mean of several sets of distances taken by different observers, and with different instruments, agreed within four seconds of that shown by 1024, with its rate for the interval of 56 days applied. It may be also stated, as affording an inference that the rate had been particularly maintained during the early part of this interval, that a second chronometer of Mr. EARNSHAW'S, No. 815, had been sent on board, also on the 15th of April, with a rate gaining 0″,54 daily, determined by a similar trial to No. 1024; on the 1st of May 1024 had gained on 815 since the 15th of April 6,3 seconds, being only 6-tenths of a second less than the difference of their respective rates.

The latitude of Mr. MOUATT'S house 60° 09′ 42″ N. was

ascertained by a mean of meridian altitudes observed in November 1818, with a sextant and artificial horizon, by Captain PARRY, who on this and on all occasions most kindly studied to render me every assistance in his power, consistent with the due performance of his own duties. The house being close to the sea, the height of the clock above low water mark was ascertained by direct measurement 24 feet.

In the subjoined table is given an account of the going of the clock, as compared with No. 1024; the clock was set up on the afternoon of the 30th of April, but the account was not commenced until time had been allowed for the pendulum to acquire the temperature of the room. The temperatures and arcs of vibration are a mean of frequent observations in the times to which they correspond; and as these were of irregular duration, the corrections due to the several means have been given an influence on the general correction, proportioned to the length of their respective periods.

The correction for the arc is the number of vibrations lost by the pendulum in 24 hours, from its vibrating in a circular, instead of a cycloidal arc; the arcs being less than two degrees, the time of a vibration in a circular arc, whose radius is r: the time of a vibration in a cycloid whose axis is $\frac{1}{2}r$:: $1 + \frac{a}{8r} : 1$, (a being the versed sine of the arc), and the errors arising from the greater length of the vibration in a circular arc being nearly as the square of the arc, when the number of vibrations lost by the pendulum at each station in 24 hours by vibrating in an arc of 1 degree has been ascertained, the corrections due to the arcs in which the pendulum did actually vibrate are obtained by multiplying the square of these arcs by the loss for one degree.

The correction for temperature is the reduction of the mean temperatures to 50 degrees, assumed as a convenient standard at which to compare the observations of the first voyage with each other, it being nearly the mean at which they were made; the correction has been computed from the change in the length of the pendulum due to differences of temperature, the expansion of brass being considered +·00220 inches per foot in 180 degrees of FAHRENHEIT.

The correction for the height above the sea, is the part of a vibration lost in 24 hours by the pendulum in vibrating at such elevation instead of at the level of the sea, the force of gravity increasing inversely as the square of the distance from the centre of the earth. The differences of latitude being considerable between the stations at which the clocks have been set up, and the elevations being small, and differing but little from each other, it has not been deemed necessary to diminish this correction, by taking the geological character of the different stations into consideration; the character is however noted wherever it was not previously well known.

The correction for the buoyancy of the atmosphere has been computed in the manner explained by Captain KATER, in his Account of Experiments for determining the length of the Seconds Pendulum, published in the Philosophical Transactions for 1818; the specific gravity of the pendulum being considered 8,4.

Clock 2 at Brassa. Barom. Mean height 29.745 inches.

1818.	Time shown by: 1024 gaining 1 second per diem.	Time shown by: The Clock.	The Clock's gain: on 1024.	The Clock's gain: on Time.	The Clock's gain: per diem.	Mean arc.	Mean Temp.	Corrections: Arc.	Corrections: Temp.	Corrections: Elev.	Corrections: Buoy.	Corrected vibrations.
	h. m. s.	h. m. s.	s.	s.	s.	°	°	s.	s.	s.	s.	
Apr. 30	18.46.10,5	18.07.10,5				1.8117	53					
May 1	3.21.10,75	2.42.52,75				1.798	53,6					
	11.55.10,75	11.17.34				1.782	54,26					
	22.55.10,35	22.18.27	222	223,9167	116,8488	1.785	55,4	+ 5,3027	+ 2,0164	+ 0,099	+ 6,24	86530,507.
2	9.12.10,25	8.36.16,5				1,8	56,96					
	16.45.40,25	16.10.22,25										

Being 86530,507 vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 50°.

Hare Island.

The expedition having ascended Davis' Strait to the 70th degree of latitude, their progress in a northerly direction was interrupted on the 16th of June, by a temporary accumulation of ice. There being a possibility that the detention might be of some days continuance, the instruments were landed on the morning of the 17th, on the NE side of a small island situated on the west coast of Greenland, in latitude 70° 26′, called in some charts Waygat, and in others Hare Island. Being uninhabited, and consequently affording no accommodation, a marquee was pitched for the reception of the clock; and for its more effectual protection, the marquee was itself inclosed within a large laboratory tent, and a stove placed in

the space between the tent and the marquee for the purpose of regulating the temperature. The weather from the 17th, which was the day of landing, to the 20th, when the instruments were re-embarked, was extremely clear and fine, admitting of transit observations on the 18th, 19th, and 20th; the details of which, with the rate of the clock in the intervals, are given in the annexed Table. The latitude of the tents was ascertained by Captain PARRY, by a mean of meridian altitudes of the sun, observed with a sextant and artificial horizon, 70° 26′ 17″ N.; the elevation above the sea was measured 44 feet; the temperatures and arcs of vibration were observed every second hour, the daily mean being inserted in the Table.

Clock 2 at Hare Island: Barom. Mean height 30,1 inches.

1818.	Observ. Times of ⊙'s trans.	Mean time of App. noon.	Clock slow.	Daily gain.	Mean arc.	Mean temp.	Corrections.				Corrected vibrations.
							Arc.	Temp.	Elev.	Buoy.	
	h. m. s.	h. m. s.	m. s.				+	—	+	+	
June 18	23.48.35,58	0.00.35,06	11.59,48	153,62	1.783	43,9	5,239	2,664	0,1826	6,448	86562,8256
19	23.51.22	0.00.47,86	9.25,86	152,51	1.7825	45,6	5,236	1,925			86562,4516
20	23.54.07.31	0.01.00,66	6.53,35							Mean	86562,6386

Being 86562,6386 vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 50°.

London.

No other opportunity of pursuing these experiments presented itself during the remainder of the voyage; the ships

having returned to England in the autumn of 1818, the clock was disembarked to have its rate in London ascertained. Mr. BROWNE having kindly permitted the observations for this purpose to be made at his house in Portland-place, the clock was set up in a room adjoining the one in which Captain KATER's Experiments for determining the length of the seconds pendulum had been made; the latitude, as stated by Captain KATER, being 51° 31′ 08″,4 N. and the height above the sea 84,5 feet. The clock was going on the 23d of December, and the account taken up on the 24th at noon, and continued through the ten following days, as shown in the annexed Table; the rate of the chronometer with which the clock was compared was supplied by Mr. BROWNE:

Clock No. 2, London; Barom. mean height 30,31 inches; Chron. No. 112, of ARNOLD losing 0,8ˢ per diem.

1818.	Clock fast of 112.	Daily gain. on 112.	Daily gain. on Time.	Mean arc.	Mean temp.	Corrections. Arc.	Corrections. Temp.	Daily Vibrations.	Corrections. Elev.	Corrections. Buoy.	Corrected vibrations.
	m. s.	s.	s.	°	°	s. +	s. −		s.	s.	
Dec. 24	0 47,3	88,7	87,9	1,664	45	4,559	2,18	86490,279			
25	02 16	88,8	88	1,69	45,8	4,703	1,838	86490,865			
26	03 44,8	88,9	88,1	1,7	44,5	4,759	2,398	86490,461			
27	05 13,7	89	88,2	1,7	45	4,759	2,18	86490,779			
28	06 42,7	89,1	88,3	1,7	45	4,759	2,18	86490,879	+0,35	+6,457	86497,4.
29	08 11,8	88,7	87,9	1,76	44,5	5,1	2,398	86490,602			
30	09 40,5	89,4	88,6	1,82	44	5,454	2,62	86491,434			
31	11 09,9	88,5	87,7	1,82	44	5,454	2,62	86490,534			
1819. Jan. 1	12 38,4	88,5	87,7	1,83	44	5,514	2,62	86490,594			
2	14 06,9	87,6	86,8	1,835	43,5	5,544	2,84	86489,504			
3	16 34,5										

Being 86497,4 vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 50°.

Results of the first Voyage.

Recapitulation.

Place of observation.	Latitude	Vibrations in a mean solar day.	Acceleration.
London	51.31.08,4N	86497,4	
			33,107 vibrations between London & Brassa.
Brassa	60.09.42 N	86530,507	
			32,1316 between Brassa and Hare Island.
Hare Island	70.26.17N	86562,6386	
			and 65,2386 between London and Hare Island

SECOND VOYAGE.

It has been already noticed that both clocks were employed on the second expedition; they were placed in my charge early in 1819, to afford time for the determination of their rates in London previously to their embarkation.

The observations, of which the details are given in the subjoined Tables I. and II, were made, by Mr. BROWNE'S permission, in the room already described in Portland-place; the rate of the chronometer with which the clocks were compared being supplied, as before, by Mr. BROWNE: the temperatures are corrected to 45°, being the mean to which all the observations of the second voyage are reduced;

TABLE I.

Clock No. 1. in London; Barom. mean height 30,31 in.; Chron. No. 112, losing 0,8ˢ per diem.

1818.	Clock fast of 112.	Daily loss. on 112.	Daily loss. on Time.	Mean arc.	Mean temp.	Corrections. Arc.	Corrections. Temp.	Daily vibrations.	Corrections. Elevation.	Corrections. Buoy.	Corrected vibrations, Temp. 45°.
Dec. 24	1.00.22					+	+				
		18,3	19,1	1,6	46,6	4,21	0,702	86385,812			
25	1.00.03,7										
		18,8	19,6	1,622	47,4	4,327	1,055	86385,782			
26	0.59.44,9										
		18,4	19,2	1,6	48	4,21	1,32	86386,33			
27	0.59.26,5										
		17.7	18,5	1,6	48	4,21	1,32	86387,03			
28	0.59.08,8										
		19	19,8	1,6	49	4,21	1,75	86386,16			
29	0.58.49,8										
		18,9	19,7	1,56	48,5	4,	1,535	86385,835			
30	0.58.39										
		18,6	19,4	1,51	47,5	3,75	1,1	86385,45			
31	0.58.12,3										
1819.		18	18,5	1,5	47,5	3,7	1,1	86386			
Jan. 1	0.57.54,3										
		19	19,8	1,49	47,5	3,651	1,1	86384,951			
2	0.57.35,3										
		19,3	20,1	1,485	47	3.627	0,88	86384.407			
3	0.57,16										
									+0,3496	+6,442	86392,5673

TABLE II.

Clock No. 2, in London; Barom. mean height 29,88 inches; Chron. No. 112, losing 1ˢ. per diem.

1819.	Clock slow of 112.	Clocks gain. on 112.	Clocks gain. Per diem. on 112.	Clocks gain. Per diem. on Time.	Mean arc.	Mean temp.	Correction Arc.	Correction Temp.	Daily vibrations.	Corrections. Elevation.	Corrections. Buoy.	Corrected vibrations. Temp. 45°.
March	m. s.	s.	s.	s.	°	°	s.	s.		s.	s.	
15 Mid.	13.26						+	+				
		86	86	85	1.69	45	4,703	—	86489,703			
16	12.0											
		84	84	83	1.73	50	4,928	2,18	86490,108			
17	10.36											
		84	84	83	1.73	50	4,928	2,18	86490,108			
18	9.12											
		211,5	84,6	83,6	1.73	50	4,928	2,18	86490,708			
21 Noon	5.40,5									+0,35	+6,34	86496,997.

On the return of this expedition to England in the autumn of the following year, 1820, it was judged proper to repeat these observations, for the purpose of ascertaining whether any injury producing an alteration of rate, had been sustained by either of the clocks or pendulums during the voyage; they were accordingly once more set up in Portland-place, and their going compared with Mr. BROWNE'S excellent clock by CUMMING, the rate of which, losing 0,1' per diem, was furnished by Mr. BROWNE; the details are comprised in the following Tables III. and IV.

TABLE III.

Clock No. 1, in London; Barom. mean height 29,906. Cumming losing 0,1'. daily.

1820.	Clock fast of Cumming.	Clock's loss.			Mean arc.	Mean temp.	Corrections.		Daily vibrations.	Corrections.		Corrected vibrations. Temp. 45°.
		on Cumming.	Per diem. on Cumming.	Per diem. on Time.			Arc.	Temp		Elev.	Buoy.	
	m. s.	s.	s.	s.	°	°	s.	s.		s.	s.	
							+	+ 1				
Dec. 5	18.02,1	19	19	19,1	1.38	49,14	3.132	1.811	86385,843			
6	17.43,1	18,6	18,6	18,7	1.4	50,1	3.223	2.224	86386,747			
7	17.24,5	19,5	19,5	19,6	1.4	50,2	3.223	2.268	86385,891			
8	17.05	19,9	19,9	20	1.4	50,5	3.223	2.398	86385,621	+ 3,496	+ 6,335	86392,3353
9	16.45,	19,1	19,1	19,2	1.4	50,3	3.223	2.312	86386,335			
10	16.26	20,2	20,2	20,3	1.41	51,1	3.27	2.664	86385,634			
11	16.05,8	76,8	19,2.	19,3	1.4	47,7	3.223	1.186	86385,101			
15	14.49											

TABLE IV.

Clock No. 2 in London ; Barom. mean height 29,906 inches. Cumming losing 0,1". daily.

1820.	Clock fast of Cumming.	Clocks Gain. on Cumming.	Per diem. on Cumming.	Per diem. on Time.	Mean Arc.	Mean temp.	Corrections. Arc.	Corrections. Temp.	Daily vibrations.	Corrections. Elev.	Corrections. Buoy.	Corrected vibrations. Temp. 45°.
	m. s.	s.	s.	s.	°	°	s.	s.		s.	s.	
Dec. 5	8.45,2						+	+				
		82,1	82,1	82,	1.73	52,8	4,928	3,409	86490,337			
6	10.07,3											
		82,6	82,6	82,5	1.73	53,6	4,928	3,752	86491,18			
7	11.29,9											
		81,9	81,9	81,8	1.73	53,25	4,928	3,6	86490,328			
8	12.51,8									+	+	
		81,8	81,8	81,7	1 73	53,2	4,928	3,578	86490,206	0,35	6,3	86496,9741
9	14.13,6											
		82,4	82,4	82,3	1.73	53,3	4,928	3,622	86490,85			
10	15,36											
		81,6	81,6	81,5	1.73	54	4,928	3,92	86490,348			
11	16,57,6											
		330,2	82,55	82,45	1.73	51	4,928	2,62	86489,998			
15	22.27,8											

The very near agreement of the results in Tables III. and IV, with those in Tables I. and II, afforded a satisfactory proof, that no part of the apparatus had suffered by any of the accidents to which instruments are liable on a voyage of such length and peculiar circumstances, and against which the utmost precaution and care may not always be able to provide.

Rate of the clocks in London deduced from the preceding Tables.

	Vibrations in a mean solar day, Temperature 45°	
Clock 1.	Table I. Dec. 1818. 86392,5673	86392,4513
	Table III. Dec. 1820. 86392,3353	
Clock 2.	Table II. March 1819. 86496,997	86496,9855
	Table IV. Dec. 1820. 86496,9741	

Whilst the observations which have been detailed were making in 1819, it suggested itself, (at first only as a matter of curiosity), to ascertain what difference would take place in the number of vibrations made in a day by each pendulum, on its being removed into the clock numbered differently from itself. Accordingly before the instruments quitted Portland-place to be embarked, No. 1 pendulum was shifted into the clock numbered 2, and No. 2 pendulum into clock No. 1, when the following observations were made; the rate of 112 being supplied, as before, by Mr. BROWNE.

Pendulum 1 in clock 2, London; Bar. mean height 30,2 inches. Chron. No. 112 losing 0,8ˢ. per diem.

1819.	Clock fast of 112.	Daily loss. on 112.	Daily loss. on Time.	Mean arc.	Mean temp.	Corrections. Arc.	Corrections. Temp.	Daily Vibrations.	Corrections. Elevation.	Corrections. Buoy.	Corrected vibrations, Temp. 45°.
Jan.	m. s.	s.	s.	°	°	s.	s.			s.	
3 Mid.	6.02,5					+	+				
		23,5	24,3	1.74	46,25	4,979	0,55	86381,229			
4	5.39								+	+	
		24	24,8	1.775	47,25	5,181	0,99	86381,371	0,3496	6,43	86388,0967
5	5.15										
		24,1	24,9	1.77	47,5	5,152	1,1	86381,352			
6	4.50,9										

Pendulum 2 in clock 1, London; Bar. mean height 30,2 inches. Chron. No. 112 losing 0,8ˢ. per diem.

1819.	Clock fast of 112.	Daily gain. on 112.	Daily gain. on Time.	Mean arc.	Mean temp.	Corrections. Arc.	Corrections. Temp.	Daily Vibrations.	Corrections. Elevation.	Corrections. Buoy.	Corrected vibrations. Temp. 45°.
Jan.	h. m. s.	s.	s.	°	°	s.	s.		s.	s.	
3 Mid.	0.58.575					+	+				
		136,4	135,6	0,913	49	1,373	1,75	86538,723			
4	1.01.13,9								+	+	
		134,6	133,8	0,983	50	1,592	2,18	86537,572	0,3503	6,398	86545,0623
5	1.03.28,5										
		135,4	134,6	1	50,5	1,647	2,4	86538,647			
6	1.05.43,9										

Whence it appeared that the pendulum No. 1, vibrating in clock No. 2, would make 86388,0967 vibrations; and the pendulum No. 2, vibrating in clock No. 1, 86545,0623 vibrations, in a mean solar day, in *vacuo*, at the level of the sea, the temperature being 45°.

Melville Island.

Only one opportunity presented itself in the course of the second voyage of setting up the Pendulum clocks; this was during the detention of the ships at Melville Island, in the Polar Sea, in the winter of 1819—1820.

The time afforded for the observations at this station was limited by the nature of the climate alone; they were accordingly continued until the rates of the clocks were obtained with much accuracy: it has been thought proper, therefore, to give a more circumstantial detail of the proceedings at this station, than at those of the former voyage.

As soon as the harbour was determined in which it was purposed to secure the ships for the winter, and whilst a canal was cutting to admit them through the ice by which it was already occupied, its shores were carefully examined, with a view to select a suitable spot for an observatory.

The land was found of little elevation, and generally level, except where intersected by ravines, being the courses in which the winter's fall of snow drained on dissolution to the sea. The soil, which appeared by the banks of these channels to be many feet in depth, consisted of sand intermixed with small stones, being the debris of the sandstone rock of which the island is composed; it was at this time consolidated by the frost, and was harder than the original rock, but much the greater part bore evident marks of being swampy at times; and even the more elevated spots afforded little prospect of a solid foundation for the clock-stands on the return of summer.

However, as no preferable situation could be found within

such distance from the ships, as it would have been convenient, or indeed prudent, to venture, one of these was fixed on; and it was hoped that by sinking the legs of the stands a few inches into the frozen soil, and by commencing the experiments as early in the ensuing year as the season should admit, they might be completed before the ground should be affected by a thaw.

It was desirable therefore to be thoroughly prepared before the severity of the winter should set in; accordingly when the ships had been secured, and a party of men could be spared for the occasion, an observatory house was commenced. The house was built of the store plank and boards carried by the ships, care being taken to cut or injure them as little as possible; the walls were weather-boarded, lined, and filled in between with moss; the roof was protected by a tarpaulin covering: it was divided into two rooms, whereof the inner, being designed for the reception of the clocks, was warmed by pipes proceeding from a stove placed in the outer room; the floors were boarded, and the walls furnished on the inside with Russia matting. The house was finished and the clocks moved into it before the end of October.

If any hope had been entertained of being able to do more during the winter than merely to prepare for the return of more favourable weather, it was ended by the severity of cold, far exceeding expectation, with which November set in. From this date until the close of March, the highest degree registered by a thermometer, suspended in the air, was + 6° of FAHRENHEIT, and in no one of these five months did the mean temperature rise above —18°; under such circumstances, an attempt to raise the temperature of the house,

sufficiently to carry on the experiments, and to keep it up during their course, with the requisite steadiness and uniformity, must have altogether failed. It may not be amiss to remark, that notwithstanding the house was as effectual for the purpose as the utmost liberality in the supply of materials, with no labour spared in their application, could produce, a very little wind with so low a temperature abstracted the heat with such rapidity, that the influence of the stove was scarcely felt beyond its immediate vicinity; and a thermometer placed in those parts of the inner room where the clocks would have stood, could not be kept above zero, with such fire in the stove as it would have been prudent to maintain.

The clocks were therefore suffered to remain unpacked during the winter in the inner room, whilst the outer served a variety of useful purposes, which could not have been conveniently effected on board ship.

On the 24th of February, the matting with which the walls of the outer room were covered accidentally caught fire, and notwithstanding the endeavours of the persons who were present, the fire was communicated rapidly to the roof; it was at length fortunately extinguished by the exertions of the officers and men from the ships, before the clocks or any part of their apparatus had received injury; the packing chest alone of one was slightly scorched: the only personal sufferer on the occasion was an artilleryman, who had accompanied me on the voyage, and who, in his anxiety to place the instruments out of danger, exposed his hands incautiously, and was in consequence so severely frost-bitten, as to render necessary the amputation of three fingers of the left hand, and two of the right.

The house was speedily repaired, the outer room being reduced in size to a porch sufficient to contain the stove; and the inner room, which had scarcely been touched by the fire, remaining as before.

Towards the end of April the sun had influence to keep the thermometer a few degrees above zero for some hours of the day. The clocks were now unpacked and set up: the flooring being removed, the legs of the stands were placed on sleepers sunk some inches into the frozen ground in grooves which were excavated by crow bars.

It may be worthy of remark, that when the boxes containing the thermometers which accompany the clocks were opened, the mercury was observed to be retired into the bulbs and frozen, although the temperature of the air had not been so low as the freezing point of mercury for several weeks. The thermometer boxes were enclosed each with the pendulum to which it belonged, in a stout case of oak; and these again were contained in chests holding each one clock with its apparatus complete. The thermometers had been thoroughly cooled in their cases by the long continued severity of the winter; but the warmth had not yet made its way through such a multiplicity of enclosures. It may be also mentioned, in proof of the slowness with which such a mass of solid brass as constituted the bob of the pendulums conforms to the temperature of the surrounding atmosphere, compared with the mercury in the thermometer tubes, that several hours had elapsed, after the pendulums were taken out of their cases, (when it is presumed they also may have been at —40°) before they ceased to cause a deposit of moisture from the air of the room, which was about the same number

of degrees above zero: the mercury in the thermometers, on the other hand, took up the temperature of the room within half an hour after their exposure. The clocks were put in motion on the 30th of April, and the account taken up on the 4th of May, the room having been kept at about the temperature of +45° for the preceding three days and nights.

It proved however an erroneous supposition, that a sufficient interval to complete the observations would occur between the first return of mild weather, and the thorough breaking up of the frost: it was not indeed until the third week in May, that the weather became sufficiently settled or warm, to commence them to any purpose: during the first fortnight strong northerly winds prevailed with heavy snow drifts, preventing the reference to a meridian mark, and occasionally burying the house altogether beneath the drift snow; when the only access to it was by digging down to the window of the room in which the clocks were going. It was desirable to keep the temperature of the room at about the same degree as in the experiments in London, namely, about 45°; but the mean height of the thermometer in the air during this fortnight was not more than +6°. The walls of the house had been hung round with a double folding of canvass, and were well banked up with snow on the outside; nevertheless, it was necessary to introduce the stove into the same room with the clocks to effect so great a difference of temperature, and even to place it not far distant from them. It will readily be imagined that a forced temperature of such amount, and under such circumstances, must have been liable to incessant fluctuation and uncertainty, as indeed it was. The thermometers were suspended in the clock cases in such manner that their bulbs were on a level

with the bobs of the pendulums, and as near them as the extent of their arcs of vibration would admit: it is probable, therefore, that each thermometer was an index to the variations in temperature to which the principal part of its pendulum was subjected; but other thermometers, placed one or two feet higher in the clock cases, so far from corresponding, frequently differed many degrees from the lower one. Every gradation between the temperature of the external air and that of the stove, might be remarked at the same time by thermometers placed in different parts of the room; nor was it possible to provide against effects which changed with the situation of the sun and the direction of the wind. The thermometer was registered frequently in the hour, but the result was necessarily very unsatisfactory. Moreover, in consequence of the introduction of the stove into the room, the ground beneath the nearest legs of the stand were softened, and the levels affected, which might not have been the case could the room have been sufficiently heated by pipes.

The mean height of the thermometer in the air during the second fortnight in May was between 24° and 25°; it is probable that the registry of the temperature of the clocks became then an approximation to the truth; but this is by no means certain, as there was yet very much inequality between the heat of the days and of the nights, the latter being still very cold; but the effects of the heat acquired by the land were now becoming manifest every where, and advancing with great rapidity.

It was soon found impracticable to keep the levels in any thing like adjustment; and by the end of the fortnight, the thaw prevailed to such an extent as to oblige the aban-

donment of the house, before any satisfactory conclusions had been obtained.

Towards the middle of June, the land was tolerably clear of snow in the neighbourhood of the harbour; the mean temperature of the air had become but little less than that at which it was desired to carry on the experiments; and the range of the thermometers in the course of the twenty-four hours had greatly diminished. An elevated and dry spot was now chosen, and the earth being removed for nearly two feet in depth (it having thawed above one foot), a foundation for the stands was made with as large stones as could be brought for the purpose, filled in with sand; the clocks were then set up, and protected by a marquee, pitched, as at Hare Island, within a laboratory tent, a stove being placed at the door of the marquee with pipes leading through the tent.

The clocks were going on the 18th of June; but a heavy gale of wind continuing through the two following days, forced the pegs and other fastenings of the tent on the weather side (it being bad holding ground), and bore it down on the marquee, until relief was sent from the Hecla, when the tent was permanently secured by ice anchors. Whilst the marquee sustained the weight of the tent, the inner walls were unavoidably pressed in several places against the clocks and stands, which were shaken thereby; one of the clocks was also stopped for the purpose of putting its pendulum in safety. This difficulty being passed, no other interruption took place to the success of the experiments. The foundation subsided a little at first, but soon became sufficiently firm and steady; a fire was generally required in the stove at night, but only occasionally during the day, the tem-

perature being very regular and satisfactory; a thermometer suspended in the marquee on a level with the dial plates of the clocks, rarely differing more than one or two degrees at farthest from those within the cases.

In the following tables, [A. B. C.] an account is given of the going of the clocks from the 20th of June to the 14th of July, when it was conceived that a sufficient number of results had been obtained, exclusive of those before the foundation had settled, which are omitted.

The times of transit were noted by a very steady going chronometer, No. 259 of Messrs. PARKINSON and FRODSHAM. The distance being small between the tent and the observatory, the chronometer could be carried from one to the other, without inconvenience, as often as was required, by which means the comparison of intermediate watches was avoided.

The mark to which the transit instrument was adjusted previously to every observation, was about three hundred yards distant, being as far as could be distinctly seen at all times; other marks were fixed in the prolongation of the same line at distances of one and a half, and three miles, by which the position of the first was occasionally verified.

The clocks were compared with No. 259,

1st. At every revolution of twelve hours by the chronometer, the daily rate of which was less than two seconds; the time of comparison was, whenever No. 259 showed seven hours, or more precisely of clock 1, one minute before, and of clock 2, one minute after seven hours; the sun's transit hav-

1820	Chronometer.					Clock No. 1.								
	Obsd. Times of Transits.	Mean Time of Appar. Noon.	259 Fast of Mean Time.	Interval.	259's Gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temperature.	Corrections. for Arc.	Corrections. for Temperature.	Vibrations in Solar day, Ten
	h. m. s.	h. m. s.	h. m. s.	days	s.	m. s.	s.	s.	s.	°	°	s.	s.	
June 25	6.37.22,81	0.02.15,25	6.35.07,56			19.00,5						+		
				1	0,78		54,5	55,28	55,28	1.496	46,16	3,684	+0,51	86459,474
26	6.37.36,05	0.02.27,71	6.35.08,34			19 55								
				4	4,64		218,2	222,84	55,71	1.497	45,59	3,689	+0,257	86459,656
30	6.38.28,88	0.03.15,9	6.35.12,98			23.33,2								
				2	2,31		108,8	111,11	55,555	1.5	46,16	3,704	+0,51	86459,769
July 2	6.38.54,13	0.03.38,84	6.35.15,29			25.22								
				2	3,03		108,5	111,53	55,765	1.493	45,69	3,669	+0,301	86459,735
4	6.39.19,11	0.04.00,79	6.35.18,32			27.10,5								
				1	2,01		54,2	56,21	56,21	1.505	45,34	3,728	+0,15	86460,088
5	6.39.31,63	0.04.11,3	6.35.20,33			28.04,7								
				1	1,83		54,4	56,23	56,23	1.533	47,09	3,868	+0,919	86461,017
6	6.39.43,64	0.04.21,48	6.35.22,16			28.59,1								
				1	1,44		54,4	55,84	55,84	1.497	45,336	3,689	+0,148	86459,677
7	6.39.54,88	0.04.31,28	6.35.23,6			29.53,5								
				1	1,26		54,1	55,36	55,36	1.522	47,044	3,813	+0,899	86460,072
8	6.40.05,67	0.04.40,81	6.35.24,86			30.47,6								
				2	2,48		108,3	110,78	55,39	1.5	46,31	3,704	+0,576	86459,67
10	6.40.25,95	0.04.58,61	6.35.27,34			32.35,9								
				1	1,58		55,3	56,88	56,88	1.43	44,57	3,366	—0,188	86460,058
11	6.40.35,78	0.05.06,86	6.35.28,92			33.31,2								
				3	5,26		162,8	168,06	56,02	1.484	46,33	3,625	+0,585	86460,23
14	6.41.02,91	0.05.28,73	6.35.34,18			36.14								

Barom. mean height 29,864 inches.

Table A, *to face p.* 185.

brations in a mean lar day, Temp. 45°,		Clock No. 2.									
		Fast of 259.	Gain.			Mean Arc.	Mean Temperature.	Corrections.		Vibrations in a mean solar day, Temp. 45°.	
			on 259.	on Time.	per diem.			for Arc.	for Temperature.		
		m. s.	s.	s.	s.	°	°	s. +	s.		
459,474		58.01,2									
459,656			635,5	640,14	160,035	1.68	45,76	4,651	+0,332	86565,018	
459,769		68.36,7	317,8	320,11	160,055	1.6735	46,37	4,615	+0,603	86565,273	
459,735		73.54,5	317	320,03	160,015	1.662	45,94	4,552	+0,409	86564,976	
460,088		79.11,5	158,7	160,71	160,71	1.66	45,76	4,541	+0,332	86565,583	
461,017	86459,897, or corrected for buoyancy 86466,273.	81.50,2	159	160,83	160,83	1.666	47,7	4,574	+1,186	86566,59	86565,3, or corrected for buoyancy 86571,683.
459,677		84.29,2	158,8	160,24	160,24	1.672	45,81	4,607	+0,353	86565,2	
460,072		87.08	158	159,26	159,26	1.666	47,584	4,574	+1,135	86564,969	
459,67		89.46	317	319,48	159,74	1.672	47	4,607	+0,88	86565,227	
460,058		95.03	159,4	160,98	160,98	1.673	45,2	4,613	+0,088	86565,681	
460,23		97.42,4	474,6	479,86	159,953	1.674	47	4,618	+0,88	86565,451	
		105.37									

By Transits of the Sun, North of the Zenith; Baron

1820	Chronometer.					Clock No. 1.								
	Observ. Times of Transits.	Mean Time of App. Midnight.	259 fast of mean time.	Interval.	259's gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean temp.	Corrections. for Arc.	Corrections. for Temp.	Vibratic so Temp.
	h. m .	h. m. s.	h. m. s.	days.	s.	m. s.	s.	s.	s.	°	°	s. +	s. +	
June 25	18.37.29,49	12.02.21,49	6.35.08			19.27,4								
				3	2,4		165,6	168,	56,	1,482	45,24	3,615	0,1	86459,7
28	18.38.08,57	12.02.58,17	6.35.10,4			22.13								
				6	8,62		325	333,62	55,603	1,507	45,84	3,738	0,366	86459,7
July 4	18.39.25	12.04.05,98	6.35.19,2			27.38								
				1	1,72		53,2	54,92	54,92	1,533	47,41	3,868	1,06	86459,8
5	18.39.37,08	12.04.16,34	6.35.20,74			28.31,2								
				4	6,42		217,8	224.22	56,055	1,506	46,14	3,733	0,486	86460,2
9	18.40.21,38	12.04.54,22	6.35.27,16			32.09								
				4	6,33		218,7	225,03	56,258	1,46	45,42	3,509	0,184	86459,9
13	18.40.59,18	12.05.25,29	6.35.33,49			35.47,7								
				1	2,07		52,3	54,37	54,37	1,56	51,23	4,006	2,721	86461,6
14	18.41.07,55	12.05.31,99	6.35.35,56			36.40								

By Transits of Capella, North of the Zenith; Baro

	Chronometer.					Clock No. 1.								
	Observ. Times of Transits.	Difference.	Interval.	Differ. between m. solar & sid. days.	259's gain.	Fast of 259.	Gain. on 259.	Gain. on sid. time.	Gain. per diem. Sidereal	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in solar da Temp. 45 d
	h. m. s.	m. s.	days.	m. s.	s.	m. s.	s.	s.	s.	s.	°	°	s. +	s. +	
June 28	17.09.38,37					22.09,4									
		27.20,07	7	27.31,37	11,3		377,1	388,4	55,486	55,638	1.51	46,074	3.753	0,472	86459,863
July 5	16.42.18,3					28.26,5									
		11.42,58	3	11.47,73	5,15		162	167,15	55,717	55,87	1.52	46,8	3.803	0,789	86460,462
8	16.30.35,72					31.08,5									
		23.27,14	6	23.35,46	8,32		325,2	333,52	55,587	55,738	1.48	46,15	3.606	0,506	86459,85
14	16.07.08,58					36.33,7									

Barom. mean height 29,864 inches.

Table B, *to face p.* 185.

Vibrations in a mean solar day, Temp. 45 degrees.		Clock No. 2. Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day, Temp. 45 degrees.	
		m. s.	s.	s.	s.	°	°	s. +	s. +		
86459,715	86459,96, or corrected for buoyancy 86466,336.	56.41,8									
			477,9	480,3	160,1	1.674	45,25	4,618	0,11	86564,828	86565,294, or corrected for buoyancy 86571,677.
86459,707		64.39,7									
			951,8	960,42	160,07	1.672	46,11	4,607	0,488	86565,165	
86459,848		80.31,5									
			158	159,72	159,72	1.665	47,73	4,569	1,199	86565,488	
86460,274		83.09,5									
			634	640,42	160,105	1.67	46,72	4,596	0,755	86565,456	
86459,981		93.43,5									
			636	642,33	160,583	1,674	46,03	4,618	0,453	86565,654	
86461,097		104.19,5									
			155,5	157,57	157,57	1.681	51,77	4,657	2,956	86565,183	
		106.55									

Barom. mean height 29,864 inches.

Vibrations in a mean solar day, Temp. 45 degrees.		Clock No. 2. Fast of 259.	Gain. on 259.	Gain. on sid. time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day, Temp. 45 degrees.	
		m. s.	s.	s.	s.	s.	°	°	s. +	s. +		
459,863	86459,971, or cor. for buoyancy 86466,346.	64.29										
			1106,5	1117,8	159,686	160,123	1,67	46,34	4,596	0,589	86565,308	86565,338, or cor. for buoyancy 86571,721.
460,462		82.55,5										
			473,5	478,65	159,55	159,987	1,67	47,32	4,596	1,02	86565,603	
459,85		90.49										
			948,2	956,52	159,42	159,857	1,674	46,75	4,618	0,77	86565,245	
		106.37,2										

By Transits of Arcturus, South of the Zenith ; I

Chronometer.						Clock, No. 1.									
1820.	Observ. Times of Transits.	Difference.	Interval.	Diff. between mean solar and Sid. days.	259's Gain.	Fast of 259.	Gain.				Mean arc.	Mean temp.	Corrections.		Vibr
							on 259.	on Time.	per diem. Sidereal.	per diem. Solar.			for Arc.	for Temp.	Te
	h. m. s.	m. s.	days.	m. s.	s.	m. s.	s.	s.	s.	s.	°	°	s.	s.	
June 26	14.22.04,36					20.11							+		
		7.50,26	2	7.51,82	1,56		111,	112,56	56,28	56,434	1.4625	44,5	3,521	—0,218	8645
28	14.14.14,1					22.03									
		19.32,73	5	19.39,55	6,82		268,6	275,42	55,084	55,235	1.512	46,29	3,763	+0,567	8645
July 3	13.54.41,37					26.31,6									
		7.48,67	2	7.51,82	3,15		108,4	111,55	55,775	55,928	1.503	45,443	3,718	+0,193	8645
5	13.46.52,7					28.20									
		3.54,61	1	3.55,91	1,3		54,5	55,8	55,8	55,953	1.533	46,664	3,868	+0,73	8646
6	13.42.58,09					29.14,5									
		7.48,99	2	7,51,82	2,83		107,9	110,73	55,365	55,517	1.515	46,83	3,778	+0,802	8646
8	13.35.09,					31.02,4									
		15.38,03	4	15.43,64	5,61		219,1	224,71	56,178	56,332	1.463	45,1	3,523	+0,044	8645
12	13.19.31,07					34.41,5									
		7.47,64	2	7.51,82	4,18		106,	110,18	55,09	55,241	1.512	48,18	3,763	+1,399	8646
14	13.11.43,43					36.27,5									

By Transits of α Lyræ, South of the Zenith ;

July 5	18.09.32,93					28.30							+		
		11.42,43	3	11.47,73	5,3		161,5	166,8	55,6	55,753	1.52	46,74	3,803	+0,763	8646
8	17.57.50,5					31.11,5									
		3.54,72	1	3.55,91	1,19		55,6	56,79	56,79	56,946	1.48	44,66	3,606	—0,149	8646
9	17.53.55,78					32.07,1									
		15.38,73	4	15.43,64	4,91		217,9	222,81	55,703	55,856	1.459	45,35	3,505	+0,154	8645
13	17.38.17,05					35.45									
		3.54,02	1	3.55,91	1,89		52,2	54,09	54,09	54,243	1.56	51,05	4,006	+2,642	8646
14	17.34.23,38					36.37,2									

By Transits of α Aquilæ, South of the Zenith; B

July 5	19 20.31,17					28.32,2							+	+	
		11.42,52	3	11.47,73	5,21		162,3	167,51	55,837	55,99	1.515	46,67	3,778	0,733	8646
8	19.08.48,65					31.14,5									
		7.49,8	2	7.51,82	2,02		109,6	111,62	55,81	55,963	1.487	45,2	3,64	0,088	8645
10	19.00.58,85					33.04,1									

nith ; Barom. mean height 29,864 inches.

Table C, *to face p.* 185.

	Vibrations in a mean solar day. Temp. 45 degrees.		Clock, No. 2.											
			Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean arc.	Mean Temp.	Corrections. for arc.	Corrections. for Temp.	Vibrations in a mean solar day. Temp. 45 degrees.	
			m. s.	s.	s.	s.	s.	o	o	s. +	s.		
			58.51										
218	86459,737	86459,896 or corrected for the buoyancy of the atmosphere. 86466,272.		318,8	320,36	160,18	160,62	1.676	44,7	4,63	—0,132	86565,118	86565,268 or corrected for the buoyancy of the atmosphere. 86571,651.
			64.09,8										
567	86459,565			789,7	796,52	159,304	159,738	1.678	46,49	4,64	+0,654	86565,032	
			77.19,5										
193	86459,839			316,3	319,45	159,725	160,162	1.658	45,79	4,53	+0,345	86565,037	
			82.35,8										
73	86460,551			158,7	160,	160,	160,438	1.67	47,244	4,596	+0,987	86566,021	
			85.14,5										
802	86460,097			315,5	318,33	159,165	159,601	1.67	47,38	4,596	+1,047	86564,244	
			90.30										
044	86459,899			634,5	640,11	160,062	160,5	1.68	45,77	4,651	+0,337	86565,488	
			101.04,5										
399	86460,403			313,5	317,68	158,84	159,275	1.674	48,72	4,618	+1,635	86565,528	
			106.18										

enith ; Barom. mean height 29,90 inches.

			83.05							+	+		
763	86460,319	86460,032 or corrected for buoyancy 86466,462.		473,5	478,8	159,6	160,037	1.67	47,26	4,596	0,994	86565,627	86565,344 or corrected for buoyancy, 86571,783.
			90.58,5										
149	86460,403			159	160,19	160,19	160,63	1.67	45,283	4,596	0,126	86565,352	
			93.37,5										
154	86459,515			633,5	638,41	159,602	160,039	1.674	45,97	4,618	0,422	86565,079	
			104.11										
642	86460,89			155,7	157,59	157,59	158,022	1.681	51,56	4,657	2,864	86565,543	
			106.46,7										

iith; Barom. mean height 29,935 inches.

+			83.12,8							+	+		
733	86460,501	86460,177 or corrected 86466,568		473,8	479,1	159,7	160,137	1.67	47,26	4,596	0,994	86565,727	86565,555 or corrected 86571,953
			91.06,6										
088	86459,691			317,9	319,92	159,96	160,397	1.672	45,68	4,607	0,297	86565,301	
			96.24,5										

ing preceded the comparison within half an hour. The rate of 259 on mean time from one noon transit to the next, and from one midnight transit to the next, being added (as the rate was always gaining) to the gain of each clock on 259 in the corresponding interval, showed the gain of the clocks respectively on mean time, as deduced from transits of the sun.

2nd. Clock 1 was compared at nine minutes, and clock 2 at eleven minutes, after a star had been observed to pass the middle wire of the transit; the gain of 259 between the transits of the star being applied, as before, to the gain of the clocks on the chronometer, their rates were obtained in the intervals of sidereal time.

The temperatures were registered every hour, and the arcs of vibration every third hour: the temperatures were occasionally noted by the serjeant of artillery, the arcs always by myself.

The results in one view of the Tables A. B. and C. are as follow;

By Transits of	Vibrations per diem.	
	Clock 1.	Clock 2.
The Sun, S. of the Zen. mean of 18 days	86466,273	86571,683
The Sun, N. of the Zen. mean of 19 days	86466,336	86571,677
Capella, N. of the Zen. mean of 16 days	86466,346	86571,721
α Lyræ, S. of the Zen. mean of 9 days	86466,462	86571,783
α Aquilæ, S. of the Zen. mean of 5 days	86466,568	86571,953
Arcturus, S. of the Zen. mean of 18 days	86466,272	86571,651

Each result being given a value proportioned to the number of days of which it is the average, the means are obtained of clock No. 1, 86466,338 vibrations, and of clock No 2, 86571,7165 vibrations per diem.

The elevation of the clocks above the sea was ascertained

by a theodolite, the telescope of which being placed on a level with the pendulums, and adjusted horizontally, the height on the ship's mast cut by the middle wire was carefully noted: this height was thirty-four feet six inches above the low water mark on a graduated tide pole, which was moored to the bottom near the ship. The measurement was repeated with the magnetic transit instrument, and gave precisely the same result. The distance between the station and the ship being about seven hundred yards, the true height may be considered thirty-four feet, the six inches being omitted in compensation of the distance. The corrections due to this elevation are for clock 1, +0,1413, and for clock 2, +0,1415, making the final results 86466,4793 and 86571,858 vibrations in a mean solar day, in *vacuo*, at the level of the sea; the temperature being 45°.

It has been noticed, that previous to the embarkation of the clocks on the voyage, they had gone for a few days in London with the pendulums interchanged, with a view to ascertain the comparative influence of the maintaining power of the clocks, on the number of vibrations made by each pendulum.

The preceding observations having been concluded at Melville Island on the 14th of July, at which time there appeared no immediate prospect of putting to sea as no water was yet visible, a second series was commenced with the pendulums placed in the clocks marked differently from themselves; the ships did not quit the harbour until the 1st of August, which afforded sufficient time for the completion of this series also; and thus four results were obtained, instead of two, towards the deduction of the acceleration of the pendulum at Melville Island.

1820.	Chronometer.					Pendulum 2, in Clock 1.								Barom. mean height, 29,6
	Observ. Times of Transit.	Mean Time of App. Noon.	259 fast of mean time.	Interval.	259's gain.	Fast of 259.	Gain. on 259.	Gain. on Time	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temperature.	Vibratic da
	h. m. s.	h. m. s.	h. m. s.	days.	s.	m. s.	s.	s.	s.	°	°	s.	s.	
July 17	6.41.22,92	0.05.46,17	6.35.36,75			10.20,3						+		
				1	1,89		208,7	210,59	210,59	0,92	50,025	1.396	+2,189	86614,
18	6.41.29,55	0.05.50,91	6.35.38,64			13.49								
				1	0,61		211,7	213,31	213,31	0,86	45,1	1.22	+0,04	86613,
19	6.41.34,38	0.05.55,13	6.35.39.25			17.20,7								
							212,2	212,99	212,99	0,894	44,97	1.318	—0,013	86614,
20	—	—	—	2	1,59	20.52,9								
							212,1	212,9	212,9	0,9	44,9	1.336	—0,04	86614,
21	6.41.42,6	0.06.01, 6	6.35.40,84			24.25								
				1	1,21		210,5	211,71	211,71	0,939	46,9	1.454	+0,832	86613,
22	6.41.46,22	0.06.04,17	6.35.42,05			27.55,5								
							211,	212,12	212,12	0,899	44,63	1.333	—0,162	86613,
23	—	—	—	2	2,2	31.26,5								
							211,5	212,63	212,63	0,872	44,44	1.254	—0,244	86613,
24	6.41.51,64	0.06.07,34	6.35.44,3			34.58								
				1	1,34		210,9	212,24	212,24	0,95	47,63	1.488	+1,155	86614,
25	6.41.53,59	0.06.07,95	6.35.45,64			38.28,9								
							210	210,97	210,97	0,91	48,21	1.366	+1,41	86613,
26	—	—	—			41.58,9								
				3	2,92		211,6	212,57	212,57	0,82	44,7	1.109	—0,13	86613,
27	—	—	—			45.30,5								
							210,8	211,78	211,78	0,88	44,	1.277	—0,44	86612,
28	6.41.54,96	0.06.06,4	6.35.48,56			49.01,3								
				1	2,04		210,2	212,24	212,24	0,9	45,15	1.336	+0,066	86613,
29	6.41.55,35	0.06.04.75	6.35.50,6			52.31,5								
				1	1,98		213	214,98	214,98	0,79	43,54	1.029	—0,64	86615,
30	6.41.55	0.06.02,42	6.35.52,58			56.04,5								
				1	1,74		211,3	213,04	213,04	0,915	44,9	1.381	—0,04	86614,
31	6.41.54	0.05.59,68	6.35.54,32			59.35,8								

outh of the Zenith.

Table A, *to face p.* 186.

ght, 29,653 inches.			Pendulum 1, in Clock 2.				Barom. mean height, 29,76 inches.				
pe-	Vibrations in a mean Solar day, Temp. 45°		Fast of 259.	Gain on 259.	Gain on Time.	Gain per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp. 45°
			m. s.	s.	s.	s.	°	°	s. +	s.	
9	86614,175	86613,953, or corrected for the buoyancy of the atmosphere, 86620,293.	4.52,3	47,9	49,79	49,79	1,71	49,59	4,813	+2,007	86456,61 — 86456,222, or corrected for buoyancy, 86462,583.
	86613,57		5.40,2	50,1	50,71	50,71	1,698	44,48	4,746	—0,22	86455,236
3	86614,295		6.30,3	50,5	51,29	51,29	1,71	43,	4,813	—0,88	86455,223
	86614,196		7.20,8	50,5	51,3	51,3	1,669	44,62	4,585	—0,167	86455,718
2	86613,996		8.11,3	52,2	53,41	53,41	1,332	47.	2,92	+0,88	86457,21
2	86613,291		9.03,5	52,5	53,62	53,62	1,56	43,86	4,006	—0,5	86457,126
4	86613,64		9.56.	51,7	52,83	52,83	1,564	44,03	4,026	—0,422	86456,434
5	86614,883		10.47,7								
	86613,746										
	86613,549										
	86612,617										
3	86613,642										
	86615,368										
	86614,381										

By Transits of the Sun, North of the Ze

1820.	Chronometer.					Pendulum 1, in Clock 2.							
	Observ. Times of Transit.	Mean Time of App. Midnight.	259 fast of Mean Time.	Interval.	259's Gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temp.	Corre for Arc.
	h. m. s.	h. m. s.	h. m. s.	days.	s.	m. s	s.	s.	s.	°	°	s.
July 17	18.41.27,36	12.05.48,64	6.35,38,72			5.15,7						
				7	7		354,8	361,8	51.686	1.592	45.04	+4,172
24	18.41.53,44	12.06.07,72	6.35.45,75			11.10,5						

By Transits of Stars South of the Zen

1820.	Chronometer.					Pendulum 1, in Clock 2.								
	Observ. Times of Transit.	Difference.	Interval.	Diff. between Solar & Sidereal days.	259's Gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp
	Arcturus.					m. s.								
July 17	12.59.58	m. s.	days.	m. s.	s.	5.04,5	s.	s.	s.	s.	°	°	s.	s.
		3.54,55	1	3.55,91	1,36		49	50,36	50,36	50,498	1.71	47.72	+4,813	+1,18
18	12.56.03,45					5.53,5								
		23.28,95	6	23.35,46	6,51		305,5	312,01	52,001	52,144	1.588	44,8	+4,151	—0,08
24	12.32.34,5					10.59								
		3.55,08	1	3.55,91	0,83									
25	12.28.38,92													
	α. Lyræ.													
17	17.22.39,02					5.13,1								
		3.54,37	1	3.55,91	1,54		49,1	50,64	50,64	50,778	1.707	45,83	+4,796	+0,36
18	17.18.44,65					6.02,2								
		23,30,2	6	23.35,46	5,26		304,8	310,06	51,677	51,818	1.587	44,81	+4,146	—0,08
24	16.45.14,48					11.07								
		7.49,6	2	7.51,81	2,21									
26	16.47.24,85													
	α. Aquilæ.													
17	18.33.37,08					5.15,7								
		3.54.05	1	3.55,91	1,86		48,6	50,46	50,46	50,598	1.707	45,54	+4,796	+0,23
18	18.29.43,03					6.04,3								
		23.29,83	6	23.35,46	5,63		304,8	310,43	51,738	51,88	1.587	44,81	+4,146	—0,08
24	18.06.13,2					11.09,1								
		7.49,38	2	7.51,81	2,03									
26	17.58.23,42													

the Zenith. Barom. mean height 29,76 inches.

Table B, *to face p.* 186.

Clock 2.			Pendulum 2, in Clock 1								
Corrections.		Vibrations in a mean Solar day, Temp. 45°.	Fast of 259.	Gain.			Mean Arc.	Mean Temp.	Corrections.		Vibrations in a mean Solar day, Temp. 45°.
for Arc.	for Temp.			on 259.	on Time.	per diem.			for Arc.	for Temp.	
s.	s.		m. s.	s.	s.	s.	°	°	s.	s.	
+4,172	+0,017	86455,875, or cor. for buoyancy 86462,236.	12.00,5 36.42,7	1482,2	1489,2	212,743	0,895	45,4	+1.321	+0,175	86614,239, or cor. for buoyancy, 86620,612.

he Zenith. Barom. mean height, 29,76 Inches.

rections.		Vibrations in a mean Solar day, Temp. 45°,		Pendulum 2, in Clock 1.										
	for Temp.			Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp.	
	s.			m. s.	s.	s.	s.	s.	°	°	s.	s.		
13	+1,186	86456,497	86456,249,	11.10,2	209,3	210,66	210,66	211,236	0,9	48,34	+1.336	+1.469	86614,041	86614.299.
51	—0,088	86456,207	86462,61.	14.39,5	1268,3	1274,81	212,47	213,051	0,892	45,17	+1.312	+0,075	86614,438	
				35.47,8	209,7	210,53	210,53	211,103	0,95	47,97	+1.488	+1,155	86613,746	
				39.17,5										
96	+0,362	86455,936	86455,889,	11.47,7	210,4	211,94	211,94	212,52	0,879	46,4	+1.274	+0,615	86614,409	86614.205.
46	—0,083	86455,881	86462,25.	15.18,1	1268,1	1273,36	212,227	212,807	0,897	45,24	+1.327	+0,105	86614,239	
				36.26,2	420	422,21	211,1	211,68	0,892	47,32	+1.312	+1,02	86614,012	
				43.26,2										
96	+0,235	86455,629	86455,898,	11.58,2	210,5	212,36	212,36	212,941	0,899	46,1	+1.274	+0,484	86614,699	86614.252.
46	—0,083	86455,943	86462,259.	15.28,7	1267,8	1273,43	212,238	212,819	0,897	45,28	+1.327	+0,123	86614,269	
				36.36,5	420,2	422,23	211,115	211,695	0,889	47,26	+1.303	+0,994	86613,992	
				43.36,7										

corrected for the buoyancy of the atmosphere,

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ions in a mean
ay, Temp. 45°.

041
438
746

86614,299,
or corrected for the buoyancy of the atmosphere,
86620,672.

409
239
012

86614,205,
86620,578.

699
269
992

86614,252.
86620,625.

From the Tables A. and B. are derived the following results.

By Transits of	Vibrations per diem.	
	Pendulum 1, in Clock 2.	Pendulum 2, in Clock 1.
The Sun, S. of Zen.	Mean of 7 days, 86462,583	Mean of 14 days, 86620,293
The Sun, N. of Zen.	7 86462,236	7 86620,612
Arcturus -	7 86462,61	8 86620,672
α Lyræ -	7 86462,25	9 86620,578
α Aquilæ -	7 86462,259	9 86620,625

Each result being given a value proportioned to the number of days of which it is the average, the mean results are of No. 1 pendulum 86462,3876, and of No. 2 pendulum 86620,523 vibrations; by adding to these numbers the corrections due to the elevation above the sea, being +0,1413 to No. 1, and +0,1416 to No. 2, a final result is obtained; that No. 1 Pendulum vibrating in Clock No. 2 at Melville Island would make 86462,5289 vibrations, and No. 2 Pendulum in Clock No. 1, 86620,6646 vibrations, in a mean solar day, *in vacuo*, at the level of the sea, the temperature being 45°.

The latitude of the spot where the preceding observations were made was 74° 47′ 12,4″, deduced by a mean of 39 meridian altitudes of the sun, observed by Captain PARRY and Mr. BEECHEY, with reflecting circles and sextants with an artificial horizon; the results have been re-computed since the return of the Expedition, using the table of atmospherical refractions, published by Dr. YOUNG in the Nautical Almanack of 1822; the elements of these observations are given in the Appendix to the Narrative of the Voyage, pages lxxxviii and lxxxix.

Results of the preceding operations.

It remains to recapitulate the results which have been detailed, and to state the deductions thereupon.

The acceleration of the pendulum between the stations visited in the first voyage has been already mentioned, viz.

33,107 vibrations between London and Brassa;

32,1316 vibrations between Brassa and Hare Island;

And 65,2386 vibrations between London and Hare Island;

The following Table presents in one view, the results of the four series of observations, by which the acceleration between London and Melville Island has been determined.

		Vibrations.		Acceleration.		
		London.	Melville Island			
Clock 1,	Pendulum 1,	86392,4513	86466,4793	74.028	74.8151	74,734
	Pendulum 2,	86545,0623	86620,6646	75.6023		
Clock 2,	Pendulum 1,	86388,0967	86462,5289	74.4332	74,6529	
	Pendulum 2,	86496,9855	86571,858	74,8725		

It should be remarked, that in the earliest trial which was made of the clocks, No. 2 was considered to be deserving of preference, from its greater precision of beat, occasioned probably in part by the crutch of No. 1 being rather larger than the diameter of the pendulum rods; the above results seem to justify the preference, as the acceleration produced by each of the pendulums vibrating in No. 2, corresponds better than their results when vibrating in No. 1. It will be seen, however, that a mean of the results of either clock separately,

coincides within a tenth of a vibration, with the mean result in the foregoing table.

Assuming then the length of the pendulum vibrating seconds in the latitude of London, viz. 51° 31′ 08,4″ at 39,13929 inches, which has been determined by Captain KATER, the following Table presents its length at each of the stations at which the clocks have been set up, deduced from the observations which have been detailed.

Place of Observation.	Latitude.	Length of the pendulum vibrating seconds.
	° ′ ″	Inches.
London	51.31.08,4 N.	39.13929
Brassa	60.09.42	39.16929
Hare Island	70.26.17	39.1984
Melville Island	74.47.12,4	39.207

Deductions as to the Figure of the Earth.

The following Table contains the diminution of gravity from the Pole to the Equator, and the resulting ellipticity of the earth deduced from the preceding observations.

The method which has been followed in obtaining these deductions, is the same which has been described by Captain KATER in the Philosophical Transactions for 1819, p. 420, and 421.

	Diminution of Gravity.	Ellipticity.
London and Brassa	·0055066	$\frac{1}{314,3}$
London and Hare Island	·0055082	$\frac{1}{314,2}$
Brassa and Hare Island	·0055139	$\frac{1}{313,6}$
London and Melville Island	·0055258	$\frac{1}{312,6}$

In concluding the account of these experiments, it is proper that I should notice, that their success is in great measure to be attributed to Mr. BROWNE and to Captain KATER: to Captain KATER for his care and judgment in preparing the instruments, and to Mr. BROWNE for permitting the clocks to be set up in his house in London, and for the advantage of comparison with his excellent timepieces.

I would also avail myself of this occasion, to express my personal obligations to those Gentlemen, for the opportunity which I have enjoyed of conducting these experiments; and for which I am sensible that I am chiefly indebted to the statement they were pleased to make, of my competency to fulfil the purposes which the Society had in view.

By Transits of the Sun, South of the Zenith; Barom. mean height 29,864 inches.

Table A, *to face p.* 185.

1820	Chronometer. Obsd. Times of Transits.	Mean Time of Appar. Noon.	259 Fast of Mean Time.	Interval.	259's Gain.	Clock No. 1. Fast of 259.	Gain. on 259.	on Time.	per diem.	Mean Arc.	Mean Temperature.	Corrections. for Arc.	for Temperature.	Vibrations in a mean Solar day, Temp. 45°.	
	h. m. s.	h. m. s.	h. m. s.	days	s.	m. s.	s.	s.	s.	°	°	s. +	s.		
June 25	6.37.22,81	0.02.15,25	6.35.07,56			19.00,5									
				1	0,78		54,5	55,28	55,28	1.496	46,16	3,684	+0,51	86459,474	86459,897, or corrected for buoyancy 86466,273.
26	6.37.36,05	0.02.27,71	6.35.08,34			19 55									
				4	4,64		218,2	222,84	55,71	1.497	45,59	3,689	+0,257	86459,656	
30	6.38.28,88	0,03.15,9	6.35.12,98			23.33,2									
				2	2,31		108,8	111,11	55,555	1.5	46,16	3,704	+0,51	86459,769	
July 2	6.38.54,13	0.03.38,84	6.35.15,29			25.22									
				2	3,03		108,5	111,53	55,765	1.493	45,69	3,669	+0,301	86459,735	
4	6.39.19,11	0.04.00,79	6.35.18,32			27.10,5									
				1	2,01		54,2	56,21	56,21	1.505	45,34	3,728	+0,15	86460,088	
5	6.39.31,63	0.04.11,3	6.35.20,33			28.04,7									
				1	1,83		54,4	56,23	56,23	1.533	47,09	3,868	+0,919	86461,017	
6	6.39.43,64	0.04.21,48	6.35.22,16			28.59,1									
				1	1,44		54,4	55,84	55,84	1.497	45,336	3,689	+0,148	86459,677	
7	6.39.54,88	0.04.31,28	6.35.23,6			29.53,5									
				1	1,26		54,1	55,36	55,36	1.522	47,044	3,813	+0,899	86460,072	
8	6.40.05,67	0.04.40,81	6 35.24,86			30.47,6									
				2	2,48		108,3	110,78	55,39	1.5	46,31	3,704	+0,576	86459,67	
10	6.40.25,95	0.04.58,61	6.35.27,34			32.35,9									
				1	1,58		55,3	56,88	56,88	1.43	44,57	3,366	—0,188	86460,058	
11	6.40.35,78	0.05.06,86	6.35.28,92			33.31,2									
				3	5,26		162,8	168,06	56,02	1.484	46,33	3,625	+0,585	86460,23	
14	6.41.02,91	0.05.28,73	6.35.34,18			36.14									

Clock No. 2. Fast of 259.	Gain. on 259.	on Time.	per diem.	Mean Arc.	Mean Temperature.	Corrections. for Arc.	for Temperature.	Vibrations in a mean solar day, Temp. 45°.	
m. s.	s.	s.	s.	°	°	s. +	s.		
58.01,2									
	635,5	640,14	160,035	1.68	45,76	4,651	+0,332	86565,018	86565,3, or corrected for buoyancy 86571,683.
68.36,7									
	317,8	320,11	160,055	1.6735	46,37	4,615	+0,603	86565,273	
73.54,5									
	317	320,03	160,015	1.662	45,94	4,552	+0,409	86564,976	
79.11,5									
	158,7	160,71	160,71	1.66	45,76	4,541	+0,332	86565,583	
81.50,2									
	159	160,83	160,83	1.666	47,7	4,574	+1,186	86566,59	
84.29,2									
	158,8	160,24	160,24	1.672	45,81	4,607	+0,353	86565,2	
87.08									
	158	159,26	159,26	1.666	47,584	4,574	+1,135	86564,969	
89.46									
	317	319,48	159,74	1.672	47	4,607	+0,88	86565,227	
95.03									
	159,4	160,98	160,98	1.673	45,2	4,613	+0,088	86565,681	
97.42,4									
	474,6	479,86	159,953	1.674	47	4,618	+0,88	86565,451	
105.37									

By Transits of the Sun, North of the Zenith; Barom. mean height 29,864 inches.

Table B, *to face p.* 185.

1820	Chronometer. Observ. Times of Transits.	Mean Time of App. Midnight.	2ɔ fast of mean time.	Interval.	2ɔ's gain.	Clock No. 1. Fast of 2ɔ.	Gain. on 2ɔ.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day, Temp. 45 degrees.	Clock No. 2. Fast of 2ɔ.	Gain. on 2ɔ.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day, Temp. 45 degrees.
	h. m .	h. m. s.	h. m. s.	days.	s.	m. s.	s.	s.	s.	°	°	s. +	s. +		m. s.	s.	s.	s.	°	°	s. +	s. +	
June 25	18.37.29,49	12.02.21,49	6.35.08			19.27,4									56.41,8								
				3	2,4		165,6	168,	56,	1,482	45,24	3,615	0,1	86459,715		477,9	480,3	160,1	1.674	45,25	4,618	0,11	86564,828
28	18.38.08,57	12.02.58,17	6.35.10,4			22.13									64.39,7								
				6	8,62		325	333,62	55,603	1,507	45,84	3,738	0,366	86459,707		951,8	960,42	160,07	1.672	46,11	4,607	0,488	86565,165
July 4	18.39.25	12.04.05,98	6.35.19,2			27.38									80.31,5								
				1	1,72		53,2	54,92	54,92	1,533	47,41	3,868	1,06	86459,848		158	159,72	159,72	1.665	47,73	4,569	1,199	86565,488
5	18.39.37,08	12.04.16,34	6.35.20,74			28.31,2									83.09,5								
				4	6,42		217,8	224.22	56,055	1,506	46,14	3,733	0,486	86460,274		634	640,42	160,105	1.67	46,72	4,596	0,755	86565,456
9	18.40.21,38	12.04.54,22	6.35.27,16			32.09									93.43,5								
				4	6,33		218,7	225,03	56,258	1,46	45,42	3,509	0,184	86459,951		636	642,33	160,583	1,674	46,03	4,618	0,453	86565,654
13	18.40.59,18	12.05.25,29	6.35.33,49			35.47,7									104.19,5								
				1	2,07		52,3	54,37	54,37	1,56	51,23	4,006	2,721	86461,097		155,5	157,57	157,57	1.681	51,77	4,657	2,956	86565,183
14	18.41.07,55	12.05.31,99	6.35.35,56			36.40									106.55								

86459,96, or corrected for buoyancy 86466,336.

86565,294, or corrected for buoyancy 86571,677.

By Transits of Capella, North of the Zenith; Barom. mean height 29,864 inches.

	Chronometer. Observ. Times of Transits.	Difference.	Interval.	Differ. between m. solar & sid. days.	2ɔ's gain.	Clock No. 1. Fast of 2ɔ.	Gain. on 2ɔ.	Gain. on sid. time.	Gain. per diem. Sidereal	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day, Temp. 45 degrees.	Clock No. 2. Fast of 2ɔ.	Gain. on 2ɔ.	Gain. on sid. time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day, Temp. 45 degrees.
	h. m. s.	m. s.	days.	m. s.	s.	m. s.	s.	s.	s.	s.	°	°	s. +	s. +		m. s.	s.	s.	s.	s.	°	°	s. +	s. +	
June 28	17.09.38,37					22.09,4										64.29									
		27.20,07	7	27.31,37	11,3		377,1	388,4	55,486	55,638	1.51	46,074	3.753	0,472	86459,863		1106,5	1117,8	159,686	160,123	1,67	46,34	4,596	0,589	86565,308
July 5	16.42.18,3					28.26,5									86459,971 or cor. for buoyancy 86466,346.	82.55,5									86565,338, or cor. for buoyancy 86571,721.
		11.42,58	3	11.47,73	5,15		162	167,15	55,717	55,87	1.52	46,8	3.803	0,789	86460,462		473,5	478,65	159,55	159,987	1,67	47,32	4,596	1,02	86565,603
8	16.30.35,72					31.08,5										90.49									
		23.27,14	6	23.35,46	8,32		325,2	333,52	55,587	55,738	1.48	46,15	3.606	0,506	86459,85		948,2	956,52	159,42	159,857	1,674	46,75	4,618	0,77	86565,245
14	16.07.08,58					36.33,7										106.37,2									

By Transits of Arcturus, South of the Zenith ; Barom. mean height 29,864 inches.

Table C, *to face p.* 185.

Chronometer.						Clock, No. 1.									Clock, No. 2.									
1820.	Observ. Times of Transits.	Difference.	Interval.	Diff. between mean solar and Sid. days	259's Gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean arc.	Mean temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean solar day. Temp. 45 degrees.		Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean arc.	Mean Temp.	Corrections. for arc.	Corrections. for Temp.	Vibrations in a mean solar day. Temp. 45 degrees.	
	h. m. s.	m. s.	days.	m. s.	s.	m. s.	s.	s.	s.	s.	°	°	s.	s.			m. s.	s.	s.	s.	s.	°	°	s.	s.		
June 26	14.22.04,36					20.11							+				58.51							+			
		7.50,26	2	7.51,82	1,56		111,	112,56	56,28	56,434	1.4625	44,5	3,521	—0,218	86459,737	86459,896 or corrected for the buoyancy of the atmosphere. 86466,272.		318,8	320,36	160,18	160,62	1.676	44,7	4,63	—0,132	86565,118	86565,268 or corrected for the buoyancy of the atmosphere. 86571,651.
28	14.14.14,1					22.03											64.09,8										
		19.32,73	5	19.39,55	6,82		268,6	275,42	55,084	55,235	1.512	46,29	3,763	+0,567	86459,565			789,7	796,52	159,304	159,738	1.678	46,49	4,64	+0,654	86565,032	
July 3	13.54.41,37					26.31,6											77.19,5										
		7.48,67	2	7.51,82	3,15		108,4	111,55	55,775	55,928	1.503	45,443	3,718	+0,193	86459,839			316,3	319,45	159,725	160,162	1.658	45,79	4,53	+0,345	86565,037	
5	13.46.52,7					28.20											82.35,8										
		3.54,61	1	3.55,91	1,3		54,5	55,8	55,8	55,953	1.533	46,664	3,868	+0,73	86460,551			158,7	160,	160,	160,438	1.67	47,244	4,596	+0,987	86566,021	
6	13.42.58,09					29.14,5											85.14,5										
		7.48,99	2	7,51,82	2,83		107,9	110,73	55,365	55,517	1.515	46,83	3,778	+0,802	86460,097			315,5	318,33	159,165	159,601	1.67	47,38	4,596	+1,047	86564,244	
8	13.35.09,					31.02,4											90.30										
		15.38,03	4	15.43,64	5,61		219,1	224,71	56,178	56,332	1.463	45,1	3,523	+0,044	86459,899			634,5	640,11	160,062	160,5	1.68	45,77	4,651	+0,337	86565,488	
12	13.19.31,07					34.41,5											101.04,5										
		7.47,64	2	7.51,82	4,18		106,	110,18	55,09	55,241	1.512	48,18	3,763	+1,399	86460,403			313,5	317,68	158,84	159,275	1.674	48,72	4,618	+1,635	86565,528	
14	13.11.43,43					36.27,5											106.18										

By Transits of α Lyræ, South of the Zenith ; Barom. mean height 29,90 inches.

July 5	18.09.32,93					28.30							+				83.05							+	+		
		11.42,43	3	11.47,73	5,3		161,5	166,8	55,6	55,753	1.52	46,74	3,803	+0,763	86460,319	86460,032 or corrected for buoyancy 86466,462.		473,5	478,8	159,6	160,037	1.67	47,26	4,596	0,994	86565,627	86565,344 or corrected for buoyancy, 86571,783.
8	17.57.50,5					31.11,5											90.58,5										
		3.54,72	1	3.55,91	1,19		55,6	56,79	56,79	56,946	1.48	44,66	3,606	—0,149	86460,403			159	160,19	160,19	160,63	1.67	45,283	4,596	0,126	86565,352	
9	17.53.55,78					32.07,1											93.37,5										
		15.38,73	4	15.43,64	4,91		217,9	222,81	55,703	55,856	1.459	45,35	3,505	+0,154	86459,515			633,5	638,41	159,602	160,039	1.674	45,97	4,618	0,422	86565,079	
13	17.38.17,05					35.45											104.11										
		3.54,02	1	3.55,91	1,89		52,2	54,09	54,09	54,243	1.56	51,05	4,006	+2,642	86460,89			155,7	157,59	157,59	158,022	1.681	51,56	4,657	2,864	86565,543	
14	17.34.23,38					36.37,2											106.46,7										

By Transits of α Aquilæ, South of the Zenith; Barom. mean height 29,935 inches.

July 5	19 20.31,17					28.32,2							+	+			83.12,8							+	+		
		11.42,52	3	11.47,73	5,21		162,3	167,51	55,837	55,99	1.515	46,67	3,778	0,733	86460,501	86460,177 or corrected 86466,568		473,8	479,1	159,7	160,137	1.67	47,26	4,596	0,994	86565,727	86565,555 or corrected 86571,953
8	19.08.48,65					31.14,5											91.06,6										
		7.49,8	2	7.51,82	2,02		109,6	111,62	55,81	55,963	1.487	45,2	3,64	0,088	86459,691			317,9	319,92	159,96	160,397	1.672	45,68	4,607	0,297	86565,301	
10	19.00.58,85					33.04,1											96.24,5										

By Transits of the Sun, South of the Zenith.

Table A, *to face p.* 186.

1820.	Chronometer. Observ. Times of Transit.	Chronometer. Mean Time of App. Noon.	Chronometer. 259 fast of mean time.	Chronometer. Interval.	Chronometer. 259's gain.	Pendulum 2, in Clock 1. Barom. mean height, 29,653 inches. Fast of 259.	Gain. on 259.	Gain. on Time	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temperature.	Vibrations in a mean Solar day, Temp. 45°	Pendulum 1, in Clock 2. Barom. mean height, 29,76 inches. Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp. 45°
	h. m. s.	h. m. s.	h. m. s.	days.	s.	m. s.	s.	s.	s.	°	°	s.	s.		m. s.	s.	s.	s.	°	°	s.	s.	
July 17	6.41.22,92	0.05.46,17	6.35.36,75			10.20,3						+			4.52,3						+		
				1	1,89		208,7	210,59	210,59	0,92	50,025	1.396	+2,189	86614,175		47,9	49,79	49,79	1,71	49,59	4,813	+2,007	86456,61
18	6.41.29,55	0.05.50,91	6.35.38,64			13.49									5.40,2								
				1	0,61		211,7	213,31	213,31	0,86	45,1	1.22	+0,04	86613,57		50,1	50,71	50,71	1,698	44,48	4,746	—0,22	86455,236
19	6.41.34,38	0.05.55,13	6.35.39.25			17.20,7									6.30,3								
							212,2	212,99	212,99	0,894	44,97	1.318	—0,013	86614,295		50,5	51,29	51,29	1,71	43,	4,813	—0,88	86455,223
20	—	—	—	2	1,59	20.52,9									7.20,8								
							212,1	212,9	212,9	0,9	44,9	1.336	—0,04	86614,196		50,5	51,3	51,3	1,669	44,62	4,585	—0,167	86455,718
21	6.41.42,6	0.06.01, 6	6.35.40,84			24.25									8.11,3								
				1	1,21		210,5	211,71	211,71	0,939	46,9	1.454	+0,832	86613,996		52,2	53,41	53,41	1,332	47.	2,92	+0,88	86457,21
22	6.41.46,22	0.06.04,17	6.35.42,05			27.55,5									9.03,5								
							211,	212,12	212,12	0,899	44,63	1.333	—0,162	86613,291		52,5	53,62	53,62	1,56	43,86	4,006	—0,5	86457,126
23	—	—	—	2	2,2	31.26,5									9.56.								
							211,5	212,63	212,63	0,872	44,44	1.254	—0,244	86613,64		51,7	52,83	52,83	1,564	44,03	4,026	—0,422	86456,434
24	6.41.51,64	0.06.07,34	6.35.44,3			34.58									10.47,7								
				1	1,34		210,9	212,24	212,24	0,95	47,63	1.488	+1,155	86614,883									
25	6.41.53,59	0.06.07,95	6.35.45,64			38.28,9																	
							210	210,97	210,97	0,91	48,21	1.366	+1,41	86613,746									
26	—	—	—			41.58,9																	
				3	2,92		211,6	212,57	212,57	0,82	44,7	1.109	—0,13	86613,549									
27	—	—	—			45.30,5																	
							210,8	211,78	211,78	0,88	44,	1.277	—0,44	86612,617									
28	6.41.54,96	0.06.06,4	6.35.48,56			49.01,3																	
				1	2,04		210,2	212,24	212,24	0,9	45,15	1.336	+0,066	86613,642									
29	6.41.55,35	0.06.04.75	6.35.50,6			52.31,5																	
				1	1,98		213	214,98	214,98	0,79	43,54	1.029	—0,64	86615,368									
30	6.41.55	0.06.02,42	6.35.52,58			56.04,5																	
				1	1,74		211,3	213,04	213,04	0,915	44,9	1.381	—0,04	86614,381									
31	6.41.54	0.05.59,68	6.35.54,32			59.35,8																	

86613,953, or corrected for the buoyancy of the atmosphere, 86620,293.

86456,222, or corrected for buoyancy, 86462,583.

By Transits of the Sun, North of the Zenith. Barom. mean height 29,76 inches.

Table B, *to face p.* 186.

1820.	Chronometer.					Pendulum 1, in Clock 2.									Pendulum 2, in Clock 1								
	Observ. Times of Transit.	Mean Time of App. Midnight.	259 fast of Mean Time.	Interval.	259's Gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp. 45°.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp. 45°.
	h. m. s.	h. m. s.	h. m. s.	days.	s.	m. s	s.	s.	s.	°	°	s.	s.		m. s.	s.	s.	s.	°	°	s.	s.	
July 17	18.41.27,36	12.05.48,64	6.35,38,72			5.15,7									12.00,5								
				7	7		354,8	361,8	51.686	1.592	45.04	+4,172	+0,017	86455,875, or cor. for buoyancy 86462,236.		1482,2	1489,2	212,743	0,895	45,4	+1.321	+0,175	86614,239, or cor. for buoyancy, 86620,612.
24	18.41.53,44	12.06.07,72	6.35.45,75			11.10,5									36.42,7								

By Transits of Stars South of the Zenith. Barom. mean height, 29,76 Inches.

1820.	Chronometer.					Pendulum 1, in Clock 2.										Pendulum 2, in Clock 1.									
	Observ. Times of Transit.	Difference.	Interval.	Diff. between Solar & Sidereal days.	259's Gain.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp. 45°.	Fast of 259.	Gain. on 259.	Gain. on Time.	Gain. per diem. Sidereal.	Gain. per diem. Solar.	Mean Arc.	Mean Temp.	Corrections. for Arc.	Corrections. for Temp.	Vibrations in a mean Solar day, Temp. 45°.
	Arcturus.					m. s.										m. s.									
July 17	12.59.58	m. s.	days.	m. s.	s.	5.01,5	s.	s.	s.	s.	°	°	s.	s.		11.10,2	s.	s.	s.	s.	°	°	s.	s.	
		3.54,55	1	3.55,91	1,36		49	50,36	50,36	50,498	1.71	47.72	+4,813	+1,186	86456,497		209,3	210,66	210,66	211,236	0,9	48,34	+1.336	+1.469	86614,011
18	12.56.03,45					5.53,5									86456,249, 86462,61.	14.39,5									86614,299, 86620,672.
		23.28,95	6	23.35,46	6,51		305,5	312,01	52,001	52,144	1.588	44,8	+4,151	—0,088	86456,207		1268,3	1274,81	212,47	213,051	0,892	45,17	+1.312	+0,075	86614,438
24	12.32.34,5					10.59										35.47,8									
		3.55,08	1	3.55,91	0,83												209,7	210,53	210,53	211,103	0,95	47,97	+1.488	+1,155	86613,746
25	12.28.38,92															39.17,5									
	α. Lyræ.																								
17	17.22.39,02					5.13,1										11.47,7									
		3.54,37	1	3.55,91	1,54		49,1	50,64	50.64	50,778	1.707	45,83	+4,796	+0,362	86455,936		210,4	211,94	211,94	212,52	0,879	46,4	+1.274	+0,615	86614,409
18	17.18.44,65					6.02,2									86455,889, or corrected for the buoyancy of the atmosphere, 86462,25.	15.18,1									86614,205, 86614,239 86620,578.
		23,30,2	6	23.35,46	5,26		304,8	310,06	51,677	51,818	1.587	44,81	+4,146	—0,083	86455,881		1268,1	1273,36	212,227	212,407	0,897	45,24	+1.327	+0,105	86614,239
24	16.45.14,48					11.07										36.26,2									
		7.49,6	2	7.51,81	2,21												420	422,21	211,1	211,68	0,892	47,32	+1.312	+1,02	86614,012
26	16.47.24,85															43.26,2									
	α. Aquilæ.																								
17	18.33.37,08					5.15,7										11.58,2									
		3.54.05	1	3.55,91	1,86		48,6	50,46	50,46	50,598	1.707	45,54	+4,796	+0,235	86455,629		210,5	212,36	212,36	212,941	0,899	46,1	+1.274	+0,484	86614,699
18	18.29.43,03					6.04,3									86455,898, or corrected for the buoyancy of the atmosphere, 86462,259.	15.28,7									86614,252. or corrected for the buoyancy of the atmosphere, 86620,625.
		23.29,83	6	23.35,46	5,63		304,8	310,43	51,738	51,88	1.587	44,81	+4,146	—0,083	86455,943		1267,8	1273,43	212,238	212,819	0,897	45,28	+1.327	+0,123	86614.269
24	18.06.13,2					11.09,1										36.36,5									
		7.49,38	2	7.51,81	2,03												420,2	422,23	211,115	211,695	0,889	47,26	+1.303	+0,994	86613,992
26	17.58.23,42															43.36,7									