PHILOSOPHICAL TRANSACTIONS.

I. *Experiments to ascertain the ratio of the magnetic forces acting on a needle suspended horizontally, in Paris and in London.* *By Captain* EDWARD SABINE, *of the Royal Artillery, Secretary of the Royal Society.*

Read June 21, 1827.

THE magnetic needles employed in these experiments were cylinders of 0,16 inch diameter, and 2,4 inches in length, pointed at the ends: they were suspended by a single silk fibre of rather more than five inches in length. The box in which they were inclosed, as a protection from the weather, was of wood, having at the bottom a graduated circle in ivory, rather exceeding in diameter the length of the needles, and over the centre of which the silk fibre was suspended. The bottom of the box being rendered horizontal by means of foot screws, and shown to be so by an unattached spirit level, the zeros of the circle were placed in the direction of the magnetic meridian, and a needle was suspended in a horizontal position. Another needle was then employed to draw it 50 or 60 degrees from its natural direction; on the removal of which, the suspended needle resumed its direction in the ordinary process of vibration. The registry of the vibrations was commenced when the arc had diminished to 30°, and continued until it was reduced to below 5°: the method of registering the vibration will be best understood by a reference to the Tables at the close, and is too simple to require further explanation. The number of vibrations made by each needle between the arcs of 30° and 5° was usually from 300 to 400; and the time in which these were performed varied, in the different needles, from 12 to 16 minutes: the mean time of performing 100 vibrations between the specified arcs is the result deduced for each experiment.

Four of the needles, Nos. IV, VIII, X, and XI, with an apparatus in duplicate, were sent to me in the summer of 1826 by Professor HANSTEEN of Christiania, to be employed in obtaining the comparative magnetic intensity in different parts of Great Britain. Shortly after their arrival, an opportunity occurred of sending two of the needles, Nos. IV and XI, with an apparatus, to Captain BASIL HALL, in Edinburgh; by whom, assisted by Lieut. ROBERT CRAIGIE, of the Royal Navy, the experiments numbered 12 to 16 in the subjoined tables were made, in February 1827; and the needles returned, so as to be included in the comparative experiments between Paris and London.

The two remaining needles, marked A and B, making six in all, were made, at my request, by Mr. DOLLOND, in the autumn of 1826, of the same size and form as those sent me by Professor HANSTEEN.

On the 3rd of December 1826, being about seven weeks before I expected to leave England for Paris, I made the experiments 1 to 4, with needles A and B, VIII and X, in the garden of the Horticultural Society at Chiswick; and after an interval of six weeks, repeated, with the same needles, at Shernfold Park near Tunbridge Wells, on the 15th of January, the experiments 5 to 8, to ascertain that their magnetism had sustained no change. On the 30th of January, fifteen days only after this second trial, three of the needles, No. VIII, A, and B, (No. X having been accidentally mislaid on that day,) were employed in the garden of the Royal Observatory at Paris, in the experiments numbered 9 to 11; and on the 14th of March, Nos. X and XI (which last had been returned by Captain HALL from Edinburgh), and the needles A and B repeated, were employed in the experiments numbered 17 to 20; in which observations I had the pleasure of being assisted by Mr. WILLIAM RITCHIE, rector of Tain Academy in Scotland.

An opportunity occurring, Nos. VIII, X, and XI, were sent to England early in April, and the experiments numbered 21 to 24 made with those three needles and, with No. IV (sent by Captain HALL to London, but which had not been forwarded to me in Paris), in the garden of the Horticultural Society at Chiswick, on the 23rd of April, by Captain CHAPMAN of the Royal Artillery, who kindly undertook this trouble at my request; and having done so, returned them again to me at Paris.

By Professor HANSTEEN's recommendation, the four needles which he had

sent me were kept at all times separate from each other; the two which Mr. DOLLOND made had been on the contrary kept together in a small ivory case; the needles being placed parallel, but not touching, the north pole of the one being opposed to the south pole of the other, but not connected. Being desirous of ascertaining the effect which separation might have on the magnetism of these needles (A and B), they were removed from each other after the experiments of the 14th of March, and kept apart until the 30th of April; when they were again tried in the garden of the Observatory at Paris, in experiments 25 and 26, and their time of vibration was found the same as before. Nos. VIII and XI, which had arrived from Captain CHAPMAN, were tried on the same day, Experiments 27 and 28, and Nos. IV and X, which arrived a few days after, on the 10th of May, in the experiments 29 and 30. Finally, on my return to England in June, the needles were again taken to the garden at Chiswick, and the experiments 31 to 34 made on the 11th of June.

The place of observation in the garden at Chiswick was near the middle of the Arboretum; and in the garden of the Observatory at Paris, in the Cabinet of M. ARAGO, specially constructed for magnetic observations, which he kindly permitted me to occupy for the purpose.

The Tables at the close contain the full details of the temperatures and the hours of the day at which the several experiments were made. It will be seen that the variations of temperature included at each station were very considerable; but care was taken that the mean temperature of the several experiments with each needle should, in most cases at least, approach the same amount at London and at Paris:

With Needle IV	the mean temp. at London was	54,5	and at Paris 62
With Needle VIII	. . . . .	50	 52,5
With Needle X	. . . . .	40,5	 59
With Needle XI	. . . . .	54,5	 66,5
With Needle A	. . . . .	55	 54
With Needle B	. . . . .	54,5	 53

Still the preponderance of high temperatures was at Paris; and it is expedient therefore to reduce the several results to a nearer accord with what they would have been, had they been all made at the same temperature. I avail myself for this purpose of a formula for the reduction of different tem-

peratures, which Professor HANSTEEN has derived from experiments made with a cylinder precisely similar in all respects to those which he sent to me. Supposing the time of n vibrations in the temperature t to be T seconds, and in the temperature t' to be T′ seconds, $T = T'\,[1 - 0{,}000165\,(t' - t)]$, the temperature being expressed in degrees of Fahrenheit. It is possible that this reduction may not be strictly correct for all cylinders of the same shape and make as that from whence it was originally derived; but it may at least be confidently presumed, that the results obtained by such cylinders being corrected by it, will more nearly approach a strict relation to each other, than when no attempt is made to counteract the effect of differences of temperature: and that, viewing the small ultimate amount to be compensated in the present case, this formula may be considered as being quite sufficient for the purpose.

The following Table presents in one view the results obtained with each needle at the different stations at which they were tried.

Needle.	LONDON.					PARIS.				
	Date.	Therm.	Time of Vibration.	Reduction to 40°.	Corrected Time of Vibration.	Date.	Therm.	Time of Vibration.	Reduction to 40°.	Corrected Time of Vibration.
		°	s	s	s		°	s	s	s
IV	Apr. 23, 1827, 1 P.M.	40	341,69	0,00	341,69	May 10, 1827, 5½ P.M.	62	331,12	−1,20	329,92
	June 11, 1827, 2½ P.M.	69	343,21	−1,64	341,57					
	Mean.....	...	.....	.....	341,63	Mean.....	...	.....	.....	329,92
VIII	Dec. 3, 1826, 2½ P.M.	41	275,85	−0,05	275,80	Jan. 30, 1827, 11½ A.M.	28	267,22	+0,53	267,75
	Apr. 23, 1827, 2 P.M.	40	276,44	0,00	276,44	Apr. 30, 1827, 5½ P.M.	77	268,76	−1,64	267,12
	June 4, 1827, 1½ P.M.	69	278,02	−1,33	276,69					
	Mean.....	...	.....	.....	276,31	Mean.....	...	.....	.....	267,435
X	Dec. 3, 1826, 2 P.M.	41	329,63	−0,05	329,58	Mar. 14, 1827, 1½ P.M.	56	319,17	−0,84	318,33
	Apr. 23, 1827, 2½ P.M.	40	330,86	0,00	330,86	May 10, 1827, 5 P.M.	62	320,38	−1,16	319,22
	Mean.....	...	.....	.....	330,22	Mean.....	...	.....	.....	318,775
XI	Apr. 23, 1827, 3 P.M.	40	313,98	0,00	313,98	Mar. 14, 1827, 2½ P.M.	56	304,13	−0,80	303,33
	June 11, 1827, 3½ P.M.	69	315,37	−1,53	313,84	Apr. 30, 1827, 5 P.M.	77	304,73	−1,86	302,87
	Mean.....	...	.....	.....	313,91	Mean.....	...	.....	.....	303,10
A	Dec. 3, 1826, 3½ P.M.	41	247,03	−0,05	246,98	Jan. 30, 1827, Noon.	28	238,95	+0,48	239,43
	June 11, 1827, 4 P.M.	69	250,07	−1,20	248,87	Mar. 14, 1827, 2½ P.M.	56	240,73	−0,63	240,10
						Apr. 30, 1827, 3½ P.M.	77	241,20	−1,47	239,73
	Mean.....	...	.....	.....	247,925	Mean.....	...	.....	.....	239,573
B	Dec. 3, 1826, 3 P.M.	41	345,94	−0,05	345,89	Jan. 30, 1827, 1 P.M.	28	331,85	+0,66	332,51
	June 15, 1827, 3½ P.M.	68	349,16	−1,59	347,57	Mar. 14, 1827, 3 P.M.	56	337,21	−0,88	336,33
						Apr. 30, 1827, 3 P.M.	77	338,01	−2,06	335,95
	Mean.....	...	.....	.....	346,73	Mean.....	...	.....	.....	334,93

From the results in the preceding Table it appears that when the horizontal intensity in London is taken as unity, the same intensity in Paris is shown by the several cylinders to be as follows:

By Needle IV = 1,0732
By Needle VIII = 1,0675
By Needle X = 1,0726
By Needle XI = 1,0723
By Needle A = 1,0709
By Needle B = 1,0717

Mean.... 1,07137 or 1,0714.

From the very careful observations which are regularly made on the dip of the needle at the Royal Observatory at Paris, the mean dip corresponding to the period when these experiments were made is known to have been 67° 58′. In assuming the dip at the same period at London to have been 69° 45′, which is allowing a diminution of 3′ per annum since it was observed in 1821 to be 70° 04′, (Phil. Trans. for 1822, Art. I.) we cannot fail to be sufficiently near the truth for the present purpose. The horizontal intensity at Paris being then as 1,0714, to unity at London, it results that the absolute intensity of terrestrial magnetism was greater at London than at Paris at the period of these experiments by about eleven parts in a thousand.

The experiments of Captain HALL and Lieut. CRAIGIE at Edinburgh with Nos. IV and XI give the following results:

Needle.	EDINBURGH.					LONDON.	
	Date.	Temp.	Time of Vibration.	Reduction to 40°.	Corrected Time of Vibⁿ.		Corrected Time of Vibⁿ.
		°	s	s	s		s
No. IV	Feb. 15, 1827.	32	350,47	+0,46	350,93	Vibrations in London at 40° page 4.	341,63
No. XI	Feb. 15, 1827.	32	321,07	+0,43	321,50	Vibrations in London at 40° page 4.	313,91

Whence the horizontal intensity at Edinburgh, when the same intensity at London is taken as unity, is by

No. IV = 0,9477
No. XI = 0,9534

} And by a mean of the two Needles, 0,9505.

In the Horticultural Society's Garden at Chiswick, near London: December 3d, 1826.

Observer, Captain Sabine. Therm. 41°. Chron. Molyneux 407. Rate, nearly Mean Time.

Exp. 1. Needle VIII. Hour 2½ P.M.

Vib^ns.	Time.	Vib^ns.	Time.	260 Vib^ns. in
	m s		m s	m s
0	40 29,6	260	52 27,6	11 58
10	40 57,6	270	52 55,2	11 57,6
20	41 25,2	280	53 22,8	11 57,6
30	41 53,2	290	53 50,4	11 57,2
40	42 20,8	300	54 17,6	11 56,8
50	42 48,8	310	54 45,6	11 56,8
60	43 16,4	320	55 12,8	11 56,4
80	44 12			
100	45 07,2		Mean 11 57,2	
120	46 02,8			
140	46 57,6		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
160	47 52,8			
180	48 47,6		275,85 sec.	
200	49 42,8			
220	50 38			
240	51 32,4			

Exp. 2. Needle X. Hour 2 P.M.

Vib^ns.	Time.	Vib^ns.	Time.	200 Vib^ns. in
	m s		m s	m s
0	8 56	200	19 56,4	11 00,4
10	9 29,2	210	20 29,2	11 00
20	10 02,8	220	21 02	10 59,2
30	10 35,6	230	21 34,8	10 59,2
40	11 08,8	240	22 08	10 59,2
50	11 42,4	250	22 40,8	10 58,4
60	12 15,2	260	23 13,6	10 58,4
80	13 21,2			
100	14 27,2		Mean 10 59,26	
120	15 32,8			
140	16 38,8		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
160	17 44,8			
180	18 50,4		329,63 sec.	

Exp. 3. Needle A. Hour 3½ P.M.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns. in
	m s		m s	m s
0	40 43,2	300	53 05,2	12 22
10	41 08,4	310	53 30	12 21,6
20	41 33,2	320	53 54,8	12 21,6
30	41 58,4	330	54 19,2	12 20,8
40	42 23,2	340	54 44	12 20,8
50	42 48	350	55 08,4	12 20,4
60	43 12,8	360	55 33,2	12 20,4
80	44 02,8			
100	44 52		Mean 12 21,09	
120	45 41,6			
140	46 31,2		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
160	47 20,4			
180	48 09,6			
200	48 59,2		247,03 sec.	
220	49 48,4			
240	50 37,6			
260	51 26,8			
280	52 16			

Exp. 4. Needle B. Hour 3 P.M.

Vib^ns.	Time.	Vib^ns.	Time.	200 Vib^ns. in
	m s		m s	m s
0	14 33,6	200	26 06,8	11 33,2
10	15 08,8	210	26 41,6	11 32,8
20	15 43,6	220	27 16	11 32,4
30	16 18,4	230	27 50	11 31,6
40	16 53,2	240	28 24,4	11 31,2
50	17 28	250	28 59,2	11 31,2
60	18 02,8	260	29 33,6	11 30,8
80	19 12			
100	20 21,2		Mean 11 31,89	
120	21 30,4			
140	22 39,6		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
160	23 48,8			
180	24 58,4		345,94 sec.	

In the grounds of Shernfold Park, Frant, Sussex: January 15th, 1827.

Observer, Captain SABINE. Therm. 38°. Chron. MOLYNEUX 407. Rate, Mean Time.

EXP. 5. NEEDLE VIII. Hour 2½ P.M.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns. in
	m s		m s	m s
0	31 13,6	300	44 58	13 44,4
10	31 41,6	310	45 25,2	13 43,6
20	32 09,2	320	45 52,6	13 43,4
30	32 37,2	330	46 20	13 42,8
40	33 05,2	340	46 47,6	13 42,4
50	33 32,2	350	47 14,2	13 42
60	34 00,8	360	47 42,8	13 42
80	34 55,2			
100	35 50		Mean 13 42,94	
120	36 45,2			
140	37 40,4			
160	38 35,2			
180	39 29,6		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
200	40 24,4			
220	41 19,6		274,31 sec.	
240	42 14,4			
260	43 09,2			
280	44 04			

EXP. 6. NEEDLE X. Hour 1½ P.M.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns. in
	m s		m s	m s
0	43 28,8	300	59 54	16 25,2
10	44 02	310	00 26,4	16 24,4
20	44 35,2	320	00 59,6	16 24,4
30	45 08,4	330	01 32	16 23,6
40	45 41,2	340	02 04,4	16 23,2
50	46 14,4	350	02 37,2	16 22,8
60	46 47,2	360	03 10	16 22,8
80	47 53,2			
100	48 58,8		Mean 16 23,77	
120	50 04,4			
140	51 10			
160	52 15,2			
180	53 21,2		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
200	54 26,8			
220	55 32		327,92 sec.	
240	56 37,2			
260	57 42,8			
280	58 48,4			

EXP. 7. NEEDLE A. Hour 3½ P.M.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns. in
	m s		m s	m s
0	30 06	300	42 24	12 18
10	30 31,6	310	42 48,8	12 17,2
20	30 56	320	43 12,8	12 16,8
30	31 20,8	330	43 37,6	12 16,8
40	31 45,6	340	44 02	12 16,4
50	32 10,4	350	44 26,4	12 16
60	32 35,2	360	44 50,8	12 15,6
80	33 24,8			
100	34 14		Mean 12 16,69	
120	35 03,2			
140	35 52			
160	36 41,2		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	37 30			
200	38 19,2			
220	39 08		245,56 sec.	
240	39 57,2			
260	40 46			
280	41 35,2			

EXP. 8. NEEDLE B. Hour 4 P.M.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns. in
	m s		m s	m s
0	2 32,8	300	19 47,6	17 14,8
10	3 07,6	310	20 21,6	17 14
20	3 42,4	320	20 56	17 13,6
30	4 17,2	330	21 30,4	17 13,2
40	4 52	340	22 05,2	17 13,2
50	5 26,8	350	22 39,2	17 12,4
60	6 01,2	360	23 13,2	17 12
80	7 10,4			
100	8 19,2		Mean 17 13,31	
120	9 28,4			
140	10 37,2			
160	11 46,4		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	12 55,2			
200	14 04,4			
220	15 12,8		344,44 sec.	
240	16 21,2			
260	17 30			
280	18 39,2			

In the Garden of the Observatory at Paris: January 30th, 1827.

Observer, Captain SABINE. Therm. 28°. Chron. MOLYNEUX, No. 407. Rate, Mean Time.

EXP. 9. NEEDLE VIII. Hour 11¼.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns in
	m s		m s	m s
0	15 47,2	300	29 09,6	13 22,4
10	16 14	310	29 36,4	13 22,4
20	16 41,2	320	30 03,2	13 22
30	17 08	330	30 29,6	13 21,6
40	17 35,2	340	30 56	13 20,8
50	18 01,6	350	31 23,2	13 21,6
60	18 28,8	360	31 49,6	13 20,8
80	19 22,4			
100	20 16		Mean 13 21,66	
120	21 09,6			
140	22 03,2			
160	22 56,8			
180	23 50		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
200	24 43,6			
220	25 37,2		267,22 sec.	
240	26 30,4			
260	27 23,2			
280	28 16,8			

EXP. 10. NEEDLE A. Hour Noon.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns in
	m s		m s	m s
0	14 15,6	300	26 13,2	11 57,6
10	14 39,6	310	26 37,2	11 57,6
20	15 04	320	27 00,8	11 56,8
30	15 28	330	27 24,8	11 56,8
40	15 52	340	27 48,8	11 56,8
50	16 16	350	28 12,4	11 56,4
60	16 40,4	360	28 36,4	11 56
80	17 28,8			
100	18 16		Mean 11 56,86	
120	19 03,6			
140	19 51,6			
160	20 39,6			
180	21 27,6		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
200	22 15,2			
220	23 02,8		238,95 sec.	
240	23 50,4			
260	24 38,4			
280	25 26			

EXP. 11. NEEDLE B. Hour 12 to 1 P.M.

Vib^ns.	Time.	Vib^ns.	Time.	300 Vib^ns in
	m s		m s	m s
0	43 49,6	300	00 26,8	16 37,2
10	44 23,6	310	01 00	16 36,4
20	44 56,8	320	01 32,8	16 36
30	45 30,4	330	02 05,6	16 35,2
40	46 04	340	02 39,2	16 35,2
50	46 37,2	350	03 12	16 34,8
60	47 10,8	360	03 44,8	16 34
80	48 17,6			
100	49 24		Mean 16 35,54	
120	50 30,4			
140	51 36,8			
160	52 43,2			
180	53 49		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
200	54 55,6			
220	56 02		331,85 sec.	
240	57 08			
260	58 14,4			
280	59 20,4			

Edinburgh: February 15th, 1827.

Observers, Captain Basil Hall and Lieut. Robert Craigie, R.N. Therm. 32°. Barom. 30,00.
Chron. gaining 1ˢ,5 per diem.

Exp. 12. Needle IV.

Vibns.	Time.	Vibns.	Time.
	m s		m s
0	8 47,5	300	26 18,9
10	9 23,5		
20	9 58,5		
30	10 34		
40	11 09,5		
50	11 45,5		
60	12 19,5		
80	13 29,8		
100	14 59,7		
120	15 50,0		
140	16 59,5		
160	18 09,5		
180	19 19,5		
200	20 29,5		
220	21 39,5		
240	22 49,8		
260	23 59,2		
280	25 09,0		

300 Vibrations in 17m 31ˢ,4.
Whence the Mean Time of 100 Vibrations in Arcs between 30° and 5°
350,47 sec.

Exp. 13. Needle IV.

Vibns.	Time.	Vibns.	Time.
	m s		m s
0	33 59,5	290	50 55,5
10	34 35,5		
20	35 11,0		
30	35 45,5		
40	36 20,7		
50	36 56,0		
70	38 06,5		
90	39 16,5		
110	40 26,5		
130	41 37,0		
150	42 46,5		
170	43 57,0		
190	45 06,5		
210	46 16,5		
230	47 26,0		
250	48 36,5		
270	49 46,0		

290 Vibrations in 16m 56ˢ.
Whence the Mean Time of 100 Vibrations in Arcs between 30° and 5°
350,35 sec.

Exp. 14. Needle IV.

Vibns.	Time.	Vibns.	Time.
	m s		m s
0	4 24	300	21 55,8
20	5 35		
40	6 45,5		
60	7 55,8		
80	9 06,5		
100	10 16,5		
120	11 26,5		
140	12 36,8		
160	13 46,8		
180	14 56,5		
200	16 06,5		
220	17 16,5		
240	18 26,5		
260	19 35,9		
280	20 46,0		

300 Vibrations in 17m 31ˢ,8.
Whence the Mean Time of 100 Vibrations in Arcs between 30° and 5°
350,6 sec.

Exp. 15. Needle XI.

Vibns.	Time.	Vibns.	Time.	300 Vibns in
	m s		m s	m s
0	47 31,0	300	63 26	16 05
10	48 03,5	310	64 08	16 04,5
20	48 36,0	320	64 40	16 04
30	49 08,5	330	65 12	16 03,5
40	49 41,0	340	65 44	16 03
50	50 13,5	350	66 16	16 02,5
60	50 45,5	360	66 47,5	16 02
80	51 50,2			
100	52 54,8			
120	53 58,8			
140	55 03,5			
160	56 07,5			
180	57 12,0			
200	58 16,2			
220	59 20,0			
240	60 24,0			
260	61 28,0			
280	61 32,0			

Mean 16 03,5

Whence the Mean Time of 100 Vibrations in Arcs between 30° and 5°
321,17 sec.

Exp. 16. Needle XI.

Vibns.	Time.	Vibns.	Time.	300 Vibns in
	m s		m s	m s
0	16 52,5	300	32 57	16 04,5
10	17 25,0	310	33 29	16 04
20	17 57,5	320	34 00,2	16 02,7
30	18 30,0	330	34 33	16 03
40	19 02,5	340	35 04,8	16 02,3
50	19 35,0	350	35 37,0	16 02
60	20 07,3	360	36 09,0	16 01,7
80	21 11,7			
100	22 16			
120	23 20			
140	24 24,5			
160	25 29			
180	26 33			
200	27 37			
220	28 41,2			
240	29 45			
260	30 49			
280	31 53,2			

Mean 16 02,9

Whence the Mean Time of 100 Vibrations in Arcs between 30° and 5°
320,97 sec.

In the Garden of the Observatory at Paris: March 14th, 1827.

Observers, Captain Sabine and Mr. Ritchie. Therm. 56°. Chron. Molyneux, No. 407.
Rate, Mean Time.

Exp. 17. Needle X. Hour 1 to 2 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	31 13,6	300	47 12,4	15 58,8
10	31 46	310	47 44	15 58
20	32 18,4	320	48 16	15 57,6
30	32 50,4	330	48 48	15 57,6
40	33 22,4	340	49 19,6	15 57,2
50	33 54,8	350	49 51,6	15 56,8
60	34 26,8	360	50 23,2	15 56,4
80	35 30,8			
100	36 34,8		Mean 15 57,5	
120	37 38,8			
140	38 42,8			
160	39 46,4			
180	40 50		Whence the Mean Time of	
200	41 54		100 Vibrations between	
220	42 58		the Arcs of 30° and 5°	
240	44 01,6		319,17 sec.	
260	45 05,2			
280	46 08,8			

Exp. 18. Needle XI. Hour 2 to 3 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	59 17,2	300	14 31,2	15 14
10	59 48	310	15 01,2	15 13,2
20	00 18,8	320	15 31,6	15 12,8
30	00 49,6	330	16 01,6	15 12
40	01 20,4	340	16 32	15 11,6
50	01 50,8	350	17 02,4	15 11,6
60	02 21,2	360	17 32,8	15 11,6
80	03 22,4			
100	04 23,6		Mean 15 12,4	
120	05 24,8			
140	06 25,2			
160	07 26			
180	08 26,8		Whence the Mean Time of	
200	09 27,6		100 Vibrations between	
220	10 28,4		the Arcs of 30° and 5°	
240	11 28,8		304,13 sec.	
260	12 29,6			
280	13 30,4			

Exp. 19. Needle A. Hour 2 to 3 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	26 54	300	38 57,2	12 03,2
10	27 18,2	310	39 21,2	12 03
20	27 42,8	320	39 45,2	12 02,4
30	28 07,2	330	40 09,2	12 02
40	28 31,2	340	40 33,2	12 02
50	28 55,6	350	40 57,2	12 01,6
60	29 20	360	41 21,2	12 01,2
80	30 08,4			
100	30 56,8		Mean 12 02,2	
120	31 44,8			
140	32 32,8			
160	33 21,2			
180	34 09,2		Whence the Mean Time of	
200	34 57,2		100 Vibrations between	
220	35 45,2		the Arcs of 30° and 5°	
240	36 33,2		240,73 sec.	
260	37 21,2			
280	38 09,2			

Exp. 20. Needle B. Hour 3 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	51 52	300	08 45,2	16 53,2
10	52 26	310	09 18,4	16 52,4
20	53 00,6	320	09 52,4	16 51,8
30	53 34,4	330	10 26	16 51,6
40	54 08,4	340	10 59,6	16 51,2
50	54 42,8	350	11 33,6	16 50,8
60	55 16,4	360	12 06,8	16 50,4
80	56 24			
100	57 31,6		Mean 16 51,63	
120	58 39,6			
140	59 46,8			
160	00 54			
180	02 01,6		Whence the Mean Time of	
200	03 08,8		100 Vibrations between	
220	04 16		the Arcs of 30° and 5°	
240	05 23,2		337,21 sec.	
260	06 30,8			
280	07 37,6			

In the Garden of the Horticultural Society, at Chiswick, near London: April 23d, 1827.

Observer, Captain CHAPMAN, R.A. Therm. 40°.

EXP. 21. NEEDLE IV. Hour 1 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	27 32	300	44 37	17 05
10	28 06	310	45 11	17 05
20	28 40	320	45 45	17 05
30	29 15	330	46 20	17 05
40	29 49	340	46 54,5	17 05,5
50	30 23	350	47 28	17 05
60	30 57	360	48 02	17 05
80	32 07			
100	33 15		Mean 17	05,07
120	34 23,5			
140	35 31			
160	36 39			
180	37 49			
200	38 57			
220	40 05			
240	41 13			
260	42 21			
280	43 29,5			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

341,69 sec.

EXP. 22. NEEDLE VIII. Hour 2 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	7 32	300	21 21	13 49
10	8 00	310	21 49	13 49
20	8 27	320	22 16	13 49
30	8 55	330	22 45	13 50
40	9 23	340	23 13	13 50
50	9 51	350	23 40	13 49
60	10 18			
80	11 14		Mean 13	49,33
100	12 09			
120	13 04			
140	14 00			
160	14 56			
180	15 51			
200	16 46			
220	17 41,5			
240	18 36			
260	19 32			
280	20 27			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

276,44 sec.

EXP. 23. NEEDLE X. Hour 2 to 3 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	38 26	300	54 59	16 33
10	38 58	310	55 32	16 34
20	39 32,5	320	56 05	16 32,5
30	40 05	330	56 38	16 33
40	40 39	340	57 11	16 32
50	41 11,5	350	57 44	16 32,5
60	41 46	360	58 17	16 31
80	42 52,5			
100	43 58		Mean 16	32,57
120	45 05			
140	46 10,5			
160	47 17			
180	48 23			
200	49 29,5			
220	50 35,5			
240	51 42			
260	52 48			
280	53 53,5			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

330,86 sec.

EXP. 24. NEEDLE XI. Hour 3 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	4 09	300	19 51	15 42
10	4 40	310	20 22	15 42
20	5 11,5	320	20 54	15 42,5
30	5 44	330	21 26	15 42
40	6 15	340	21 57	15 42
50	6 47	350	22 29	15 42
60	7 18	360	22 59	15 41
80	8 21			
100	9 24		Mean 15	41,93
120	10 27			
140	11 30,5			
160	12 33			
180	13 35			
200	14 38			
220	15 40,5			
240	16 44			
260	17 46			
280	18 49,5			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

313,98 sec.

In the Garden of the Observatory at Paris: April 30th, 1827.

Observer, Captain Sabine. Therm. 77°. Chron. Molyneux No. 407. Rate, Mean Time.

Exp. 25. Needle A. Hour $3\frac{1}{2}$ P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	33 29,2	300	45 33,6	12 04,4
10	33 53,6	310	45 58	12 04,4
20	34 18	320	46 22	12 04
30	34 42,8	330	46 46	12 03,2
40	35 07,2	340	47 10,4	12 03,2
50	35 31,2	350	47 34,4	12 03,2
60	35 55,6	360	47 58,4	12 02,8
120	38 20,4			
180	40 44,8		Mean 12 03,6	
240	43 09,2			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

241,2 sec.

Exp. 26. Needle B. Hour 3 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	1 41,6	300	18 37,2	16 55,6
10	2 16	310	19 41,2	16 55,2
20	2 50,4	320	19 45,2	16 54,8
30	3 24,8	330	20 18,8	16 54
40	3 58,8	340	20 52,4	16 53,6
50	4 33,2	350	21 26,0	16 52,8
60	5 07,2	360	22 00,4	16 52,2
100	7 22,8			
140	9 37,6		Mean 16 54,03	
180	11 52,8			
220	14 07,6			
280	17 30			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

338,01 sec.

Exp. 27. Needle XI. Hour 5 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	350 Vib^{ns} in
	m s		m s	m s
0	58 43,2	350	16 31,2	17 48
10	59 14,4	360	17 01,6	17 47,2
20	59 45,2	370	17 32	17 46,8
30	00 16	380	18 02,4	17 46,4
40	00 46,8	390	18 32,8	17 46
50	01 17,2	400	19 03,2	17 46
60	01 48	410	19 33,6	17 45,6
120	04 51,2			
180	07 54,4		Mean 17 46,57	
200	08 55,2			
220	09 56			
240	10 57,2			
260	11 58			
280	12 58,8			
300	14 00			
320	15 00,8			
340	16 01,2			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

304,734 sec.

Exp. 28. Needle VIII. Hour $5\frac{1}{2}$ P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	31 21,2	300	44 48,4	13 27,2
10	31 48	310	45 15,2	13 27,2
20	32 15,6	320	45 42	13 26,4
30	32 42,8	330	46 09,2	13 26,4
40	33 10	340	46 35,6	13 25,6
50	33 36,8	350	47 02,4	13 25,6
60	34 04	360	47 29,6	13 25,6
80	34 58			
100	35 51,6		Mean 13 26,286	
120	36 45,2			
140	37 39,3			
160	38 32,8			
180	39 26,4			
200	— —			
220	41 13,6			
240	42 07			
260	43 01,2			
280	43 54,4			

Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°

268,76 sec.

In the Garden of the Observatory at Paris: May 10th, 1827.

Observer, Captain SABINE. Therm. 62°. Chron. MOLYNEUX No. 407. Rate, Mean Time.

EXP. 29. NEEDLE X. Hour 5 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	10 52,4	300	26 55,2	16 02,8
10	11 25,2	310	27 27,2	16 02
20	11 57,6	320	27 59,2	16 01,6
30	12 30	330	28 30,8	16 00,8
40	13 02,4	340	29 02,8	16 00,4
50	13 34,4	350	29 34,8	16 00,4
60	14 06,8	360	30 06,8	16 00
80	15 11,2			
100	16 15,2		Mean	16 01,14
120	17 19,2			
140	18 23,2			
160	19 27,2		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	20 31,6			
200	21 35,6		320,38 sec.	
220	22 39,6			
240	23 43,6			
260	24 47,2			
280	25 51,2			

EXP. 30. NEEDLE IV. Hour 5½ P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	39 57,2	300	56 32	16 34,8
10	40 31,2	310	57 04,8	16 33,6
20	41 04,4	320	57 38	16 33,6
30	41 38	330	58 11,2	16 33,2
40	42 11,2	340	58 44,4	16 33,2
50	42 44,4	350	59 17,2	16 32,8
60	43 18	360	59 50,4	16 32,4
80	44 25,2			
100	45 31,2		Mean	16 33,37
120	46 37,2			
140	47 43,6			
160	48 49,6		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	49 56			
200	51 02,4		331,12 sec.	
220	52 08			
240	53 14			
260	54 20			
280	55 26			

In the Garden of the Horticultural Society at Chiswick: June 11th, 1827.

Observer, Captain SABINE. Therm. 69°. Chron. MOLYNEUX No. 407. Rate, Mean Time nearly.

EXP. 31. NEEDLE IV. Hour 3½ P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	45 04,6	300	62 15,2	17 11,6
10	45 39,6	310	62 49,6	17 10
20	46 14	320	63 23,6	17 09,6
30	46 48,4	330	63 57,6	17 09,2
40	47 23,4	340	64 32	17 08,6
50	47 57,6	350	65 06,8	17 09,2
60	48 32	360	65 41,2	17 09,2
80	49 41,2			
100	50 50		Mean	17 09,63
120	— —			
140	53 07,6			
160	— —		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	55 24,8			
200	56 33,2		343,21 sec.	
220	57 41,6			
240	58 50			
260	59 58,4			
280	61 05,6			

EXP. 32. NEEDLE VIII. Hour 1½ P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	44 43,2	300	58 38	13 54,8
10	45 11,6	310	59 06	13 54,4
20	45 39,6	320	59 34,4	13 54,8
30	46 07,6	330	60 01,6	13 54
40	46 35,6	340	60 29,6	13 54
50	47 03,6	350	60 56,8	13 53,2
60	47 31,6	360	61 24,8	13 53,2
80	48 27,6			
100	— —		Mean	13 54,06
120	50 18,8			
140	51 14,4			
160	52 10,4		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	53 05,6			
200	54 01,2		278,02 sec.	
220	54 56,8			
240	55 52,4			
260	56 48			
280	57 43,2			

In the Garden of the Horticultural Society at Chiswick, near London: June 11th, 1827.

Observer, Captain Sabine. Therm. 69°. Chron. Molyneux No. 407. Rate, Mean Time nearly.

Exp. 33. Needle XI. Hour $3\frac{1}{2}$ P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	21 00,4	300	36 48	15 47,6
10	21 32,4	310	37 19,2	15 46,8
20	22 04,4	320	37 50,8	15 46,4
30	22 36	330	38 22,4	15 46,4
40	23 08	340	38 53,6	15 45,6
50	23 39,6	350	39 24,8	15 45,2
60	24 11,2	360	39 56	15 44,8
80	25 14,8			
100	26 18		Mean	15 46,11
120	27 21			
140	28 24,4			
160	29 27,6		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	30 30,4			
200	31 33,2			
220	32 36,4		315,37 sec.	
240	33 39,6			
260	34 42,4			
280	35 45,2			

Exp. 34. Needle A. Hour 4 P.M.

Vib^{ns}.	Time.	Vib^{ns}.	Time.	300 Vib^{ns} in
	m s		m s	m s
0	48 57,2	300	01 28,8	12 31,6
10	49 22,4	310	01 53,6	12 31,2
20	49 48	320	02 18,4	12 30,4
30	49 13,2	330	02 43,2	12 30
40	50 38,8	340	03 08,4	12 29,6
50	51 03,6	350	03 43,2	12 29,6
60	51 29,2	360	03 58,4	12 29,2
80	52 19,2			
100	53 09,2		Mean	12 30,23
120	53 59,2			
140	54 49,2			
160	55 39,2		Whence the Mean Time of 100 Vibrations between the Arcs of 30° and 5°	
180	56 29,2			
200	57 18,8			
220	58 08,8		250,07 sec.	
240	58 58,8			
260	59 48,8			
280	00 38,8			