

KEW OBSERVATORY,

1881.

REPORT

OF THE

KEW COMMITTEE

FOR THE

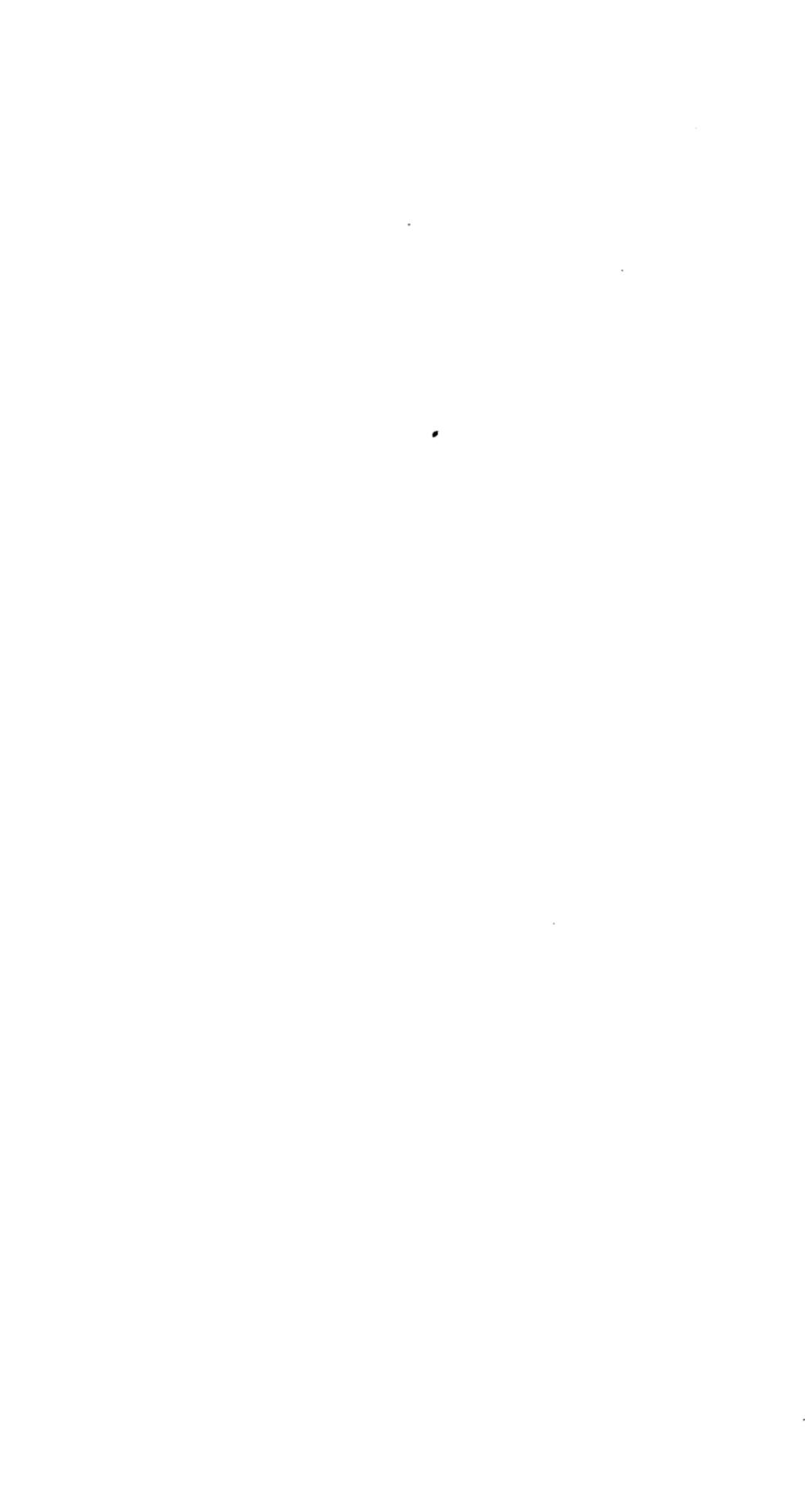
Year ending October 31, 1881,

WITH APPENDICES CONTAINING RESULTS OF MAGNETICAL AND
METEOROLOGICAL OBSERVATIONS MADE AT THE
OBSERVATORY.

[*From the PROCEEDINGS OF THE ROYAL SOCIETY, 1881.*]

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty.

1881.



*Report of the Kew Committee for the Year ending
October 31, 1881.*

The operations of the Kew Observatory, in the Old Deer Park Richmond, Surrey, are controlled by the Kew Committee, which is constituted as follows :

General Sir E. Sabine, K.C.B., *Chairman.*

<p>Mr. De La Rue, <i>Vice-Chairman.</i> Capt. W. de W. Abney, R.E. Prof. W. G. Adams. Capt. Sir F. Evans, K.C.B. Prof. G. C. Foster. Mr. F. Galton.</p>	|	<p>Vice-Adm. Sir G. H. Richards, C.B. The Earl of Rosse. Mr. R. H. Scott. Lieut.-General W. J. Smythe. Lieut.-Gen. R. Strachey, C.S.I.</p>
Mr. E. Walker.		

Lieut.-Gen. Sir J. H. Lefroy, K.C.M.G., having been appointed Deputy-Governor of Tasmania, withdrew from the Committee in December, and Capt. Abney was elected to fill the vacancy.

The work at the Observatory may be considered under seven heads:—

- 1st. Magnetic observations.
- 2nd. Meteorological observations.
- 3rd. Solar observations.
- 4th. Experimental, in connexion with any of the above departments.
- 5th. Verification of instruments.
- 6th. Aid to other Observatories.
- 7th. Miscellaneous.

I. MAGNETIC OBSERVATIONS.

On January 10 the magnetograph needles were dismounted and re-magnetized, having become weakened by age. Since then work has continued as usual.

The scale values of all the instruments were re-determined in January, in accordance with the practice of previous years, both before and after the re-magnetization of the needles.

The following are the values of the ordinates of the various photographic curves:—

Declination 1 inch = $0^{\circ} 22' \cdot 04$. 1 mm. = $0^{\circ} 0' \cdot 87$.

Bifilar Jan. 4, 1881,	for 1 inch	$dH=0\cdot0739$	foot grain units.
	„ 1 mm.	„	$=0\cdot00134$ mm. mgr. units.
„ Jan. 12, 1881	„ 1 inch	„	$=0\cdot0442$ foot grain units.
	„ 1 mm.	„	$=0\cdot00080$ mm. mgr. units.
Balance Jan. 7, 1881	„ 1 inch	$dV=0\cdot0643$	foot grain units.
	„ 1 mm.	„	$=0\cdot00117$ mm. mgr. units.
„ Jan. 14, 1881	„ 1 inch	„	$=0\cdot0323$ foot grain units.
	„ 1 mm.	„	$=0\cdot00059$ mm. mgr. units.

Two magnetic storms, or periods of considerable disturbance of the needles, have been registered during the year; one on the night of January 31st, and a second on September 12th and 13th, both being accompanied by brilliant auroral displays.

The monthly observations with the absolute instruments have been made regularly, and the results are given in the tables forming Appendix I of this Report.

Professor W. Grylls Adams has during the year continued his investigations on the comparison of magnetic disturbances in various localities. In addition to the curves mentioned in last year's Report, he has received through the Committee several supplies of copies of selected traces from Mauritius, Toronto, and Zi-Ka-Wei, near Shanghai, as well as from those Observatories already enumerated in the last report.

Professor Adams has embodied the results of his researches in two papers read before the British Association, and in a Friday evening lecture delivered at the Royal Institution.

The discussion of the great magnetic storm of January 31st, 1881, having been undertaken by Dr. H. Wild, of the Central Physical Observatory, St. Petersburg, such particulars respecting that occurrence as the Committee possessed were transmitted to that gentleman.

The magnetic instruments have been studied, and a knowledge of their manipulation obtained by Lieutenant Moore, R.N., Dr. Brauner, and Dr. Monckman.

Information on matters relating to terrestrial magnetism and various data have been supplied to Professor W. G. Adams, Dr. Atkinson, Dr. Buys Ballot, Mr. Gee, Mr. J. E. H. Gordon, Rev. F. Howlett, M. Mascart, Dr. Müller, Professor Balfour Stewart, and Dr. Wild.

The following is a summary of the number of magnetic observations made during the year:—

Determinations of Horizontal Intensity	29
„ Dip	160
„ Absolute Declination	43

II. METEOROLOGICAL OBSERVATIONS.

The several self-recording instruments for the continuous registration respectively of, atmospheric pressure, temperature, and humidity, of wind (direction and velocity), sunshine, and rain have been maintained in regular operation throughout the year.

The standard eye observations made five times daily, for the control of the automatic records, have been duly registered through the year, together with the additional daily observation at 0 h. 8 m. P.M. in connexion with the Washington synchronous system. The 6 h. 45 m. P.M. observation, for the second synchronous system organized by M. Mascart, Directeur du Bureau Central Météorologique, Paris, was discontinued on December 31st.

The tabulation of the meteorological traces has been regularly carried on, and copies of these, as well as of the eye observations, with notes of weather, cloud, and sunshine have been transmitted weekly to the Meteorological Office.

The following is a summary of the number of meteorological observations made during the past year:—

Readings of standard barometer	1929
„ dry and wet thermometers	7508
„ maximum and minimum thermometers	2190
„ radiation thermometers	750
„ rain gauges	730
Cloud and weather observations	2294
Measurements of barograph curves	9125
„ dry bulb thermograph curves..	9125
„ wet bulb thermograph curves..	8986
„ wind (direction and velocity)..	17320
„ rainfall curves	717
„ sunshine traces	2149

In compliance with a request made by the Meteorological Council to the Kew Committee, the Observatories at Aberdeen, Armagh, Falmouth, Glasgow, Oxford (Radcliffe), Stonyhurst, and Valencia, have been visited as on former occasions and their instruments inspected by Mr. Whipple during his vacation.

With the concurrence of the Meteorological Council, weekly abstracts of the meteorological results have been regularly forwarded to, and published by “The Times,” “The Illustrated London News,” and “The Torquay Directory,” and meteorological data have been supplied to the editor of “Symons’s Monthly Meteorological Magazine,” the Secretary of the Institute of Mining Engineers, Messrs. Buchan, Eaton, Greaves, Gwilliam, McDonald, Rowland, and others.

Electrograph.—This instrument has been in continuous action through the year, with the exception of a few occasions during the severe frost of last winter.

In July the instrument was dismantled, and a fresh supply of acid placed in the jar, the charge-keeping properties of which had become slightly deteriorated.

The tabulation of the curves given by this instrument has at last been commenced, and a suitable glass scale, arranged on a plan devised by Mr. Whipple, having been constructed by Mr. Baker, the average hourly tension of atmospheric electricity at the collector of the Electrograph has been determined for every hour in 1880, except in those cases where registration failed either from disturbance or instrumental defect.

From these values the daily, monthly, and annual means have been deduced, together with other facts bearing on the relations existing between atmospheric electricity and different meteorological phenomena. Some results of this investigation were by permission of the Meteorological Council submitted by the Superintendent to the Meeting of the British Association at York, in a paper which has since been ordered by the General Committee to be printed *in extenso* among their Reports. The expense of the tabulation was defrayed by a special grant from the Meteorological Council.

III. SOLAR OBSERVATIONS.

The only solar work done at Kew during the past year has been the regular maintenance of the eye observations of the sun, after the method of Hofrath Schwabe, as described in the Report for 1872. These have been made on 187 days, in order to preserve the continuity of the Kew records of sun-spots. The sun's surface was observed to be free from spots on three of those days.

A small portable $2\frac{3}{4}$ in. refracting telescope, with a magnifying power of 42 diameters, is used by the observer.

Transit Observations.—Ninety-four observations have been made of sun-transits, for the purpose of obtaining correct local time at the Observatory: 126 clock and chronometer comparisons have also been made.

In addition to these a considerable number of star transits have been observed in connexion with the pendulum operations in progress during the autumn of 1881.

IV. EXPERIMENTAL WORK.

Winstanley's Recording Radiograph.—This instrument, designed for the purpose of registering continuously the amount of radiation from the sky, by mechanical means, upon a sheet of blackened paper, still

remains at the Observatory, but having been accidentally deranged, it has not been at work for some months. The inventor being abroad it has not been possible to place it in re-adjustment.

Nephoscopes.—Experiments have been made with several forms of nephoscope designed by Mr. F. Galton, and also with a new cloud-camera, designed by the Superintendent.

Exposure of Thermometers.—Experiments have been continued throughout the year at the Observatory, with the view of determining the relative merits of different patterns of thermometer screens. For this purpose there were erected in 1879 on the lawn a Stevenson's screen, of the ordinary pattern, and a large wooden cage, containing a Wild's screen, of the pattern employed in Russia. Each of these screens contains a dry and a wet bulb thermometer, and a maximum and minimum, all of which are read daily at 9 A.M. and 9 P.M., their indications being compared with those of the thermograph at the same hours. A third portable metal screen, designed by Mr. De La Rue for use on board Light-ships, which contains a dry bulb thermometer only, is also carried into the open air by the observer, and read at the same time as the fixed instruments.

The cost of these experiments is borne by the Meteorological Council.

Glycerine Barometer.—This instrument, devised and erected by Mr. Jordan, has remained in successful operation throughout the year. In compliance with the request of the inventor, it has been continuously observed five times daily, in conjunction with the mercurial barometer.

Mr. Jordan has been supplied with copies of the observations, but the Committee have not yet, however, been informed of the results of these comparisons.

Pendulum Experiments.—In March, the Committee received a communication from the Council of the Royal Society calling their attention to the fact that the invariable pendulums deposited in the Loan Collection of scientific instruments at South Kensington could not be considered as in the custody of the Committee, and in consequence the Science and Art Department was requested to return the instruments to the Observatory. They were accordingly received on the 15th of June.

Subsequently an application was received from Major Herschel, R.E., F.R.S., by authority of the India Office, for permission to make certain experiments with the pendulums, and for the loan of the instruments, with their accompanying appliances, with facilities for prosecuting the experiments at the Observatory.

These requests were granted, and since the beginning of September operations have been continuously carried on, both in the Pendulum Room and in the Experimental House at Kew.

The Indian Government will defray all expenses that may be incurred in the prosecution of the experiments.

V. VERIFICATION OF INSTRUMENTS.

The following magnetic instruments have been verified, and their constants have been determined :—

A set of Self-recording Magnetographs for the Nice Observatory.

A Unifilar Magnetometer for Casella.

Three Dip Circles for Casella.

A pair of Dipping Needles for Elliott Brothers.

There have also been purchased on commission and verified :—

A Unifilar Magnetometer and Dip Circle for Professor Tacchini, Rome.

A Unifilar Magnetometer and Dip Circle for Professor Perard, Liège.

A Dip Circle for Capt. Hoffmeyer, Copenhagen.

A Dip Circle for Professor Malmberg, Stockholm.

A Pair of Dipping Needles for the Colaba Observatory.

A Dip Needle for Senhor Capello, Lisbon.

The number of meteorological instruments verified continues still to increase, having been in the past year as follows :—

Barometers, Standard	59
„ Marine and Station	109
Aneroids	34
	<hr/>
Total	202

Thermometers, ordinary Meteorological	1704
„ Standard	60
„ Mountain	40
„ Clinical	4217
„ Solar radiation	64
	<hr/>
Total	6085

Besides these, 36 Deep-sea Thermometers have been tested, 17 of which were subjected in the hydraulic press, without injury, to pressures exceeding three and a half tons on the square inch, and 18 Thermometers have been compared at the freezing-point of mercury, making a total of 6139 for the year.

Duplicate copies of corrections have been supplied in 20 cases.

Ten Standard Thermometers have also been calibrated and divided, and supplied to societies and individuals during the year.

The following miscellaneous instruments have also been verified :—

Hydrometers	47
Anemometers.....	3
Rain Gauges	6
Theodolites	3
Sextants.....	25
Index Glasses for ditto, unmounted.....	23
Horizon „ „ „	26
Coloured Shades „ „ „	188

There are at present in the Observatory undergoing verification, 8 Barometers, 395 Thermometers, and 7 Hydrometers.

A considerable increase having taken place in the number of Sextants submitted for verification, the Committee, after due consideration, have withdrawn the old form of certificate of examination, and substituted a more general statement of the efficiency of the instrument, recognising in future two classes of sextant; Class A in which the total error of the instrument, from any cause, nowhere exceeds thirty seconds; and Class B where the limit is a maximum error of three minutes of arc.

The schedule of fees payable for the verification of instruments has been revised, and copies of the new scale, together with particulars as to the transmission, &c., of instruments to and from the Observatory for the purpose of comparison, have been widely distributed amongst opticians and instrument makers.

Standard Barometers.—From time to time comparisons have been made between the two Welsh Standard Barometers, the old Royal Society Standard, and Newman No. 34, the working Standard of the Observatory. The Portable Standards of the Observatory have also been employed in making comparisons of the Standard Barometers at the Hydrographic Office, Admiralty, the University Museum, Oxford, and the Royal Engineering College, Cooper's Hill.

A metal plate, engraved with an inscription stating the history of the old Royal Society Standard Barometer and giving details of the method employed in filling it on the occasion of its recent repair, has now been affixed to the instrument.

The large difference formerly observed in the heights of the mercurial column in the flint and crown glass tubes of this barometer, has not been found to exist in the refilled tubes, and the mean difference between their indications is now less than 0·001 inch.

Standard Thermometers.—The Committee has exchanged Standard Thermometers with the Johns Hopkins University, U.S.A., Professor Rowland having on the occasion of his recent visit to this country

presented the Observatory with a Standard—Baudin 7835—which he has compared very closely with his other standard instruments.

The Committee has received very gratifying testimony as to the accuracy of the Standard Thermometers constructed at the Observatory. In a paper contributed to the "American Journal of Science," Dr. Leonard Waldo, of the Winchester Observatory, Yale College, U.S.A., remarks that after a critical examination of three Kew Standard Thermometers, in which every degree was separately measured, entailing no less than 2,300 micrometer readings, he came to the conclusion that their errors are practically insensible and too small to be detected with certainty.

Professors Thorpe and Rücker have also been engaged in testing very minutely three similar instruments made for them at Kew. In a paper read at York before the British Association, Professor Rücker stated "they had subjected the Kew Thermometers to the most rigorous test possible, and they were able to announce that in one instrument the errors left, after the application of Welsh's method of calibration and graduation, were not greater than four thousandths of a degree Centigrade, and in no case did they much exceed one-hundredth of a degree. As it is impossible to read on these thermometers less than a hundredth of a degree with certainty, Welsh's method as applied at Kew is almost perfect."

VI. AID TO OBSERVATORIES.

Waxed Papers, &c., supplied.—Waxed paper has been supplied to the following Observatories:—

Aberdeen, Adelaide, Armagh, Bengal (Meteorological Department), Colaba, Falmouth, Glasgow, Mauritius, Paris (Montsouris), Oxford (Radcliffe), Utrecht, Stonyhurst, St. Petersburg.

Anemograph Sheets have been sent to the Mauritius Observatory, and

Blank Magnetic Observation Forms have been supplied to

Professor Reinold, Royal Naval College;

Professor Louis Perard, l'Universite de Liège;

Professor Poynting, Mason's Science College, Birmingham;

and to Mr. Casella.

VII. MISCELLANEOUS.

Loan Exhibition.—The instruments specified in the Report for 1876 still remain in charge of the Science and Art Department, South Kensington, with the exception of the Invariable Pendulum Apparatus recently withdrawn, as already stated, and the few articles mentioned in previous reports.

Fog Prevalence.—At the request of the Meteorological Council the

Meteorological Registers of the Observatory were searched from 1843 to the end of 1880, and an enumeration made of all the observations of fog and mist recorded in them. The cost of the examination was defrayed by the Council.

Lost Journals.—On going through the books of the Observatory for the purpose of compiling the above-mentioned tables, it was found that the volumes containing observations made between January and June 1845, and August 1848, and December 1853, were missing. On making inquiry it was discovered that the volumes containing the MSS. results for 1845 and 1849 to 1851 were in the library bequeathed by the late Sir F. Ronalds to the Society of Telegraph Engineers and Electricians, and the Council of that Society most courteously directed these records to be restored to the custody of the Kew Committee, which has been done.

Further search has failed to bring to light any regular records of observations made between April 1851, and January 1854; and it is believed that none were made during the interval which elapsed between the discontinuance of the system of observations organised under the superintendence of Sir F. Ronalds and that established by Mr. J. Welsh, after his own appointment as Superintendent.

Complete specimen sets of curves from the various photographic and autographic instruments in use at the Observatory have been prepared and forwarded to the exhibitions of the

Leeds Philosophical and Literary Society,
Yorkshire Fine Art and Industrial Institution,
Richmond Industrial and Fine Art Loan Exhibition, and the
International Photographic Exhibition at Vienna.

At the latter exhibition a silver medal was awarded to the Committee for their exhibit.

The Superintendent has, with the consent of the Committee, read the following papers before the Meteorological Society, all of which have been published in the "Quarterly Journal" of the Society:—

1. "On the Variations of Relative Humidity and Thermometric Dryness of the Air, with Changes of Barometric Pressure at the Kew Observatory," vol. vii, p. 49.

2. "On the Relative Frequency of given Heights of the Barometer Readings at the Kew Observatory during the ten years 1870-79," vol. vii, p. 52.

3. "Results of Experiments made at the Kew Observatory with Bogen's and George's Barometers," vol. vii, p. 185.

4. "Note on a Discussion of Mr. Eaton's Table of Barometric Height at London, with regard to Periodicity," vol. vii, p. 189.

Workshop.—The several pieces of Mechanical Apparatus, such as the Whitworth Lathe and Planing Machine, procured by Grants from

either the Government Grant Funds or the Donation Fund, for the use of the Kew Observatory, have been kept in thorough order, and many of them are in constant, and others in occasional, use at the Observatory, but the funds of the Committee do not allow of the employment of a mechanical assistant, although one is much needed.

Library.—During the year the Library has received, as presents, the publications of

13 English Scientific Societies and Institutions, and

72 Foreign and Colonial Scientific Societies and Institutions.

Ventilation Experiments.—The experiments on the ventilating power of cowls of different form by the Sub-Committee of the Sanitary Institute of Great Britain are still in progress in the wooden hut erected by the Institute near the Observatory, the experimental house lent by the Committee having been required for the testing of Magnetographs and other purposes.

Observatory and Grounds.—The buildings and grounds have been kept in repair throughout the year, and the exterior woodwork has been painted by the Board of Works.

The basement of the building having been again flooded, a drain has been laid across the park to the riverside to allow of flood-waters flowing directly into the river instead of requiring to be pumped out as has hitherto been necessary.

The roofs of the Verification House and Magnetic Observatory have been entirely re-covered with felt, and new gutters fitted, &c.

No action having been taken by the Commissioners of Woods and Forests with respect to the footpath across the park, its *temporary* repair has, however, been carried on at the expense of the Committee.

PERSONAL ESTABLISHMENT.

The staff employed is as follows:—

G. M. Whipple, B.Sc., Superintendent.

T. W. Baker, First Assistant.

J. Foster, Verification Department.

H. McLaughlin, Librarian and Accountant.

F. G. Figg, Magnetic Observer.

E. G. Constable, Solar Observations and Tabulation of Meteorological Curves.

T. Gunter } Verification Department.
C. Taylor }

W. Boxall, Photography.

E. Dagwell, Office duties.

J. Dawson, Messenger and Care-taker.

J. W. Hawkesworth, H. Clements, and A. Dawson have resigned their appointments during the year.

In consequence of a case of illness of a contagious nature having occurred in the care-taker's family, work was almost suspended in the Observatory for some days in May, but the self-registering instruments were maintained in action so that no loss of records took place during the time.

Visitors.—The Observatory has been honoured by the presence during the year of numerous visitors, many of whom were foreigners.

Abstract. New Observatory Receipts and Payments Account from November 3, 1880, to November 2, 1881.

Dr. RECEIPTS.

To Balance from 1879-80	£	s.	d.
Royal Society (Gassiot Trust)	£247	16	3
"	248	17	5
Meteorological Office	496	13	8
Meteorological Office, for Postages, &c.	400	0	0
Payment for Instruments on Commission	44	17	2
Sale of Waxed Paper	153	2	4
Verification Fees, Meteorological Office	121	15	6
"	95	7	0
" Observatories and Institutions	32	16	2
" Opticians, &c.	895	5	3
Sale of Standard Thermometers	19	16	6
Payments for Copying Registers	52	15	0
Sanitary Institute of Great Britain for Experimental Work	595	19	11
Mr. De La Rue for Sun-work	10	17	1
Sale of Photographic Residues	8	6	8
			6 12 0

PAYMENTS.

By Salaries	£998	2	10
Extra Payments	72	17	1
Rent of Enclosure	11	11	0
Fuel and Gas	51	2	6
Furniture and Fittings	40	14	6
Chandlery, &c.	9	2	3
Painting and Repairs	12	6	2
Maintenance of Path and Fence	6	12	9
Expenses on account of Illness	20	0	0
Printing and Stationery	151	9	1
Postages	37	5	5
Library	16	9	4
Messenger and Housekeeper	10	10	5
Advertisements	62	8	0
Porterage and Condigngencies	4	11	6
	15	11	9
Instruments purchased on Commission	145	16	5
Postages and Payments on behalf of Meteorological Office	204	17	6
Purchase of Waxed Paper, Packing ditto, &c.	47	7	7
" Chemicals and Materials	87	13	4
" Tubes for Standard Thermometers	28	8	0
Verification Department Expenses (Ice, Carbonic-Acid Gas, &c.)	2	4	8
Repair of Instruments, and Purchase of New	10	15	0
Carpenter's Work and Sundries	35	12	10
	2	19	6
Payments on behalf of Experimental Work	80	0	0
" Sun-work	2	12	1
Balance—Bank of England	8	6	8
London and County Bank	824	4	0
Cash in hand	75	0	0
	14	7	8
	414	1	8
	£2214	4	3

Examined and compared with the Vouchers, and found correct.

(Signed) G. CAREY FOSTER, Auditor.

ASSETS.

By Balance as per Statement	£	s.	d.
Meteorological Office, Allowances and Sundries	414	1	8
Commissions	39	8	8
Waxed Paper in stock	106	1	0
" sold	24	0	0
Blank Forms	11	5	0
Verification Fees due	1	13	9
Standard Thermometers sold	87	13	9
" in stock	4	7	0
	90	0	0
	£778	10	10

LIABILITIES.

To Gas, Fuel, and House Account	£	s.	d.
Apparatus, Chemicals, &c.	1	15	4
Commissions	6	17	0
Stationery and Printing	36	19	8
Balance	7	17	9
	707	1	1
	£2214	4	3

APPENDIX I.

Magnetic Observations made at the Kew Observatory, Lat. 51° 28' 6" N., Long. 0^h 1^m 15^s.1 W., for the year October 1880 to September 1881.

The observations of Deflection and Vibration given in the annexed Tables were all made with the Collimator Magnet marked K C 1, and the Kew 9-inch Unifilar Magnetometer by Jones.

The Declination observations have also been made with the same Magnetometer, Collimator Magnets N D and N E being employed for the purpose.

The Dip observations were made with Dip-circle Barrow No. 33, the needles 1 and 2 only being used; these are 3½ inches in length.

The results of the observations of Deflection and Vibration give the values of the Horizontal Force, which, being combined with the Dip observations, furnish the Vertical and Total Forces.

These are expressed in both English and metrical scales—the unit in the first being one foot, one second of mean solar time, and one grain; and in the other one millimetre, one second of time, and one milligramme, the factor for reducing the English to metric values being 0·46108.

By request, the corresponding values in C.G.S. measure are also given.

The value of $\log \pi^2 K$ employed in the reduction is 1·64365 at temperature 60° F.

The induction-coefficient μ is 0·000194.

The correction of the magnetic power for temperature t_0 to an adopted standard temperature of 35° F. is

$$0\cdot0001194(t_0 - 35) + 0\cdot000,000,213(t_0 - 35)^2.$$

The true distances between the centres of the deflecting and deflected magnets, when the former is placed at the divisions of the deflection-bar marked 1·0 foot and 1·3 feet, are 1·000075 feet and 1·300097 feet respectively.

The times of vibration given in the Table are each derived from the mean of 12 or 14 observations of the time occupied by the magnet in making 100 vibrations, corrections being applied for the torsion-force of the suspension-thread subsequently.

No corrections have been made for rate of chronometer or arc of vibration, these being always very small.

The value of the constant P, employed in the formula of reduction

$$\frac{m}{X} = \frac{m'}{X'} \left(1 - \frac{P}{r_0^2} \right), \text{ is } -0\cdot00109.$$

In each observation of absolute Declination the instrumental readings have been referred to marks made upon the stone obelisk erected 1,250 feet north of the Observatory as a meridian mark, the orientation of which, with respect to the Magnetometer, was determined by the late Mr. Welsh, and has since been carefully verified.

The observations have all been made and reduced by Mr. F. G. Figg.

Observations of Deflection for Absolute Measure of Horizontal Force.

Month.	G. M. T.	Distances of Centres of Magnets.	Tempe- rature.	Observed Deflection.	Log $\frac{m}{\bar{X}}$ Mean.
1880.	d. h. m.	foot.			
October.....	28 12 32 P.M.	1·0	54·3	15 34 $\frac{3}{8}$	
		1·3	....	7 1 11	
	2 35 "	1·0	53·6	15 35 7	9·12956
		1·3	....	7 1 42	
November.....	25 12 20 P.M.	1·0	57·2	15 32 7	
		1·3	....	7 0 28	
	2 18 "	1·0	55·6	15 31 23	9·12846
		1·3	....	6 59 59	
December.....	23 12 35 P.M.	1·0	54·3	15 32 31	
		1·3	....	7 0 29	
	2 27 "	1·0	54·5	15 32 0	9·12857
		1·3	....	7 0 28	
1881.					
January.....	28 12 27 P.M.	1·0	41·5	15 33 47	
		1·3	....	7 1 2	
	2 28 "	1·0	42·9	15 33 8	9·12826
		1·3	....	7 0 48	
February.....	24 12 34 P.M.	1·0	41·0	15 34 55	
		1·3	....	7 1 40	
	2 37 "	1·0	42·4	15 34 0	9·12870
		1·3	....	7 1 11	
March.....	25 12 26 P.M.	1·0	46·6	15 32 49	
		1·3	....	7 0 42	
	2 46 "	1·0	48·5	15 32 25	9·12824
		1·3	....	7 0 27	
April.....	25 12 38 P.M.	1·0	60·4	15 29 17	
		1·3	....	6 59 8	
	2 36 "	1·0	62·9	15 28 39	9·12761
		1·3	....	6 59 3	
May.....	26 12 27 P.M.	1·0	65·8	15 29 53	
		1·3	....	6 59 25	
	3 27 "	1·0	70·5	15 27 31	9·12787
		1·3	....	6 58 17	
June.....	28 12 24 P.M.	1·0	67·3	15 29 50	
		1·3	....	6 59 21	
	2 37 "	1·0	68·1	15 28 10	9·12795
		1·3	....	6 58 31	
July.....	28 12 27 P.M.	1·0	72·1	15 29 48	
		1·3	....	6 59 19	
	2 39 "	1·0	73·8	15 27 47	9·12824
		1·3	....	6 58 24	
August.....	26 12 37 P.M.	1·0	68·9	15 28 51	
		1·3	....	6 59 0	
	2 36 "	1·0	68·2	15 28 16	9·12778
		1·3	....	6 58 22	
September.....	28 12 28 P.M.	1·0	61·4	15 30 51	
		1·3	....	6 59 50	
	2 36 "	1·0	63·8	15 29 33	9·12818
		1·3	....	6 59 14	

Vibration Observations for Absolute Measure of Horizontal Force.

Month.	G. M. T.	Temperature.	Time of one Vibration.*	Log mX . Mean.	Value of m .†
1880.	d. h. m.		secs.		
October.....	28 11 54 A.M.	52·9	4·6468		
	3 12 P.M.	52·2	4·6450	0·30964	0·52432
November.....	25 11 39 A.M.	55·8	4·6420		
	2 59 P.M.	55·1	4·6405	0·31071	0·52430
December.....	23 12 1 P.M.	53·1	4·6411		
	2 59 P.M.	54·2	4·6406	0·31068	0·52435
1881.					
January.....	28 11 50 A.M.	39·8	4·6365		
	3 2 P.M.	42·6	4·6362	0·31077	0·52422
February.....	24 11 59 A.M.	39·3	4·6380		
	3 10 P.M.	42·8	4·6368	0·31055	0·52435
March.....	25 11 44 A.M.	45·1	4·6369		
	3 18 P.M.	48·2	4·6384	0·31081	0·52423
April.....	25 11 46 A.M.	58·7	4·6429		
	3 8 P.M.	63·4	4·6420	0·31080	0·52385
May.....	26 11 49 A.M.	65·2	4·6451		
	3 54 P.M.	70·1	4·6411	0·31110	0·52418
June.....	28 11 43 A.M.	67·1	4·6439		
	3 14 P.M.	68·6	4·6412	0·31102	0·52418
July.....	28 11 54 A.M.	71·5	4·6465		
	3 16 P.M.	73·6	4·6425	0·31093	0·52430
August.....	26 11 50 A.M.	69·7	4·6467		
	3 19 P.M.	69·7	4·6442	0·31065	0·52385
September.....	28 11 44 A.M.	59·9	4·6426		
	3 32 P.M.	64·4	4·6419	0·31075	0·52417

* A vibration is a movement of the magnet from a position of maximum displacement on one side of the meridian to a corresponding position on the other side.

† m = magnetic moment of vibrating magnet.

Dip Observations.

Month.	G. M. T.	Needle.	Dip.	Month.	G. M. T.	Needle.	Dip.
			North.				North.
1880.	d. h. m.	No.		1881.	d. h. m.	No.	
Oct.	26 3 16 P.M.	1	67° 42' 50	Apl.	27 3 4 P.M.	1	67° 39' 37
	3 16 "	2	42' 75		3 4 "	2	39' 68
	29 3 7 "	1	43' 75		29 2 50 "	1	40' 87
	3 5 "	2	42' 93		2 50 "	2	41' 12
	Mean..	....	67 42' 98		Mean..	....	67 40' 26
Nov.	29 3 6 P.M.	1	67 43' 87	May	27 2 59 P.M.	1	67 40' 31
	3 4 "	2	42' 25		2 58 "	2	40' 00
	30 3 9 "	1	44' 06		31 3 31 "	1	39' 93
	3 9 "	2	43' 37		3 30 "	2	39' 68
	Mean..	....	67 43' 39		Mean..	....	67 39' 98
Dec.	29 2 56 P.M.	1	67 43' 18	June	27 3 20 P.M.	1	67 40' 37
	2 55 "	2	43' 62		3 19 "	2	39' 46
	30 2 53 "	1	43' 31		30 3 38 "	1	40' 31
	2 52 "	2	43' 06		3 35 "	2	38' 93
	31 3 7 "	1	42' 50		Mean..	....	67 39' 77
	3 6 "	2	42' 31				
	Mean..	....	67 43' 00	July	27 3 6 P.M.	1	67 40' 75
1881.	25 3 8 P.M.	1	67 41' 93		3 6 "	2	40' 00
Jan.	3 8 "	2	41' 37		29 3 16 "	1	40' 93
	26 3 14 "	1	42' 43		3 17 "	2	40' 68
	3 14 "	2	42' 18		Mean..	....	67 40' 59
	Mean..	....	67 41' 98	Aug.	30 3 0 P.M.	1	67 41' 59
Feb.	25 3 12 P.M.	1	67 41' 87		3 1 "	2	40' 68
	3 11 "	2	41' 50		31 3 14 "	1	41' 50
	28 3 12 "	1	42' 50		3 14 "	2	40' 18
	3 13 "	2	42' 56		Mean..	....	67 40' 99
	Mean..	....	67 42' 11	Sept.	29 3 3 P.M.	1	67 41' 75
Mar.	23 2 59 P.M.	1	67 41' 25		3 6 "	2	41' 37
	2 59 "	2	41' 43		30 3 37 "	1	40' 93
	28 3 1 "	1	41' 62		3 36 "	2	41' 37
	3 1 "	2	41' 37		Mean..	....	67 41' 35
	Mean..	....	67 41' 42				

APPENDIX II.

Meteorological Observations.—Table I.

Kew Observatory.

Longitude 0° 1' 15.1" W. Latitude 51° 28' 6" N. Height above sea-level = 34 feet.
 Mean Monthly results from the continuous Records for the Twelve Months ending September 30th, 1881.

Months.	Thermometer.*				Barometer.†				Pressure.	
	Extreme maximum.		Extreme minimum.		Extreme maximum.		Extreme minimum.		Means.	
	Date.	Ther.	Date.	Ther.	Date.	Bar.	Date.	Bar.	Vapour-tension.	Dry air.
1880. October....	d. h.	64.1	30.7	d. h.	inches.	inches.	d. h.	inches.	inches.	inches.
November...	7 3 P.M.	57.5	25.2	14 10 A.M.	30.433	28.707	28 10 A.M.	28.707	.268	29.622
December..	13 noon	55.5	26.0	21 5 "	30.493	28.738	16 2 P.M.	28.738	.229	29.748
	10 2 P.M.			7 11 P.M.	30.680	29.071	29 8 "	29.071	.242	29.698
1881. January....	31 3 "	48.8	9.4	7 { 8 " 9 " }	30.623	28.868	29 3 "	28.868	.152	29.750
February...	3 1 "	52.8	26.4	24 { 10 A.M. 11 " }	30.312	28.914	11 5 A.M.	28.914	.199	29.649
March.....	18 3 "	59.2	25.1	{ 17 midt. 18 1 A.M. }	30.565	29.134	7 5 P.M.	29.134	.213	29.697
April.....	13 1 "	66.8	29.9	28 10 "	30.270	29.645	30 8 "	29.645	.219	29.737
May.....	31 5 "	76.1	31.5§	10 11 P.M.	30.680	29.410	16 4 A.M.	29.410	.283	29.824
June.....	4 4 "	78.2	38.5	30 3 A.M.	30.335	29.433	6 4 "	29.433	.339	29.645
July.....	5 2 "	90.0	44.1	30.004	30.336	29.494	31 5 P.M.	29.494	.400	29.604
August.....	5 { 3 " 4 " }	80.7	43.1	4 9 "	30.349	29.372	26 3 A.M.	29.372	.378	29.476
September..	18 4 "	71.3	39.4	29 { 9 " 10 " }	30.430	29.441	21 8 "	29.441	.363	29.621
Means.....	....	..	..	....	..	..	....	..	.274	29.672

The above Table is extracted from the Quarterly Weather Report of the Meteorological Office, by permission of the Meteorological Council.

* The thermometer-bulbs are 10 feet above the ground.
 † One of the daily means somewhat doubtful.
 ‡ Readings reduced to 32° at mean sea-level.
 § Reading somewhat doubtful.

Meteorological Observations.—Table II.

Kew Observatory.

Months.	Mean amount of cloud (0=clear, 10=over-cast).		Rainfall*.		Weather †. Number of days on which were registered						Wind ‡. Number of days on which it blew						
	Total.	Maxi- mum.	Date.	Rain.	Snow.	Hail.	Thun- der- storms.	Clear sky.	Over- cast sky.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1880.	in.	in.															
October ..	5.945	1.080	9	18	2	..	..	1	20	3	13	2	..	1	4	4	4
November	1.785	0.560	18	15	..	..	5	5	14	5	4	1	1	3	11	3	2
December	3.300	0.650	29	13	5	..	..	2	22	2	2	1	1	1	12	9	3
1881.																	
January ..	1.170	0.500	18	6	5	..	..	5	18	3	7	6	1	2	4	4	4
February .	2.540	0.645	20	11	4	..	..	..	23	5	5	2	4	3	4	2	3
March	1.980	0.535	4	9	2	1	1	6	14	1	4	8	1	2	3	10	2
April	0.765	0.275	11	9	..	1	1	..	11	2	10	5	1	2	4	3	3
May	1.115	0.330	28	10	..	1	2	8	12	3	5	7	1	..	10	2	3
June	1.620	0.530	6	11	..	1	2	2	14	3	2	2	1	5	9	6	2
July	1.915	0.675	5	13	..	..	1	3	9	2	1	1	..	2	9	10	6
August ..	4.770	1.240	12	17	..	..	3	1	15	3	1	..	1	2	11	10	3
September	2.215	0.550	24	17	..	..	1	4	14	6	4	2	1	2	4	4	7
Totals..	29.120			149	18	5	11	37	186	38	58	37	13	25	85	67	42

* Measured daily at 10 A.M. by gauge 1.75 feet above surface of ground. † Derived from observations made at 10 A.M., noon, 2, 4, and 10 P.M.
 ‡ As registered by the anemograph.

Meteorological Observations.—Table III.

Kew Observatory.

Months.	Bright Sunshine.*		Maximum temperature in sun's rays.			Minimum temperature on the ground.			Horizontal movement of the Air.†		
	Total number of hours.	Number of hours Sun was above the horizon.	Mean.	Highest.	Date.	Mean.	Lowest.	Date.	Average daily Velocity.	Greatest Movement in a day.	Date.
1880.											
October	68 7	330 53	85·6	113·0	3	37·9	22·9	24	227	538	9
November	67 1	263 47	76·5	93·9	25	81·1	19·1	2	278	626	14
December	32 8	242 51	65·6	89·2	10	84·3	22·7	22	258	505	29
1881.											
January	33 3	259 12	56·6	88·0	31	22·4	7·0	17	230	1017	18
February	27 6	278 8	63·7	95·1	10	31·2	20·0	7	265	697	8
March	111 6	367 20	92·6	112·0	10	32·0	18·8	27	289	568	7
April	133 5	415 30	105·8	125·0	13	34·0	23·9	21	356	749	3
May	224 4	482 27	119·3	131·0	21	40·2	24·4	11	277	563	23
June	214 2	494 32	125·3	137·1	26	46·5	34·3	9	213	454	22
July	251 0	496 46	129·1	143·6	5	51·5	37·0	28	205	409	31
August	160 4	448 5	119·5	133·7	4	47·2	35·6	28	223	429	26
September ..	95 1	377 13	107·0	127·7	25	45·6	36·3	16	152	412	1

* Registered by the Sunshine-recorder.

† As indicated by a Robinson's anemograph, 70 feet above the general surface of the ground.