The maximum pressure was found to be equal to sustaining a column of water 31·73 ft. high. One of the most interesting portions of the experiments was to determine, if possible, whether any other force than the vital action of the roots is necessary to produce the sap-pressure. A black birch-tree was selected, and a root was severed at 10 ft. from the trunk, and to it was attached a mercurial gauge. This showed a maximum pressure equal to 85·8 ft. of water, and proved that "the absorbing power of living birch rootlets without the aid of any of the numerous helps imposed upon them by ingenious philosophers, such as exhalation, capillarity, oscillation, &c., was quite sufficient to account for the most essential of the curious phenomena connected with the circulation of sap."

Journal of the Franklin Institute, April.—The following are some of the important papers in the number:—Report of the Committee of the Institute on the Westinghouse car-brake. This brake in its simplest form consists of a small steam-engine placed in the locomotive, which, taking steam from the boiler, works an air-pump, which compresses air into a main reservoir, secured beneath the car. By an ingenious arrangement of pipes and automatically acting valves, the air is admitted into a series of brake cylinders, one under each car, the pistons of which are connected with and act upon the ordinary brake-levers, and thus apply the brakes to the wheels. The inventor has made important improvements on this, by means of which the compressed air may be admitted almost instantaneously into the brake-cylinders, and the train brought to a standstill in an incredibly short space of time; *e.g.* a train, going at the speed of thirty miles an hour up a gradient of 29·6 ft. per mile, was brought to a stop in 16 seconds. Scott's legacy, premium, and medal, were awarded to the inventor by the Institute.—The principles of shop-manipulation for apprentices is continued.—On the mechanical calculation of earthwork (or the results of physical measurements in general) according to the prismoidal or other formulæ, by C. Herschell, C.E. This paper relates mainly to the important uses to which the polar planimeter can be put.—Prof. R. H. Thurston contributes two papers which have been published separately: On the thermal and mechanical properties of air and other gas, subjected to compression or expansion; and On the strength, elasticity, and resilience of materials of machine construction; both papers are illustrated with diagrams.

THE *Journal of Mental Science* for April, opens with the third number of the Morrisonian Lectures on Insanity for 1873, in which Dr. Skae and Dr. Clouston still further exemplify the classification of the various kinds of insanity according to the bodily disease or condition with which they are associated. In speaking of Climacteric Insanity it is contended that men between 50 and 60 have a critical period corresponding to that passed through by women between 40 and 50; but the evidence seems far from conclusive. But nothing can be more striking and terribly instructive than the amount of insanity of one kind or another that is unmistakably connected with the organs and functions of generation.—The morbid psychology of criminals by David Nicolson, M.B., continues; and his observations on this unfortunate class are very valuable and well worth recording—especially perhaps may they prove useful "as a basis of comparison for kindred phenomena occurring in circumstances less definite and uniform." No one is likely to be very seriously injured by the common prison delusion "that their food is poisoned;" but if the same painful fancy take possession, as it sometimes does, of individuals in the outer world, it may not be so readily recognised as a delusion, and the consequences may be very mournful.—A psychological study of the character of Jean Jacques Rousseau, by J. Hawkes, M.D., suggests the idea of a washerwoman sounding the Atlantic with her clothes line, and finding it very shallow all over.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, April 1.—In this number Dr. Mohn furnishes a number of data from three years' observations of the temperature in and near Christiania—at the Institute and the Observatory—and of the decrease of heat with height; a station named Frognersäter having been chosen, situated about five miles NN.W. from the Observatory, and 408 metres above the sea. The air within the city is shown (as in other localities) to be warmer than without. The temperature in general decreases with the height, and most quickly in May; in the winter months the decrease is small, and it passes, in December, into an increase. Dr. Mohn studied the meteorological conditions present in three separate cases:—(*a*) Frognersäter warmer than Christiania; (*b*) colder and excessive; (*c*) change of temperature on fall of rain or snow. As regards (*a*), it occurred in cold weather; the wind N.E. or E., and light; atmospheric pressure about 7 mm. above normal; sky most often clear, but sometimes a mist covered Christiania, while Frognersäter was in sunshine. The author inquires at some length into the causes of change of temperature with height, and points out that the elements of greatest influence here are the strength of wind and the relative moisture. The change increases with the former and decreases with the latter. To this is joined the action of precipitates, in so far as this, accompanied by greater relative moisture, contributes to lessening the decrease of temperature with the height.—Prof. Ebermayer follows with a review (in part) of a new text-book of climatology by Dr. Lorrenz and Dr. Rothe. From personal observation he disputes the authors' assertion that the increase of cells in plants takes place only by night.—Among the "Kleinere Mittheilungen," we note some meteorological observations from the north-west coast of Spain.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 7.—"Preliminary Experiments on a Magnetised Copper Wire," by Prof. Balfour Stewart, LL.D., F.R.S., and Arthur Schuster, Ph.D.

1. The following experiments were made in the physical laboratory of Owens College, Manchester:—

A copper wire was wound fifty-three times in one direction round the poles of a powerful electro-magnet, the length of wire encircling these poles being about twelve metres.

A Wheatstone bridge was employed to measure the resistance of the wire, and a very delicate Thomson's reflecting galvanometer, by Elliott Brothers, was likewise used.

Experiments were made at intervals of two minutes; and on each occasion the current was allowed to pass through the bridge for ten seconds, the measurement being taken by the first swing of the galvanometer, which lasted for about eight seconds. Three cells of Grove's battery were used for producing this current, but on the other hand six similar cells were employed for magnetising the electro-magnet.

2. In the first experiments made, the induction-current due to the wire coiled round the magnet affected the galvanometer, but after Dec. 12 a solid key put into the circuit was taken out, so that no induction-current passed.

The following is a specimen of the observations made:—

Dec. 17, 1873.

Time of putting on current. h. m.	Whole deflection observed (increasing deflection denotes increasing resistance).	Condition of magnet.
11 11	312	off
13	317	off
15	311	off
17	345	on
19	328	off
21	306	on
23	303	off
25	293	on
27	300	off
29	290	on
31	307	off
33	283	on
35	292	off
37	288	on
39	302	off
41	292	on
43	309	off

It will be seen from this experiment that the *first effect* of putting on the magnetism was a marked increase of resistance; but with this exception the resistance, when the magnetism was on, was less than the mean of the two resistances on both sides of it, representing the magnetism off.

3. The arrangement remained untouched, as far as we know, from Dec. 15, when it was finally made, until Dec. 19, when the experiments were interrupted during the Christmas holidays; and in all cases the *first effect* of putting on the magnetism was a marked increase of resistance.

It was soon seen that this *first effect* had some reference to the time elapsing since the last experiments were made. For in-

stance, there was on Dec. 18 a marked increase of resistance when the magnet was first put on; but on the afternoon of that day the experiments were repeated, and there was no apparent increase of resistance in this *first effect*. Next, with regard to the *average effect;* on Dec. 16, 17, and 18, this *average effect* of magnetism was a decrease of resistance.

4. The experiments were resumed on Jan. 7, the arrangement having remained untouched during the holidays. From this date until Jan. 10 inclusive, the key was taken out before beginning experiments in the morning; there was no peculiar *first effect;* while, on the other hand, an *average effect* denoting a decrease of resistance came out very prominently. On Jan. 12 and 13 the key was only taken out before magnetising, and on these occasions the *first effect* denoting increased resistance was sufficiently marked.

Our method of procedure was varied in the above manner up to Jan 27; and it was invariably found that whenever the key was taken out before commencing experiments there was no *first effect;* but when it was kept in until before magnetising, this *first effect* was sufficiently marked. These experiments concur in proving that the *first effect* has some reference to the previous treatment of the wire, but they do not prove that it is at the same time connected with the putting on of the magnetism. To determine this point we made a set of experiments on Jan. 22, 26, and 27. When the current had become constant the key was taken out, but the magnetism was not put on; and on these occasions there was no *first effect* of the current upon itself in the direction of increased resistance, but rather in the opposite direction. It thus appears that the *first effect* which increases the resistance has not only reference to the previous treatment of the wire, but depends also on the magnetism being put on.

This result is confirmed by experiments made previous to Dec. 12, in which the key was not taken out at all. For instance, we have on Dec. 9—

First off.	On: First effect.	Second off.
0	+ 54	+ 45

We have hitherto only spoken of the *first effect* obtained after Jan. 7, we now come to the *average effect*. From Jan. 7 to Jan. 27 inclusive, the magnetism was always put on in the same direction, and the *average effect* invariably denoted a decrease of resistance when the magnetism was on.

5. On Jan. 28 the magnetism was reversed; the effect during this day was very irregular. On Jan. 29, 30, 31, Feb. 2, the key was left in until before magnetisation. The *first effect* was now extremely large, but it was suspected that during these experiments the contact of the key was not very good.

On Jan. 29 the *average effect* denoted a decrease of resistance, but on Jan. 30, 31, Feb. 2, 4, 6, the *average effect* denoted an increase of resistance.

6. From Feb. 6 until Feb. 11 the wires were left broken; on Feb. 11 there was a very slight *first effect* in the direction of increased resistance, and a slight *average effect* in the direction of decreased resistance. On Feb. 12 a mercury interruptor was used instead of a metal key, both the wires being broken by it, and its use was continued until Feb. 18. The interruptor was left in over night, and the current was only broken before magnetisation, but no *first effect* was observed.

From Feb. 19 to Feb. 26 one wire only was broken by the fluid interruptor, nevertheless there was no *first effect*.

On Feb. 12, when the fluid interruptor was first employed, there was a very small *average effect* in the direction of increased resistance; but in all the experiments afterwards this *average effect* was in the direction of decreased resistance. The magnetism had been in one direction from Jan. 28, but during the experiment of Feb. 25 it was reversed and retained in this condition through the experiment of Feb. 26 without appearing to affect the results.

7. From these experiments we may perhaps conclude as follows:—

In the *first place* there is a *first effect* in the direction of increased resistance which appears to have reference to three things, namely, the previous state of the wire, the solidity of the circuit, and its magnetisation.

In the *second place* we have an *average effect*, of which the normal state appears to denote a decreased resistance while the magnetism is on, without reference to the direction of the magnetism.

In the *third place*, when in a solid circuit the direction of the magnetism has been recently changed, there appears to be a temporary reversal of the average effect, which appears at first as an increase of resistance. Besides the evidence herein detailed, we have other evidence in favour of the third conclusion; for in some preliminary experiments, in which we frequently reversed the poles, we found an increase of resistance when the magnetism was on.

We are led to conclude, from other experiments besides these, that the effect of the magnetism is not merely confined to the part of the copper wire wound round the poles, but is propagated all along the wire. On Dec. 2, for instance, the current was passed through the wire, the galvanometer being joined as a secondary circuit. The main current was therefore measured.

The deflections were as follows:—

297	off	300	off
300	on	302	on
297	off	301	off
300	on		

This shows an average strengthening of the current equal to about 1-200 part of the whole. Were this strengthening due merely to the change of resistance of that part of the wire wound round the poles, the effect as measured by the much more delicate arrangement of Wheatstone's bridge would be much larger than was actually observed.

9. Allusion was made in Article 7 to some preliminary experiments in which increased resistance was observed when the magnetism was put on alternately in different directions. Similar experiments were made, giving the same result with a piece of coke and graphite which were between the poles of the magnet.

10. We have also some evidence that a copper wire, one end of which is wound round the pole of the magnet, changes its position in the electromotive series. Two copper wires were dipped into dilute nitric acid and connected with the galvanometer. A weak current passed through the galvanometer owing to a slight difference in the copper wires, one of which was also connected with the copper wire wound round the magnet. When the magnet was on, the current as a rule changed in intensity; but the effect was small, and the difficulty of having two copper wires which, when joined together and dipped into nitric acid, give a current sufficiently weak and constant, prevented us from getting any decided results.

11. In conclusion we have to state that we regard these results which we have ventured to bring before the Royal Society as preliminary, the correctness of which will, we trust, be confirmed by the further experiments which it is our intention to make.

Mathematical Society, Thursday, May 14.—Dr. Hirst, president, in the chair.—The president having vacated the chair gave an account of his paper On the correlation of two planes. "A correlation is said to be established between two planes, when their points and right lines are so associated that to each point in one of the planes, and to each line passing through that point, respectively correspond, in the other plane, *one* line and *one* point in that line." It was first shown that eight conditions are necessary and sufficient for the establishment of a correlation between two planes: and in the next place it was shown that the problem of determining a correlation between two planes which shall satisfy *any* eight given conditions is susceptible in general of a finite number of solutions. Systems of correlation were then considered: as also the origin and nature of exceptional correlations. Relations were next established between the characteristics and singularities of any system of correlations. An enumeration and classification of the fundamental systems of correlations were then made and illustrated by reference to a table in which the systems were arranged in six groups. Dr. Hirst also touched upon the number and nature of exceptional correlations in the fundamental systems. A table was exhibited showing the number of correlations satisfying eight elementary conditions. If α points in one plane have given polars in the other; β right lines in the first plane have given poles in the second; γ points and δ lines in each plane have given conjugates in the other plane, then $(\alpha\beta\gamma\delta)$ is termed the *signature* of the system of correlations satisfying the above conditions. We see that the systems of correlations corresponding to the signatures $(\alpha\beta\gamma\delta)$ and $(\beta\alpha\gamma\delta)$ are identical. The following two theorems are generalisations of the results arrived at:—(I.) In a system of correlations $(\alpha\beta\gamma\delta)$, the curve of the class $[\alpha\beta(\gamma+1)\delta]$ which represents either of two conjugate points A_1, A_2, breaks up into the other, together with a point on each of the singular lines associated with those which pass through the former. The multiplicity of A_2 on the representa-

tive of A_1 is $[(\alpha+1)\beta(\gamma-1)\delta]$, and that of A_1 on the representative of A_2 is $[\alpha(\beta+1)(\gamma-1)\delta]$. The number of singular lines which pass through A_1 is $[\alpha\beta(\gamma+1)\delta] - [(\alpha+1)\beta(\gamma-1)\delta]$, and the number of those which pass through A_2 is $[\alpha\beta(\gamma+1)\delta] - [\alpha(\beta+1)(\gamma-1)\delta]$. (II.) In a system of correlations whose signature is $(\alpha\beta\gamma\delta)$, the curve of the order $[\alpha\beta\gamma(\delta+1)]$, which represents either of two conjugate lines a_1, a_2, breaks up into the other, together with a line through each of the singular points associated with those situated on the former. The multiplicity of a_2 on the representative of a_1 is $[\alpha(\beta+1)\gamma(\delta-1)]$, and that of a_1 on the representative of a_2 is $[(\alpha+1)\beta\gamma(\delta-1)]$. The number of singular points situated on a_1 is $[\alpha\beta\gamma(\delta+1)] - [\alpha(\beta+1)\gamma(\delta-1)]$, and the number of those situated on a_2 is $[\alpha\beta\gamma(\delta+1)] - [(\alpha+1)\beta\gamma(\delta-1)]$.—Mr. Spottiswoode (the chairman *pro tem.*) and Prof. Clifford spoke on the subject of Dr. Hirst's communication.—Mr. Spottiswoode, F.R.S., next briefly stated some of the results given in his paper On the contact of quadrics with other surfaces. The following were amongst those stated:—Through any m (or $m+1$) points of space 3^m-2 surfaces, having $2m-2$ (or $2m-1$) independent constants in their equation, can be drawn such that a quadric may be described touching any of the surfaces in the m (or in m out of the $m+1$) points. Thus for example:—the equation of a quartic scroll having a triple line is $(ax+by)\,zx^2 + (cx+dy)\,wy^2 - mx^2y^2 = 0$; hence, through any three points of space, three quartic scrolls having the same double line can be drawn such that a quadric may be described touching any one of the scrolls in the three points. Again, the equation of a quartic surface having for its nodal line the twisted cubic $p = xz - y^2 = 0$, $q = xw - yz = 0$, $r = yw - z^2 = 0$, may be put in the form $ap^2 + bq^2 + cr^2 + 2(fqr + grp + hpq = 0$, hence, through any four points of space, three quartics, having the same twisted cubic for their common nodal line, may be drawn such that a quadric may be described touching any one of the quartics in three of the points. Remarks were made on the paper by the president and by Prof. Clifford.—A paper by Mr. J. H. Röhrs, communicated by Prof. Cayley, was taken as read. Its subject was "The Rotation of a Hollow Sphere filled with viscous fluid and made to rotate about an axis through its centre under the action of an external impressed given periodic force."

Meteorological Society, May 20.—Dr. R. J. Mann, president, in the chair.—The following papers were read:—Some remarks on the estimation of wind force, and on the relation between pressure and velocity, by C. O. F. Cator, in which he first expressed a strong opinion on the impossibility of *estimating* the force of the wind with any degree of accuracy; but thought that for any useful purpose it must be obtained from *instrumental* observation. He then referred to the different notations for describing the wind, and condemned Beaufort's (0 - 12) as eminently unsatisfactory, both on account of the means by which the numbers were arrived at, and also especially because of the difference of standard for the lower and higher numbers. He suggested that during an observation the wind could not practically be described as an absolute force, on account of its frequent variations, but as a varying force, extending over two or three numbers; and then proceeded to account for the difference of force, as estimated, at any stations from different directions although the velocity as shown by Robinson's cups might be the same—partly by the position of the observer not being identical with that of the cups, and partly from the surrounding objects. He then suggested a new scale, and that whether pressure or velocity were the basis, it should increase in arithmetical progression, and concluded by expressing his preference for the former.—On the weather of thirteen winters, by R. Strachan.—On a new deep-sea and recording thermometer, by H. Negretti and J. W. Zambra.—On a new mercurial minimum and maximum thermometer, by S. G. Denton.

Anthropological Institute, May 26.—Prof. Busk, F.R.S., president, in the chair.—Mr. Hyde Clarke read a paper entitled "Researches in Prehistoric and Protohistoric comparative philology, mythology, and archæology, in connection with the origin of culture in America, and its propagation by the Sumerian or Akkad races." The author began with the illustrations of the common origin of culture in Asia, Africa, and America in a chronological series of the distribution of languages in the old and new worlds in the Prehistoric and Protohistoric epochs. These included the Negritos or Pygmeans, the Cannibal races, the Carib-Whydah-Aino, the Honduras African, the Khond-Wolof, the Agaw-Guarani, the Vasco-Kolaro-Lesghian, the Ugrian, the Sumerian, &c. New facts in comparative grammar were adduced, embracing the names of animals, of weapons, the series of negative terms, and the connection of philology, mythology, and archæology, with a table of convertible equivalents of primary radicals. The second part of the paper was devoted to a special consideration in detail of the community of the Aymara and Quichua of Peru, the Maya of Yucatan, and the Mexican with those of Cambodia, Pegu, and Indo-China, and of these again with the newly-deciphered Sumerian or Akkad (cuneiform) and the connection with Georgian and Etruscan. These were combined with the monuments, arts, and archæology of the respective countries. The author, referring to his identification of the languages of the Brazil with the Agaw of the Nile, and the Akkads of the Caucasus, supported the view that culture had been introduced into South America across the Pacific by Easter Island, and suggested that it was from one original source in high Asia.

PARIS

Academy of Sciences, May 25.—M. Bertrand in the chair.—The Perpetual Secretary announced the death of M. Antoine-Marie-Rémy Chazallon, correspondent for the section of geography and navigation.—The following papers were read:—Note on the movement of the conical pendulum, with consideration of the resistance of the air, by M. H. Resal.—M. P. Desains presented the continuation of his paper on solar radiation. The author has employed in these experiments a modification of Nobili and Melloni's thermo-electric apparatus.—On the transformation of iron into steel, by M. Boussingault. The author's observations and analyses tend to show that melted steels of superior quality are really iron and carbon. As the quality improves sulphur diminishes, and they are generally free from phosphorus, while manganese and silicon rarely exceed 1-1000.—Observations on the spectrum of comets, by P. Secchi. The author has observed the spectrum of Winnecke's and Tempel's comet, and also of Coggia's. The results in the latter case point again to the existence of carbon in these remarkable bodies. In the same paper further evidence was adduced that the line 1,474 does not belong to iron; and the author communicated also an observation on the effect of atmospheric oscillation on the appearance of Jupiter's first satellite just before passing on to the planet's disc.—On the Vidal ebullioscope, by M. E. Malligand and Mlle. E. Brossard-Vidal. This instrument is for the valuation of wines, and other alcoholic liquids.—On a new mineral species from the province of Lerida, by M. X. Ducloux. The analysis agrees with the formula $Sb_2O_5 + 4CuAgCO_3$.—On the conditions of the persistence of sensibility in the peripheral extremity of sectioned nerves, by MM. Arloing and L. Tripier.—On the addition of elliptic functions, by M. E. Catalin.—M. l'Abbé Aoust presented a paper in reply to the observations made by M. Serret on his paper on the integrals of curves which have an even polar surface.—M. Ch. Bontemps communicated his third note on the motion of the air in pipes.—On the action of sulphur urea and of carbon disulphide on silver urea, by M. J. Ponomareff.—Researches on germination, by MM. P. P. Dehérain and E. Landrin. Experiments on grain have shown that no gas is so hurtful to germination as carbon dioxide.—On ammonia and ammonium phenate in the treatment of cholera and diseases produced by ferments *à propos* of serpent bites, by Dr. Déclat.

CONTENTS

ERRATA.—Omit "so" in p. 62, col. 2, line 22 from bottom; p. 63, col. 2, line 20 from top, for "individual" read "undivided."