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PETTIGREW ON THE LOCOMOTIVE.

A Manual of Locomotive Engineering. By William Frank Pettigrew, M.Inst.C.E.; with a selection of American and Continental Engines, by Albert F. Ravenshear, B.Sc., Whit. Sch. Pp. 430. (London: Charles Griffin and Co., Ltd., 1899.)

IT is with much pleasure we welcome this valuable addition to the literature of locomotive engineering—a subject seldom dealt with in text-books, and one which depends more on the results of experience than on theory as usually set forth in our technical schools. An author, therefore, in a position to deal with the subject in a satisfactory manner must of necessity have had a railway experience of no ordinary kind. In fact he must have gone through the mill in the form of the shops, works-management, and finally as locomotive superintendent. The author of this volume fills these requirements exactly, consequently we are not disappointed with his work.

In a volume consisting of about 400 pages we find the subject carefully treated, and divided into twenty-two chapters with three appendices. To commence with, we naturally find the pioneer forms of locomotives historically dealt with, and this is as it should be from the student's point of view; the credit, however, for earlier successes does not always appear to be given to the proper parties. The "Rocket," for instance, was a success mainly because of the multitubular boiler patented by William Henry James, and adopted by Stephenson in consideration of one-fourth share of the patent obtained by Losh and Stephenson for locomotive engines. The progress of earlier locomotives in the United States is also described—a very interesting subject when one remembers that "Old Iron Sides" was built by W. Baldwin in 1832, this maker being represented to-day by the eminent firm of the same name in Philadelphia.

On the subject of modern simple locomotives the author has a wealth of material at hand, that is to say, on single expansion engines. In Chapter ii., dealing with this branch of the work, we find a cursory definition of wheel-base, engine power, tractive force, boiler power, &c. (all of which are exhaustively treated later on in the work), after which very full and excellent descriptions of modern practice are given. The famous "Dunalastair" of the Caledonian Railway is mentioned; but more should have been said of this engine, for Mr. J. F. McIntosh, the able locomotive superintendent of that railway, is certainly the prophet of the big boiler in this country, and deserves mention for this reason. Other Scotch engines are described, including those of the Highland Railway, the illustrations of which do not include the louvres in the chimneys, "a fatal oversight." As an example of the older practice on the Manchester, Sheffield and Lincolnshire Railway, we find Mr. Charles Sacre's single express engine; we should have preferred the double-framed four-coupled bogie as a record of this eminent locomotive engineer. But why does the author omit the present practice on the Manchester, Sheffield and Lincolnshire, or rather the Great Central Railway, an example of which would have been interesting?

Chapter iii. deals with compound locomotives, and very fully does the author describe the various systems in vogue. Here this type of locomotive is uncommon, except on the North-Western Railway, where the Webb system is in use. Many experiments have been made on different railroads, but nearly all have returned to the simple type for express work, although for heavy goods traffic the Worsdell system is in use on the North-Eastern Railway.

On primary considerations of locomotive design we find much useful information, more particularly on train resistance, the author maintaining that the older formulæ are not sufficiently accurate, due to various causes, and proposes one which agrees fairly with practice, viz. $R = 9 + \cdot 007\ V^2$, where R is the resistance in pounds per ton, and V the speed in miles per hour. On the question of proportionate heating surface the author gives minimum values, and goes on to say, get as much as the design will allow. This is no doubt the right view to take, and locomotive engineers in this country are waking up to the fact that the bigger the boiler the more satisfactory the engine.

The author having been the works manager in the Nine Elms Works of the London and South-Western Railway Company for many years, one naturally expects to find all the detailed descriptions of parts of a locomotive very practical and concise. In Chapter v., dealing with cylinders and their parts, this expectation is fulfilled. A useful addition would be to add a simple test for cylinder metal, such as a tensile test of, say, 11 tons per square inch, or the regular shearing test of a 2-inch by 1-inch bar on supports 3 feet apart, to deflect three-tenths of an inch with a breaking load of not less than 35 cwt.

The conical form of piston-head shown in Fig. 69 was adopted by the late Mr. Stroudley to enable him to get as long a connecting rod as possible, and was usually made of gun-metal for the express engines. Many piston-heads are running made of wrought iron, a fact which the author fails to mention.

The descriptions of the arrangement of single and double slide bars are good, but we fail to read that the arrangement with four bars in Fig. 81 is the best when considered from the standpoint of weight of moving parts and balancing them. Further on, our author deals with connecting and coupling rods of various designs. Generally we find very little information as to the material used for these important details, and where steel is mentioned no tensile tests are given.

Chapter ix. deals with the important question of balancing the moving parts of a locomotive when in motion, and we must cordially congratulate Mr. Pettigrew on the very clear manner he has handled this important subject. The examples given are clear, and are worked out without unnecessary use of higher mathematics.

Valve gear, as dealt with in Chapter x., is of a purely descriptive nature, and includes the usual types. The Morton gear might have been included as a curiosity, as a goods engine has been satisfactorily running for some years on the North British Railway fitted with it. Of valves of different descriptions we find much valuable information, including the piston type of valve, largely used at sea, and now, under the name of Smith's Patent, being experimented with on the North-Eastern and Midland Railways, the Highland Railway having tried and discarded it some short time ago. Valve gear in detail comes next, and we cannot agree with the author when he says that in inside cylindered engines expansion links with one bracket only are used. This is the exception and not the rule—*vide* the practice of the Brighton, Caledonian, and North British Railways.

Taken as a whole, the descriptions of all detailed work represent modern practice, and the engineering student will find much to learn in these pages. Chapter xiii. deals with the all-important question of the general construction and design of the locomotive boiler; after discussing the questions which really concern its dimensions, the question of various types is described. The now fashionable Belpaire type is badly illustrated in Fig. 155, which must represent an American or continental type of boiler, although the author does not say so, and the arrangement of stays and plating is certainly not of British design. The Belpaire boilers designed by Messrs. Neilson, Reid, and Company for the Mexican railways some years ago might be taken as fair representatives of this type of British design, and should be illustrated in a future edition—they being the prototype of some running on more than one British railway.

In order to allow freedom for expansion of the tube-plates of Belpaire boilers of British design, it is usual to arrange the last transverse rows of vertical stays so that any vertical movement of the fire-box will not be transmitted to the wrapper-plate; moreover, a similar arrangement might be placed above the door-plate with advantage.

On the use of steel in boiler construction we find much valuable information, but we most distinctly disagree with the author when he states on p. 200 that steel of boiler-plate quality contains a maximum of 15 per cent. and a minimum of 10 per cent. of carbon! What has happened to the decimal point? The author, like many others, has not yet got over the idea that steel-plates require very special treatment in the flanging-shed and boiler-shop. This is not the case; steel-plates, as manufactured to-day, are more uniform in quality, and are certainly as easily worked as Yorkshire iron. On p. 215 we read that on the Caledonian Railway the roof of the fire-box is supported by vertical stays fastened in series of threes in a longitudinal direction. These stays were on the scrap-heap years ago.

On the question of machine riveting, our author maintains that subsequent caulking of rivet-heads is unnecessary. If this is the case, why do our best firms of locomotive builders invariably carefully caulk every rivet-head before the boiler is tested? They work for a profit, not for honour and glory.

Mr. Ravenshear gives a very full description of continental and American locomotive practice, with illustrations, which will be found towards the end of this volume, besides the usual descriptive accounts of the vacuum and Westinghouse railway brakes. Taken as a whole, this work is one of the best of its kind that has been published on the subject. The strains experienced by various parts of a locomotive during work are impossible to calculate, and, therefore, it must be every-day experience that can train the successful designer. For this reason a text-book on this subject can only be descriptive of work done which successfully withstands the usages of every-day work.

NORMAN J. LOCKYER.

THE HEREFORD EARTHQUAKE OF 1896.

The Hereford Earthquake of December 17, 1896. By Charles Davison, Sc.D., F.G.S. Pp. xi + 303. (Birmingham: Cornish, 1899.)

AFTER an interval of more than two years Dr. Charles Davison has at last given us, in a volume of 303 pages, his long-promised account of the earthquake which, in the early morning of December 17, 1896, rudely awakened the inhabitants of the Severn Valley.

When we look at the 2902 epitomised accounts which Dr. Davison has brought together respecting an earthquake which in many countries would have been regarded with as much indifference as a sprinkling of rain, we are inclined to ask whether the examination of this long series of remembrances, obtained from a community more or less excited by phenomena with which they had but little experience, would be likely to lead to results of any value. Had this earthquake originated in a sparsely populated country where there were difficulties in obtaining accurate time, the analysis of observations taken under such conditions would, to a large extent, have been labour in vain.

Although no special provisions are taken in Britain for the observation of earth tremors, as the one now under consideration occurred at the waking hour of many millions of people who, lying on their beds, were in the best possible position for noticing slight vibrations, and for the most part had the means of obtaining fairly good time, and above all were intensely interested in the phenomenon they experienced, the conditions for obtaining a large series of valuable records were unusually favourable. Within the epifocal area where chimneys fell or were "hurled to some distance"—which we doubt—and buildings were unroofed, and within at least one hundred miles of the same, all the observers had but little doubts as to the nature of the movements they experienced. Beyond these limits in very many instances it is likely that many observers only realised and remembered that a something or other had rattled, perhaps the window or a lamp-shade, after they had read their morning papers, and with feelings of satisfaction as participants in an alarming disaster, they threw in their notes and helped to complete an important chapter in British seismology. If every time a window was slightly shaken, glasses rattled, or other unaccountable microphonic disturbances were perceptible could be recorded, and the collected results analysed, it is extremely probable that the seismic register for the British Islands would be considerably increased.

Before discussing the catalogue of observations, Dr. Davison sets out by showing that there is a reality of connection between the majority of earthquakes and the slow but intermittent growth or extension of faults. This done, he draws on a map isoseismals or curves surrounding all places at which the intensity of the movement, as represented in certain cases by its destructivity, has been approximately equal. The most important of these is isoseismal number 8, which is the innermost and contains some seventy-three places at which there was structural damage. It is oval or elliptical in form, with its major axis forty-three miles in length running from N.W. to S.E., and encloses the towns of Hereford, Ross and Gloucester. Outside this are the isoseismals numbered 7, 6, 5 and 4, a series which become more and more circular in form, the latter extending beyond Wexford and Dublin in the west, and Norwich on the east.

From the form of these isoseismals, especially that of No. 8, which is the most important, by reasoning familiar to seismologists it is shown that the disturbance originated along a line of fault which dips to the north-east, and has a strike coinciding with the major axis of the innermost of these curves of equal intensity.

It appears that two series of vibrations were noted, which at different places were different in intensity and duration. An examination of the records relating to these leads to the conclusion that the principal shock originated from two foci along the line of fault, one near to Hereford, and the other near to Ross.

At this point Dr. Davison is hand in hand with the geologist who, having already mapped faults bounding the triangular area of May Hill, south-east of Hereford, now sees that there are good reasons for supposing that one of these is but the south-eastern extension of that revealed by the distribution of vibrational effects accompanying the Hereford earthquake. Davison's fault therefore throws new light upon the geotectonic relationships amongst the older rocks in Western Britain, and that there is such a rupture in the Old Red Sandstone to the east of Hereford may at any time be of importance not only to the geologist but to the engineer.

Another set of lines discussed are those passing through places at which the same phase of the earthquake was felt at the same instant. These are the well-known coseismal lines, which are less elongated than the isoseismals, but have their major axis in approximately the same direction. From the distances between them, velocities of transit varying between 2814 and 3095 feet per second are calculated, suggesting, but not on very certain grounds, an apparent increase in the velocity of earthquake transmission as it radiates. With a knowledge of the velocity between any two coseismals and the distance of one of them from the epicentre, the time of origin of the earthquake is determined as having been at 5h. 31m. 45s. a.m.

To the seismologist, the most striking feature in Dr. Davison's work is his treatment of the sound phenomena. Mr. Mallet in his classical work on the Neapolitan earthquake of 1857 gives us a chapter on the sounds that attend a shock, and which are produced by steam or by the rending of rocks. In a previous publication, Dr. Davison has given us his views as to the origin of earthquake sounds, which he attributes to the slipping or mechanical disturbance in the marginal region of the seismic focus.

In the present work, he gives us a map showing isacoustic lines or lines of equal sound intensity. Any one of these lines passes through districts in which the percentage of observers who noted a sound are equal, and they are therefore more strictly speaking, as the author states, lines of equal sound audibility.

The major axis of these closed curves is, roughly speaking, at right angles to that of the iso- and coseismal curves. More accurately it is a hyperbolic trace which follows the band, along which it is shown that the two series of vibrations from the two earthquake foci are superimposed.

The general result arrived at from the study of these isacoustic lines is that they confirm the conclusion that there were two distinct, or nearly distinct, regions along the fault line from which vibrations radiated, and that the slip at the northern end of this line occurred a few seconds earlier than at the southern end. In this discussion of sound phenomena we have something distinctly original.

The shock was felt less upon hard rocks and on high ground than on soft ground and in valleys. In the Bangor-Anglesey district the shock was felt most powerfully upon the carboniferous and ordovician rocks, and less upon the volcanic materials and schists. It was felt underground in several mines; at some places it produced feelings of nausea, and many instances are recorded of horses, cows, dogs, sheep, pheasants and other birds having exhibited symptoms of alarm.

Without going further into Dr. Davison's work, taking the same as a whole, he is to be congratulated on having extracted from materials which at first sight are of very little promise a quantity of valuable and novel information. The Hereford earthquake was a transient shivering of an exceedingly small portion of the earth's crust; and, considering that there may be 10,000 of these occurring every year, this one appears to have been more carefully studied than any of its predecessors of equal magnitude.

Had the author contented himself with analysing half the facts he has collected, although the same would have made a column of print 100 yards in length, the probability is that, beyond noting a number of incidents of local interest, our knowledge of seismic phenomena would have not been materially increased. As it is, especially perhaps with regard to isacoustics, a distinct advance has been made, and in the future we shall find others working on similar lines. J. MILNE.

A BIOLOGICAL RECORD.

L'Année Biologique. Comptes rendus annuels des travaux de Biologie générale, publiés sous la direction de Yves Delage, professeur à la Sorbonne, avec la collaboration d'un Comité de Rédacteurs. Secrétaire de la rédaction, Georges Poirault, Docteur ès sciences. Première année (1895). Pp. xlv + 732. 1897. Deuxième année (1896). Pp. xxxv + 808. 1898 (Paris: Schleicher Frères.)

IN one of the Woods Holl Biological Lectures, entitled "Bibliography: a Study of Resources," Dr. Charles Sedgwick Minot, himself the author of one of the standard zoological bibliographies, compares the biological bibliographer to an explorer in a forest "who finds no open way to travel, but must laboriously hunt for his specimens . . . as they lie scattered, unclassified, and, all too often, concealed." These words were spoken in 1895, but now the two bulky volumes before us show that the biologist need not lose hope in the ever thickening jungle of literature. They form a thoroughly competent biological record for two years, and, whatever may be their defects in detail, they deserve a hearty welcome. If Prof. Delage's undertaking is supported as it should be, not only by subscribers, but by co-operators, it should do much in the future to widen the interest of naturalists in the great problems of biology, to raise the standard of biological scholarship, and to curb the impatience of those who hasten to ill-advised reiteration of tales many times told.

This "biological record" does not compete with its seniors—the *Zoological Record*, the Naples *Jahresbericht*, and others akin, nor with the Zürich Concilium over which Dr. Field presides, nor with the *Journal of the Royal Microscopical Society*, the *Zoologisches Centralblatt*, and their like, for, as the title indicates, it aims at recording and summarising and appreciating those papers which deal with or have a bearing on *general biological problems*. It is a record for biologists, not for systematists, anatomists, physiologists, embryologists, and palæontologists, who have their own "resources"—though none would be the worse of availing himself of this also.

The task is somewhat similar to that which has been attempted for many years in the first part (General Subjects) of the *Zoological Record*, and in the corresponding portion of the Naples *Jahresbericht;* but there are several notable differences. The meshes of the net used by *L'Année Biologique* are finer than in the others ; it is botanical and anthropological as well as zoological ; and there are more or less adequate signed summaries of all the important papers recorded. On the other hand, it is only fair to notice that the Records which are issued from the Zoological Society of London, by the Naples station, and by the botanists, come much more nearly up to time. Thus, we must be ungrateful enough to observe that the third volume of *L'Année Biologique* dealing with 1897 is not yet to hand ; and it is of course obvious that the editors of the later records have the advantage, which no one grudges, of being able to utilise the labours of their more up-to-date predecessors.

What the editors understand by the term "biological" is at once seen from the table of contents, which includes about a score of subjects : the cell ; the sex-cells and fertilisation ; parthenogenesis ; asexual reproduction ; ontogeny ; teratogeny ; regeneration ; grafting ; sex ; polymorphism, metamorphosis, and alternation of generations ; latent characters ; correlation ; death, immortality, and the germ-plasm ; general morphology and physiology ; heredity ; variation ; origin of species ; geographical distribution ; nervous system and mental functions ; and general theories. It is easy to criticise, but it seems to us that this classification is unwieldy, and it has certainly led to an unnecessary amount of repetition. We notice, for instance, at least one case where the same paper has been summarised twice at considerable length by different recorders, which, however interesting, is luxurious.

Prof. Yves Delage and Dr. Georges Poirault deserve the gratitude of all biologists for their monumental record, though perhaps only bibliographers will adequately appreciate the magnitude of the labour involved. It is of course a co-operative work, organised from the contributions of a large body of workers in Europe and America, and, as our own share has been a minimal one, we are bold to say that the co-operators also deserve some gratitude for their labour of love. An interesting and valuable feature is the general discourse which precedes most of the sections, sometimes rising to the dimensions of a comprehensive essay, as in the case of correlation, phagocytosis, and geographical distribution. There seems, indeed, just a hint of overdoing this part of the record.

Every one will agree that the prime and indispensable virtue of any bibliography is accuracy, and in this respect we must in honesty say that there is still room for improvement in *L'Année Biologique*. We took the trouble to correct three pages in the first volume, and the result is certainly not beautiful to look upon. We hasten, however, to add that the inaccuracies affect the letter rather than the spirit of the bibliographer's laws, and that the second volume has attained to a high standard. We ourselves well know how insidiously mistakes creep in, and we are in no mood for fault-finding, yet it must be remembered that accuracy comes first in the criteria of bibliographic work. With a task so huge, the only hope is that there may be more generous co-operation. Surely some of those who make game of a busy recorder's mistakes might sometimes remember that amelioration for the future will be furthered by the simple device of sending in copies of their works to be at hand both in the compilation and in the proof-reading of the record.

Since the volumes before us were published, we have thoroughly tested their usefulness, and, frankly, we cannot but be surprised if every serious biologist does not agree with us in calling them indispensable. As for those gay knights-errant who care not for any of these bibliographies, we can only regret that they thereby do injustice to their genius.

And, finally, we should say in welcoming this biological record, that as there is a social as well as a scientific aspect of bibliography, it seems to us a matter for genuine congratulation that the editors have endeavoured to place their record upon an international basis—an endeavour which will, we hope, eventually have further development in an increasing recognition of the cosmopolitanism of science.

J. A. T.

OUR BOOK SHELF.

A Short History of Astronomy. By Arthur Berry, M.A. Pp. xxxi + 440. (London : John Murray, 1899.)

READERS of this volume will probably be divided into two classes, those who are pleased with any description of a subject, however disconnected, and those who wish the whole of the ground to be covered, even though many details may only be slightly touched upon. To the former the book will offer much pleasant reading, but it is likely that the latter will be disappointed with the treatment of the matter as it is here presented.

Chapter i. is entitled "Primitive Astronomy," much of the space, however, being taken up by explanations of the various definitions of the celestial sphere. Considering the amount of painstaking labour which has been devoted by many modern inquirers to proving the extent of the astronomical knowledge of the Egyptians and other ancient nations, as evidenced by their temples and monuments, it is rather hard to be told that this is but "a plausible interpretation of these peculiarities."

Chapter ii., dealing with "Greek Astronomy" from 600 B.C. to 400 A.D., is much more readable. Commencing with the introduction of the calendar and its various alterations, the successive celestial systems figured out by Plato, Aristotle, Aristarchus, Hipparchus, Ptolemy, &c., are very lucidly explained. The comparatively slow development of astronomy during the Middle Ages, from 600 A.D. to 1500 A.D., forms the subject of Chapter iii. Towards the end of this period, the first authentic conceptions of the celestial bodies being situated on concentric crystal spheres were enunciated.

The fourth chapter is entirely devoted to the enormous impetus given to astronomical knowledge by the teachings and work of the great Copernicus, extending over the period 1473 A.D. to 1543 A.D. The succeeding five chapters deal with the life-works of Tycho Brahe (1543–1601), Galilei (1564–1642), Kepler (1571–1630), and Newton (1643–1727).

Chapter x. deals with the progress of observational astronomy during the eighteenth century, the chief workers during this period being Flamsteed, Halley, Bradley, Maskelyne and Lacaille; while the following chapter reviews the mathematical aspect of the science for the same epoch, Euler, D'Alembert, Lagrange and Laplace occupying the places of honour.

Chapter xii. is devoted to the work of Herschel from 1738 to 1822. These few chapters are extremely interesting, but it is very disappointing to find that the astronomical progress of the nineteenth century is crowded into the remaining fifty pages. Considering the enormous advances made during this period, this is wholly out of proportion, and in consequence many important matters have either been merely mentioned or omitted altogether. For example, although the book is sufficiently up to date to mention the discovery by Prof. Nasini of a terrestrial gas whose spectrum contained a line probably coincident with the chief coronal line, it is distressing to find no mention whatever made of the gigantic Draper Catalogue of Prof. Pickering dealing with the classification of stars according to their spectra; indeed, the only reference to photographic work on stellar spectra is in connection with motion in the line of sight. Again, the whole matter of the organisation, &c., of the great photographic survey is contained in twelve lines. The mathematical portions of the science are, however, treated much more generously.

The author has attempted a very difficult task in condensing the whole history of astronomy into so small a volume, and it is from this standpoint that the book must be judged. Although to the individual there is much that is unsatisfactory, the work contains a great amount of useful information, which will no doubt cause it to find favour.

Outlines of Physical Chemistry. By A. Reychler. Translated by John McCrae, Ph.D. Pp. xvi + 276. (London and New York: Whittaker and Co., 1899.)

THE choice and arrangement of the subject-matter of this book is fairly satisfactory. It includes the laws of chemical combination, the atomic hypothesis, the gas laws, vapour density, the specific heat of solids and the periodic system. The second part contains a fuller discussion of the properties of gases and the critical phenomena, the connection between chemical constitution and the boiling point, volume, refraction and rotation of liquids, and the properties of solutions. The third part deals with thermo- and electro-chemistry and the nature of solutions of salts. The fourth part treats of chemical equilibrium and the velocity of reactions. The treatment of this subject-matter does not, however, appear to be distinguished by any striking originality or other special merit which would warrant the translation of the book. On p. 2, the law of constant proportions is stated thus: "In order to form a substance, it is always necessary to have the same elements united in the same proportions." This is much the same as saying that any two samples of the same kind of matter have the same composition. As Mr. Hartog pointed out in these columns, a correct statement of the law of constant proportions should emphasise the view, upheld by Proust, that the proportions in which two substances combine alter *per saltum*, and that there is not (as Berthollet believed) a series of compounds of all intermediate compositions bridging over the gaps.

It might have been mentioned that the conclusions drawn by Traube from his work on the volumes of liquids (pp. 66–70) are not universally accepted.

The account given of the reasons for assuming the existence of free ions in electrolytes is so incomplete as to be misleading. The work of Clausius is not mentioned, and the considerations which led Arrhenius to his extension of the hypothesis of Clausius do not receive much better treatment.

The evolution of heat accompanying the solution of substances like hydrochloric acid or caustic soda in water is regarded by the author as an insuperable objection to the ionic hypothesis in its usual form. To overcome this objection he proposes a modified hypothesis in which the sodium ion in solutions of sodium salts, for example, is supposed to be combined with an hydroxyl group. In order to explain the phenomena of electrolysis, the charged sodium ion is supposed to be continually passing from one hydroxyl group to another; an exactly similar supposition, however, led Clausius to assume that the ions spend at least some portion of their existence in the free state, so that the author's modification appears to consist in the addition of a new (and unnecessary) hypothesis to the old one. A discussion of this kind is, in any case, somewhat out of place in a book intended for beginners.

The translation might have been better; we do not like "luminary vibration" (p. 81); "the ascension of the mercury" in a thermometer (p. 137); "measurement instruments" (p. 189); "the comparativeness of our results" (p. 197); "electrolysable compounds" instead of electrolytes; "this scientist" (presumably *ce savant* in the original); "the momentary course of the reaction" (p. 249) instead of the velocity of the reaction at a given instant.

Views on Some of the Phenomena of Nature. By James Walker. Part II. Pp. vi + 187. (London: Swan Sonnenschein and Co., Ltd.)

AMONG the views expressed are that "Light is the sensation produced through the medium of the organ of vision by the action of multitudinous effluvia, exhaled by the sublimation of the incandescent substances which exist in the sun's photosphere, and which are borne into space by an eruptive force, emanating from the contracting body of the sun." After a review of a number of scientific and unscientific statements, the book concludes with the question "As to the 'mode of motion' theory of heat, or the 'wave' theory of both light and heat, of electricity and ether, is it any more than a fiction of the imagination?" Persons who would reply in the negative will be impressed by the arguments of Mr. James Walker.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Physical Measurement of Public Schoolboys.

I ENCLOSE photographs of two lecture diagrams which were used for a paper on the physical development of public schoolboys read to the Medical Officers of Schools Association last Easter. The curves represent the various different schemes of growth followed by schoolboys from the age of 10½ to 18½, according as they are developing into large, small, or medium sized men. They are constructed from corresponding series of curves of distribution, which curves are constructed from a large number of observations recorded at various public schools. From 14,000 to 15,000 observations have been collated for the construction of each series, and I regard them as being fairly

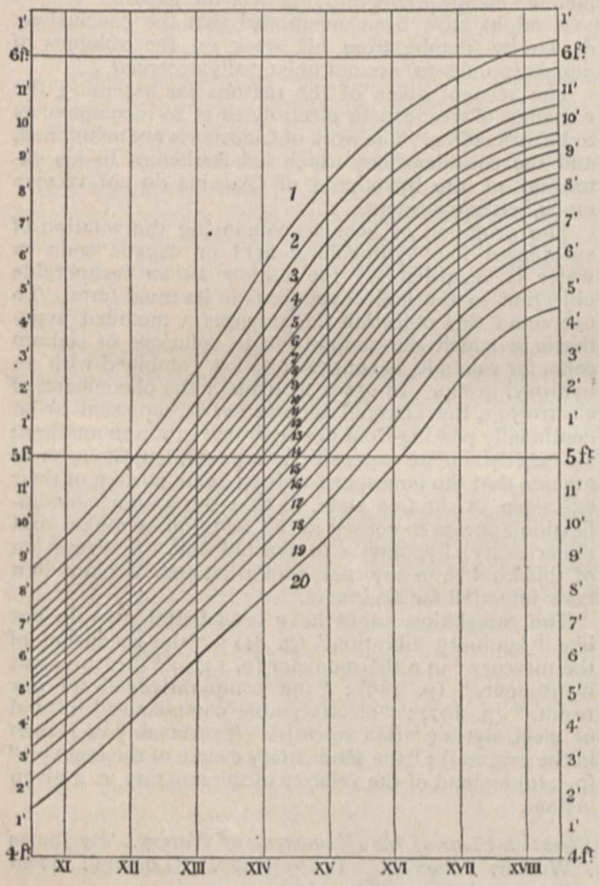


FIG. 1.—Grade curves for height of public schoolboys from 10½ to 18½ years of age. The figures on the base line refer to age. The figures down the centre of the diagram are the numbers of the grades, which are bounded by the two curves between which the several numbers are placed. There is no lower limit to grade 20, nor upper limit to grade 1.

trustworthy in form between the ages of 12 and 18. Beyond these limits the form of the curves may be slightly at fault, owing both to insufficient number of observations and to the process of natural selection which influences the physical status of the majority of boys who come early and stay late at a public school. The curves in Fig. 1 are constructed by marking off on the vertical line through each age the various heights at which the curve of distribution for that age crosses the 5 per cent., 10 per cent., 15 per cent., . . . 95 per cent. lines. Each series of corresponding points is then joined up by a flowing curve, with the result shown. The central line, between the numbers 10 and 11, shows where the various curves of distribution cross the 50 per cent. line, and consequently indicates the scheme of growth of the mean boy.

It was contended in the paper that since each of these curves represents the growth of a boy, who develops in such a manner as to preserve always the same relative position amongst his fellows, they give an accurate idea of the growth which may be reasonably expected from a boy at any stage of his development, whatever his physical status may be. A glance at the diagram will show that the rate of growth, which is measured by the pitch of the curves, varies considerably for boys of the same age but of different physique. The period of maximum growth is reached much sooner by a boy of a high grade than by one of a low grade, and lasts much longer. Thus the steepest pitch of the topmost curve occurs between the ages of 13½ and 14½, and is sensibly uniform during that period, the corresponding steepest pitch in the mean line lies between the ages of 15 and 15½, in the lowest line it lies between 16½ and 17. Consequently, during the period of fastest growth, all boys may be expected to grow at nearly the same rate; but this rate of growth is reached by some boys three or four years later than by others.

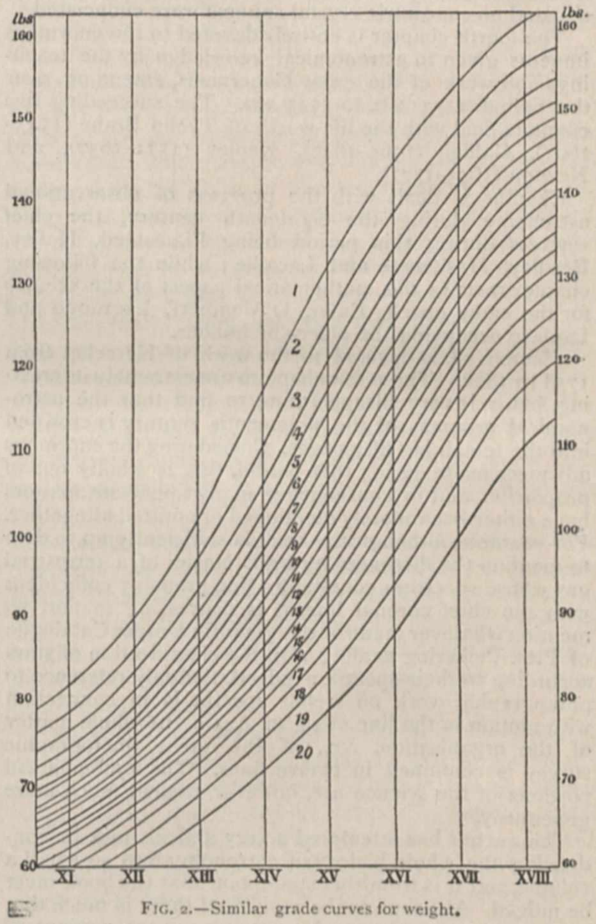


FIG. 2.—Similar grade curves for weight.

Fig. 2 represents the corresponding series of curves for weight, and teaches much the same lessons; it is evident, however, that the rate of growth in height declines much more rapidly after the period of maximum growth is passed than the rate of growth in weight, consequently boys of the same height but of different ages may be expected to differ considerably in weight. That this is generally the case was clearly shown by another set of curves exhibited at the lecture.

The curves shown have been used for constructing tables of grades, by means of which the limits of twenty grades are fixed, in some one of which a boy can be immediately placed if his measurements are known. From the mode of construction it is evident that, *a priori*, each of these grades is equally probable. The tables have in actual practice been found to be of great use in estimating the progress of individuals, and of gymnastic classes, &c. Thus an analysis of the grades of chest-girth of 255 boys before and after a three terms' course of compulsory gymnastics showed that the following improvement had been made. The numbers in the lower line give the percentage of the boys examined, who made the number of grades improvement indicated in the line above.

Improvement :—	1 gr.	2 gr.	3 gr.	4 gr.	5 gr.	6 gr.	7 gr.	8 gr.	9 gr.	10 gr.	11 gr.
Per cent. :—	11	11	12	10	7	6	4	4	1	4	1

This with the omitted fractions gave 73 per cent. of the boys who had made more or less marked improvement relative to the general mass of boys of their age, the improvement in some cases being very marked indeed.

An analysis of the growth of 161 boys by means of their grades showed that the scheme of growth corresponded to the scheme indicated by the curves in the diagram in 31 per cent. of the cases examined. There was a steady rise relative to this standard in 17 per cent. ; a steady fall in 10 per cent. ; a period of rise followed by one of fall, or *vice versâ*, in 18 per cent. In 9 per cent. the variation was erratic, and the remaining 15 per cent. probably belonged to the first group ; but not within the limits of variation allowed.

In 68 per cent. the type of structure, as indicated by the relation of height to weight, was stable throughout the period examined ; but in about one-fourth of these cases there was a considerable constant difference between the grades of height and weight, amounting in the most extreme cases to as much as eight grades.

The lesson drawn from these observations was that, in order to form a correct opinion relative to a boy's physical progress by means of his measurements, it is very desirable to keep a regular record of his growth, in order that the general scheme of his growth may be determined, and that any irregular fluctuations due to external and removable causes may be noted and properly dealt with. C. H.

The Giant Tortoises of the Galapagos.

I NOTICED in your issue of June 15 a paragraph about the Galapagos tortoises. I do not know if this information is of any interest, but during my residence in Hawaii I knew of two living there. One of them lived in a garden near Hilo, and belonged to the late Captain Thomas Spencer ; I last saw it about 1880. The other one lived on the Waimea plains in a perfectly wild state, and I used frequently to come across it when out shooting. It used to wander about within a radius of three or four miles.

It was blind of one eye, and its shell had lichen growing on it, and it could move about with a man sitting on its back.

I last saw it in 1890, but it may possibly be still living ; this, however, could easily be ascertained.

They were, I believe, brought to Hawaii from the Galapagos in whalers, and were of great age. If desired, I shall endeavour to find out if they are still alive. W. HERBERT PURVIS.

10 Alexandra Place, St. Andrews, Fife.

School Laboratory Plans.

COLLEGE plans are not always safe precedents. Boys need more supervision. Can any of your readers advise as to the best arrangement of benches for a class of twenty-four to thirty boys, aged fourteen to seventeen, doing chemistry and physics with elementary quantitative experiments?

(1) Is the double back-to-back bench the best form ? It may economise woodwork, but it makes the class face both ways, and attention to verbal instruction is less easy.

(2) Is the superstructure of shelving necessary ? If qualitative analysis is not done, fewer bottles are needed. The superstructure hinders conversation across double benches, but it stops supervision also.

(3) What is the best way of arranging the benches so as to allow of supervision and keep wall spaces free for shelving? They may be (*a*) all round the wall, leaving no space for shelves and cupboards ; or (*b*) single bench along two walls and double bench down the middle ; or (*c*) across the room, double benches alternating with windows, well lighted but difficult to supervise ; (*d*) central aisle with double bench extending to walls right and left ; (*e*) double benches, lengthways, free from walls ; (*f*) single benches, cross-ways, like the desks of an ordinary class-room.

I shall be grateful for any help or advice.

Bootham School, York, June 23. HUGH RICHARDSON.

Pair of Brazilian Marmosets Breeding in England.

A PAIR of marmosets, which for the two past winters have had a free run of our greenhouse and garden (in Buckinghamshire), produced two young ones on May 24. They seem to thrive on freedom and exercise, and the young ones are now beginning to feed themselves. In hot weather they like to remain out all night, but at first they came in to their box in the greenhouse every evening, the male parent always carrying the twins on his back, their little round furry heads merely looking like small excrescences each side of his neck ; and only handing them to the mother at feeding-times, and then carefully lifting them back with both hands and settling them into position, where they seem to cling on without being held.

Their favourite garden house appears to be an old bird's nest, rather high up in a pink thorn-tree, some distance from the greenhouse. They very rarely come down to the ground, but the female will answer a call and come to feed from the hand. Bananas, milk and water, insects and young birds are the foods they like best. DORA WHITMORE.

THE DIFFRACTION PROCESS OF COLOUR-PHOTOGRAPHY.

THE production of colour by photography has been accomplished in two radically different ways up to the present time. In one, the so-called Lippmann process, the waves of light form directly in the photographic film laminæ of varying thickness, depending on the wave-length or colour of the light. These thin laminæ show interference colours in reflected light in the same way that the soap-bubble does, and these colours approximate closely to the tints of the original.

The technical difficulties involved in this process are so great that really very few satisfactory pictures have ever been made by it. The other, or three-colour process, has been developed along several distinct lines, the most satisfactory results having been produced by Ives with his stereoscopic "Krōmskōp," in which the reproduction is so perfect that, in the case of still-life subjects, it would be almost impossible to distinguish between the picture and the original seen through a slightly concave lens. The theory of the three-colour method is so well known that it will be unnecessary to devote any space to it, except to remind the reader of the two chief ways in which the synthesis of the finished picture is effected from the three negatives. We have first the triple lantern and the Kromscope in which the synthesis is optical, there being a direct addition of light to light in the compound colours, yellow being produced, for example, by the addition of red and green. The second method is illustrated by the modern trichromic printing in pigments. Here we do not have an addition of light to light, and consequently cannot produce yellow from red and green, having to produce the green by a mixture of yellow and blue. Still a third method, that of Joly, accomplishes an optical synthesis on the retina of the eye, the picture being a linear mosaic in red, green and blue, the individual lines being too fine to be distinguished as such.

The diffraction process, which I have briefly described in the April number of the *Philosophical Magazine*, is really a variation of the three-colour process, though it possesses some advantages which the other methods do not have, such as the complete elimination of coloured screens and pigments from the finished picture, and the possibility of printing one picture from another. The idea of using a diffraction grating occurred to me while endeavouring to think of some way of impressing a surface with a structure capable of sending light of a certain colour to the eye, and then superposing on this a second structure capable of sending light of another colour, without in any way interfering with the light furnished by the first structure. This cannot, of course, be done with inks, since if we print green ink over red, the result will not be a mixture of red light and green light, but almost perfect absence of any light whatever; in other words, instead of getting yellow we get black. Let us consider first how a picture in colour might be produced by diffraction. Place a diffraction grating (which is merely a glass plate with fine lines ruled on its surface) before a lens, and allow the light of a lamp to fall upon it. There will be formed on a sheet of paper placed in the focal plane of the lens, an image of the lamp flame, and spectra, or rainbow-coloured bands on each side of it. Now make a small hole in the sheet of

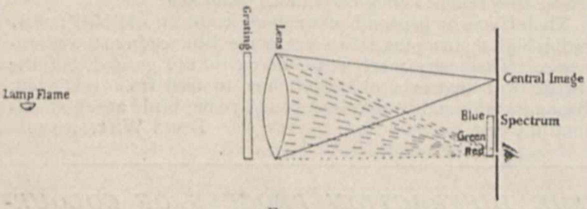


FIG. 1.

paper in the red part of one of these spectra. This hole is receiving red light from the whole surface of the grating, consequently if we get behind the paper and look through the hole we shall see the grating illuminated in pure red light over its whole extent. This is indicated in Fig. 1, where we have the red end of the spectrum falling on the hole, the paths of the red rays from the grating to the eye being indicated by dotted lines. Now the position of the spectra with reference to the central image of the flame depends on the number of lines to the inch with which the grating is ruled. The finer the ruling the further removed from the central image are the coloured bands. Suppose now we remove the grating in Fig. 1, and substitute for it one with closer ruling. The spectrum will be a little lower down in the diagram, and instead of the red falling on the hole, there will be green; consequently, if we now look through the hole, we shall see this grating illuminated in green light. A still finer ruling will give us a grating which will appear blue. Now suppose that the two first gratings be put in front of the lens together, overlapping as shown in Fig. 2. This combination will form two overlapping spectra, the red of the one falling in the same place as the green of the other, namely on the eye-hole. The upper strip, where we have the close ruling, sends

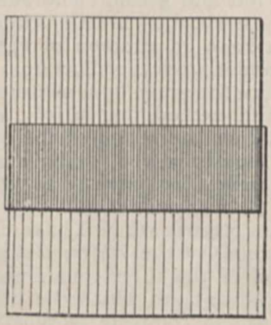


FIG. 2.

green light to the eye and appears green; the under strip, with the coarser ruling, sends red light to the eye and appears red, while the middle portion, where we have both rulings, sends both red and green light to the eye, and in consequence appears yellow, since the simultaneous action of red and green light on any portion of the retina causes the sensation of yellow. In other words, we have in superposed diffraction gratings a structure capable of sending several colours at once to the eye.

If we add the third grating, we shall see the portion where all three overlap illuminated in white, produced by the mixture of red, green and blue light.

Three gratings with 2000 lines, 2400 lines, and 2750 lines to the inch, will send red, green and blue light in the same direction, or, in other words, to the same spot on the screen behind the lens.

Suppose, now, we have a glass plate with a design of a tulip, with its blossom ruled with 2000 lines to the inch, its leaves ruled with 2400, and the pot in which it is growing ruled with 2750 lines, and place this plate before the lens. On looking through the hole we shall see a red tulip with green leaves growing in a blue pot. Thus we see how it is possible to produce a coloured picture by means of diffraction lines, which are in themselves colourless. Those portions of the plate where there are no lines send no light to the eye, and appear black.

We have now to consider how this principle can be applied to photography. That photographs which show colour on this principle can be made, depends on the fact that a diffraction grating can be copied by contact printing in sun-light, on glass coated with a thin film of bichromated

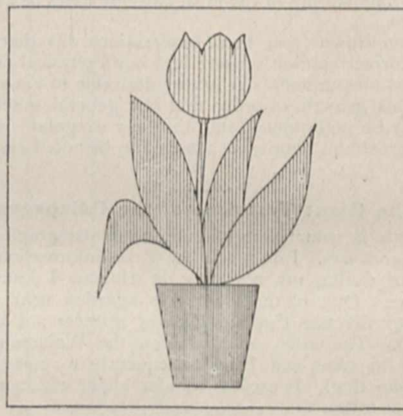


FIG. 3.

gelatine. The general method which I have found best is as follows. Three gratings ruled on glass with the requisite spacing were first prepared.[1]

To produce a picture in colour three negatives were taken through red, green, and blue colour filters in the usual manner. From these three ordinary lantern-slide positives were made. A sheet of thin plate-glass was coated with chrom gelatine, dried, and cut up into pieces of suitable size; one of these was placed with the sensitive film in contact with the ruled surface of the 2000-line grating, and the whole covered with the positive representing the action of the red light in the picture. An exposure of thirty seconds to sunlight impressed the lines of the grating on the film in those places which lay under the transparent parts of the positive. The second grating and the positive representing the green were now substituted for the others, and a second exposure was made. The yellows in the picture being transparent in both positives, both sets of lines were printed superposed in these parts of the picture, while the green parts received the impression of 2400 lines to the inch only.

The same was done for the blue, and the plate then washed for a few seconds in warm water. On drying it appeared as a coloured photograph when placed in front of the lens and viewed through the hole in the screen.

[1] These gratings were ruled for us on the dividing engine at Cornell University, through the courtesy of Prof. E. L. Nichols.

Proper registration during the triple printing is secured by making reference marks on the plates. A picture of this sort once produced can be reproduced indefinitely by making contact prints, since the arrangement of the lines will be the same in all of the copies as in the original. The finished picture is perfectly transparent, and is merely a diffraction grating on gelatine with variable spacing. In some parts of the picture there will be a double grating, and in other parts (the whites) there will be a triple set of lines. Having had some difficulty in getting three sets of lines on a single film in such a way as to produce a good white, I have adopted the method of making the red and green gratings on one plate, and the blue on another, and then mounting the two with the films in contact. It is very little trouble to multiply the pictures once the original red-green grating picture is made.

The pictures are viewed with a very simple piece of apparatus, shown in Fig. 4, consisting of a lens cut square like a reading glass, mounted on a light frame provided with a black screen perforated with an eye-hole through which the pictures are viewed. The colours are extremely brilliant, and there is a peculiar fascination in the pictures, since if the viewing apparatus be slowly turned so that its direction with reference to the light varies, the colours change in a most delightful manner, giving us, for example, green roses with red leaves, or blue roses with purple leaves, a feature which should appeal to the impressionists. The reason of this kaleidoscopic effect is evident, for by turning the viewing

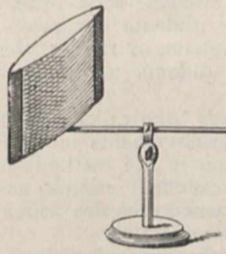


FIG. 4.

apparatus we bring the eye into different parts of the overlapping spectra.

It is possible to project the pictures by employing a very intense light, and placing a projecting lens in place of the eye behind the perforation in the screen. Of course a very large percentage of the light is lost, consequently great amplification cannot well be obtained. I have found that sun-light gives the best results, and have thrown up a three-inch picture on a four-foot sheet so that it could be seen by a fair-sized audience.

By employing a lens of suitable focus it is possible to make the viewing apparatus binocular, for similar sets of superposed spectra are formed on each side of the central image by the gratings, so that we may have two eye-holes if the distance between the spectra corresponds to the interocular distance.

It is interesting to consider that it is theoretically possible to produce one of these diffraction pictures directly in the camera on a single plate. If a photographic plate of fine grain were to be exposed in succession in the camera under red, green, and blue screens, on the surfaces of which diffraction gratings had been ruled or photographed, the plate on development should appear as a coloured positive when seen in the viewing apparatus. I have done this for a single colour, but the commercial plates are too coarse-grained to take the impression of more than a single set of lines. With specially made plates I hope to obtain better results.

R. W. WOOD.

LOCAL UNIVERSITY COLLEGES FOR LONDON.

THE adequate provision of university education for London is by no means the simple and straightforward task which some people seem to imagine. From whichever of the many possible points of view the question of the education of London is considered, the anomalous position which has to be assigned to the greatest city in the world is the most noteworthy result of the investigation. If, for instance, an endeavour is made to estimate the comparative facilities offered for higher instruction in the metropolis with those to hand in other countries and in our own large provincial towns—judged on a basis of population—the results arrived at are as remarkable as they are interesting and instructive. The population of Scotland in 1896 was 4,186,849; yet located at Edinburgh, Glasgow, Aberdeen and St. Andrews are four well-equipped and largely endowed universities; while, in addition to these, is to be found at Dundee a college providing university education, and, though working with St. Andrews, in receipt of an annual grant of 1000*l*. from the Treasury. The population of the county of London was last year 4,504,766. If, as is done in the University of London Act, 1898, the towns within thirty miles of the university buildings are included, the population must be placed at a very much higher figure, viz. about six millions and three-quarters.

So that, keeping well within limits, and running no risk of any charge of exaggeration, the inhabitants of this metropolitan area may be said to considerably outnumber those of Scotland. When the universities and university colleges provided for this immense population are enumerated the total is ludicrously small. There is no teaching university, and but three university colleges—University College, King's College, and Bedford College. Of course, there are other colleges in London; but, in defining university colleges reference is made to the Treasury Minute of June 2, 1897, dealing with the grant in aid of the university colleges of Great Britain.

At University College there were in the faculties of Arts, Laws, and Science, in the session of 1895-6, 747 students, including engineering students. At King's College, during the same session, there were in Arts and Science 284 day students, 305 evening students, and 315 lady students. At Bedford College, the number of students throughout the same period numbered 176. The total number of persons receiving instruction of university standing in officially recognised institutions was consequently not much over 1500 during the year 1895-6.

If the populations up to date of the eight large towns in England provided with university colleges be added together, the total obtained is about 3,233,765. Similarly, Wales, with a population in 1891 of 1,501,163, has three university colleges, now together constituting the University of Wales. Not only in comparison with Scotland, therefore, but also by the side of Wales and the English provinces, London is seen to be extraordinarily deficient in properly authorised establishments the prime duty of which is to provide university instruction.

It may be urged at this stage that the work of the University of London Commission now being performed will, as it is intended it shall, completely alter the present unsatisfactory aspect of things, and that ere long provisions which will satisfy the most earnest advocate of higher education will be provided. But valuable as the coordination of effort which is likely to result from the inauguration of the new University of London will be, it can hardly be contended that to confer new powers upon certain existing colleges, and to rearrange the work of the staffs of institutions which have previously proved inadequate, will be a complete solution of the proper provision of university instruction for nearly seven millions of people.

It may be said at once that London should have a university college in each one of the various parts of the enormous district it covers. If one of the most important phases of the education imparted by the university is the intimate association of the undergraduate with his professors, the free exchange of views between the students themselves, and that mellowing effect which results from the feeling of a close connection with the corporate life of an important institution —then surely many small universities are incomparably better than one many-sided and multi-tentacled body with which the individual student can have no personal connection.

Nor is this conception of local universities in the different districts which build up the straggling wilderness we call London a dream of Utopia. As has been before pointed out in these columns, there already exist in London eleven polytechnic institutions, and the foundation stone of a twelfth has been laid. These, with four branches which have been established, provide sixteen separate centres scattered throughout an area which extends from Woolwich to Wandsworth in one direction, and from New Cross to Holloway in another. Why cannot some of these extensive buildings and lavishly furnished lecture-rooms and laboratories, representing half a million sterling in capital outlay, be utilised for the purpose of university work?

A reference to previous issues of NATURE will abundantly prove that there is nothing incongruous in undertaking university education in the lecture theatres, class-rooms and laboratories of these polytechnics. Comparatively few additions to the apparatus and fittings already provided would be necessary. Indeed, the work which has already been accomplished, valuable though it is, is scarcely return enough for the munificence of the City companies, the City parochial charities, the London County Council, private donors and others, which has placed the London polytechnics in their present condition of complete equipment.

A common retort to any such suggestion as has now been briefly stated—that the work of a university college is of a much more advanced nature than anything accomplished in a polytechnic—will not bear close examination. Several tests can easily be applied. An inspection of the lists of graduates of the London University, for instance, shows that a comparison of the numbers of successful candidates is all in favour of the polytechnics as compared with the university colleges. As it happens, it is possible to obtain the verdict of former professors of university colleges who are now engaged in the work of the polytechnics, and their assurance is that a greater quantity of advanced work, at all events in science, is done in the polytechnic. Moreover, the amount of work of an advanced type accomplished in English university colleges is usually somewhat exaggerated. A few quotations from a report presented in 1897 by Mr. P. H. Warren, President of Magdalen College, Oxford, and Prof. Liveing, Fellow of St. John's College, Cambridge, to the Lords Commissioners of her Majesty's Treasury, will justify this statement. Of one university college it is stated, "On the Arts side it cannot be said that at present any amount of work of a high standard is being done in the college," or later, "most of the work, both in arts and science, is of an elementary kind." Of another similar place of instruction, "With regard to the work now being done there, judged by University standards, a good deal of it is of an educational and preparatory rather than of an advanced and learned character." In the case of another college, "It is, therefore, not to be wondered at that the work on the Arts side should be still in a somewhat incipient stage, and mainly educational rather than learned." Of a fourth college it is reported, "A great deal of this work is in the nature of things of a somewhat preparatory kind, and there is throughout the college a great deal of work of not a very advanced character." Similar remarks concerning other university colleges might be multiplied, but quotations enough have been made to show that in apportioning the Treasury grant to university colleges the mere fact that elementary instruction is a part of the work carried on in the buildings is not considered a disqualification for also undertaking university instruction.

It is true that a very large part of the instruction of the 50,000 members and students enrolled by the London polytechnics takes place in the evening. This has been urged as evidence of the wide disparity between the methods of polytechnics and those of university colleges, but such an allegation reveals a want of knowledge of the prevalent conditions of instruction in university colleges. The evening classes of King's College, London, form an important part of the whole work of the institution. At Owens College, Manchester, a very complete system of evening lectures has been arranged for schoolmasters and others engaged during the day. The evening classes at University College, Liverpool, are strong and well attended, and are encouraged by the College authorities. The number of evening class students at Mason College, Birmingham, steadily increases. Besides the regular day work of the Bristol University College, there is an extensive system of evening classes, covering almost all the subjects taught in the college. At the Durham College of Science, Newcastle-upon-Tyne, there were in 1895–6, 1092 evening students compared with 499 day students. At Nottingham, in 1894–5, there were more than three evening students to one attending during the day.

Attention has already been called (No. 1523, p. 236) to the very complete arrangements in some of the polytechnics for instruction in the methods of scientific research, and to the excellent results, as evidenced by papers read to the learned societies, which have followed the lectures and demonstrations.

It would consequently appear that a judicious system of coordination and a little levelling-up would convert some of these sixteen institutions, which in the past ten years have had a phenomenal growth, and are steadily improving in status and influence, into satisfactory university colleges, bringing the highest order of culture to the very doors of the so-called metropolitan Philistines.

THE PLANS FOR ANTARCTIC EXPLORATION.

IT is understood that the German Antarctic expedition for the year 1901 has now been fully organised. A grant of 60,000*l.* towards the expenses has been made by the Reichstag. Dr. Erich von Drygalski, one of the professors of geography in the University of Berlin, has been appointed the scientific leader, and an influential Committee is charged with perfecting the arrangements. This Committee is anxious that all the plans should be arranged for joint action, so that the German and British expeditions should supplement and reinforce one another at every point, thus ensuring the maximum return of scientific knowledge for the money expended. The expedition of the *Valdivia*, under the scientific leadership of Prof. Chun, is a proof of the splendid results which attend deep-sea expeditions under a scientific chief, if indeed the *Challenger* expedition did not supply proof enough. It is, however, still the opinion of some authorities in this country that an expedition which has to be carried in a ship must be under the sole and exclusive charge of a naval officer. The subject is one which lends itself to discussion, and many illustrations may be adduced in favour of the arguments on either side.

It is gratifying to record that a national British expedition, well organised and excellently equipped, will be sent out to co-operate with the German expedition of 1901. That this expedition will be a purely scientific one is guaranteed by the fact that the organising body is a Joint-Committee of the Royal Society and the Royal Geographical Society, on which practical oceanographers and representatives of natural science are associated with the older generation of Arctic and Antarctic explorers. A responsible and representative directing body to which the choice of the leaders of the expedition can confidently be left is the first consideration, and this has been secured in the Joint-Committee. The first task of this Committee was to ascertain what resources would be available for carrying out the objects of the expedition. Three handsome contributions had been received—two of them from private individuals may indeed be termed magnificent—viz. 25,000*l*. from Mr. L. W. Longstaff, 5000*l*. from Mr. A. C. Harmsworth, and 5000*l*. from the Royal Geographical Society, while other subscriptions raised the total to 40,000*l*. Representations to the Government had produced no effect when the expedition was merely a project, but when Mr. Longstaff's donation made it certain that a British expedition would be equipped, Mr. Balfour, the First Lord of the Treasury, agreed to receive a deputation on the subject.

Accordingly, on June 22, a deputation waited upon Mr. Balfour at the Foreign Office, introduced by Sir Clements Markham, President of the Royal Geographical Society, and including Lord Kelvin, Sir Joseph Hooker, Sir Leopold McClintock, Sir Erasmus Ommanney, Dr. A. Buchan, Dr. R. H. Scott, Admiral Markham, Sir Vesey Hamilton, Sir W. White, Dr. Günther, Prof. Ray Lankester, Sir Michael Foster, Prof. Rücker, Prof. G. Darwin, Sir William Crookes, and a number of members of the Councils of the two Societies.

Sir Clements Markham, in introducing the deputation, laid great stress upon the scientific character of the proposed expedition. After bringing forward the historical argument of the interest taken by former Governments in polar exploration, and the value of navigation in those seas as a training for seamen and officers, he said (we quote the report in the *Times*):—

"Still the avowed object of Government expeditions was scientific research. The objects of the two societies were identical. They were undertaking work which successive generations of our statesmen and naval officers had looked upon as beneficial to the country and to the navy, and for this reason thought they had a claim on the Government for assistance. But further, some of the scientific results required were of immediate practical value. Indeed, all scientific research became eventually, directly or indirectly, practically useful. Much of the Antarctic work would, however, at once be of use to navigation, especially as regarded the magnetic survey."

Sir Joseph Hooker, the last survivor of the great Antarctic exploring voyage of the *Erebus* and *Terror*, under Sir James Ross, supported Sir Clements Markham, and Lord Kelvin followed with the hope that all would be done to bring the enterprise to a triumphant issue. Prof. Ray Lankester spoke of the importance of the biological observations, and especially referred to the question of a bi-polar fauna as one likely to be greatly elucidated by the expedition; and Prof. Rücker, in conclusion, pointed out how important the magnetic survey of the Antarctic area is.

Mr. Balfour replied in a sympathetic speech, in the course of which he said:—

"I, for my own part, fully recognise that if, as I think, expeditions to the poles of the earth, or towards the poles of the earth, are eminently desirable, both on practical and purely scientific grounds, these expeditions are perhaps even more important when undertaken towards the Antarctic Pole than towards the Arctic Pole, for we certainly know much less at present about the Antarctic regions than we do about the Arctic regions, and the actual area of this unknown but immense portion of the earth's surface is much larger in the case of the South Pole than in the case of the North Pole. . . . I, however, should not be representing my own personal convictions—and I am speaking in this matter for myself—if I for a moment let it be thought that in my judgment the scientific investigations which directly, immediately, and obviously lead to some practical result are the only ones which it is worthy of a great nation to pursue. I take a different view based partly upon the scientific experience of the world. If our forefathers of the last two centuries—I do not mean men of British origin alone, but I include the great French expeditions and other expeditions sent out during the last century and during the seventeenth century—had not carried on this work, it is manifest that our ignorance of the planet on which we live would be much more profound than it is at present; and it would not be creditable to an age which flatters itself, above all other ages, to be a scientific age, if without reluctance we acquiesced in the total ignorance which now envelops us of so enormous a portion of the southern hemisphere of our planet. For my own part, while I entirely agree with all that has been said upon the important facts and issues which may be anticipated from any expedition, I by no means limit my interest to such practical results. The things which we go directly to observe, and with every intention of observing, are doubtless of the highest importance. But I shall be greatly surprised if the expedition does not come across a great many phenomena which we did not expect, and which will throw a novel light upon many of the most important scientific theories, meteorological, geological, biological and magnetic. If this expedition is sent forth, as I hope it will be, adequately equipped at the date to our satisfaction, when we shall be able to co-operate with the German expedition, in respect of scientific interest alone such co-operation must be valuable from every point of view, and it will, among other things, have the effect of strengthening, if such strengthening be necessary or possible, the cosmopolitan or international character of these sciences. . . . I am sure if the Chancellor of the Exchequer were here to-day he would tell you that, in so far as he could meet the wishes of the deputation, such action on his part must be regarded not as a reason for giving something more to some future deputation, but rather as a reason for giving less. But with that caution, which I feel bound to utter on his behalf, I think I should not arouse undue hopes if I say that the Chancellor of the Exchequer will find it in his power to give substantially to the great project which you have in hand. I do not say that the aid given will reach the limits of your largest wishes, but I hope and believe that it will be sufficient to enable us to send out this expedition in a manner not unworthy either of the great societies which have interested themselves in this matter or of those liberal members of the public who have subscribed out of private means to further the object which you have in view, and not unworthy of the country which has done more than any other country in the past to send forth expeditions similar in character to the one which you desire to send forth."

Nothing could be more satisfactory than Mr. Balfour's view of the claims of research in pure science to public recognition, or his promise that a liberal grant to the Antarctic expedition shall be given by Government. It remains for the Joint-Committee to settle the plan of the expedition and to select the scientific leader on whose qualifications as a man of science and on whose freedom of action with regard to the executive authority of the ship or ships the success of the expedition as a scientific enterprise will entirely depend. This choice cannot be made too soon, for the details of scientific equipment must largely determine the plan of the ship which has to be built; and no one can be so well qualified to advise upon and carry out the preparations as the man whose reputation depends on the result of those scientific investigations which every one of the promoters of the expedition has declared to be its exclusive object.

CHARLES WILLIAM BAILLIE.

WE regret to have to announce the sudden death, at Broadstairs, on June 24, at the age of fifty-five years, of Naval Lieutenant Charles William Baillie, Marine Superintendent of the Meteorological Office, a post which he had held for eleven years.

Mr. Baillie was perhaps best known by his sounding machine, which he invented while on the North American Station about 1871, and which is still in use. It is a modification of the apparatus known as the "Hydra" machine. It was used in the *Challenger* expedition, and is described in Sir W. Thomson's book, "The Voyage of the *Challenger*." Lieut. Baillie was much employed in surveying, and while in the *Sylvia*, under Captain (now Vice-Admiral) St. John, on the China Station, he was selected by the Admiralty to be Director of Nautical Studies at the Imperial Naval College at Tokio, Japan. The results of his teaching are to be seen in the condition of the Japanese Navy at the present day.

After several years of duty in this important post he returned to England on half-pay. In October 1879 he joined the Meteorological Office, so that he had nearly completed twenty years of service in that institution.

The principal works which he has carried out there have been the charts of sea surface temperature, of barometrical pressure, and of currents for all oceans.

The discussion of the meteorology of the South Indian Ocean, from the Cape of Good Hope to New Zealand, which is shortly about to appear, has been carried out under Lieut. Baillie's superintendence, while he had laid down the lines of inquiry to be pursued in the work now in hand at the office—the "Meteorology of the South Atlantic and of the Coasts of South America." Lieut. Baillie was a Fellow of the Royal Geographical and the Royal Astronomical Societies. He married Miss Conyers, of Bermuda, and leaves a numerous family.

NOTES.

PROF. W. C. BRÖGGER, of the University of Christiania, has accepted an invitation to deliver the second course of the George Huntington Williams memorial lectures at the Johns Hopkins University, in April 1900. He has selected as his subject "Modern deductions regarding the origin of igneous rocks."

DR. G. AGAMENNONE has been selected to succeed the late Prof. M. S. de Rossi as director of the important Geodynamic Observatory at Rocca di Papa, near Rome. Dr. Agamennone, who is well known by his numerous seismological papers, has for several years been assistant at the Central Office of Meteorology and Geodynamics at Rome; and, during the years 1895-96, was in charge of the seismic department of the Meteorological Observatory at Constantinople.

NEWS has been received of the death of Mr. John Whitehead while on a scientific mission in the Island of Hainan. Mr. Whitehead left England in the autumn of last year for the purpose of exploring the less known islands of the Philippine group and obtaining a collection of their fauna for the British Museum (Natural History).

WE learn from *Science* that President McKinley has appointed a Commission to determine the best route for a canal across the Isthmus of Panama or Nicaragua. The sum of 1,000,000 dollars has been appropriated for the expenses of the Commission, and a number of surveyors will accompany the party which will shortly leave for Colon.

DR. D. G. BRINTON, Professor of American Archæology and Linguistics at the University of Pennsylvania, has presented to the University his entire collection of books and manuscript relating to the aboriginal languages of North and South America, representing the work of twenty-five years, and embracing about 2000 titles.

AN excursion to Derbyshire, extending from August 3 to August 9, has been arranged by the Geologists' Association. The directors of the excursion are Mr. H. H. Arnold-Bemrose, Dr. Wheelton Hind, Mr. J. Shipman, and Mr. J. Barnes. A sketch of the geology of the Lower Carboniferous rocks of Derbyshire will be given by Mr. Arnold-Bemrose at a meeting of the Association on July 7.

THE preliminary programme of the thirteenth International Medical Congress, to be held in Paris from August 2 to August 9, 1900, has just been issued from the central offices in the Rue de l'École de Médecine. M. Lannelongue is president of the Congress, and Dr. Chauffard is the secretary-general. National Committees have been formed in each country to further the work of the Congress. The president of the Committee for Great Britain is Sir William MacCormac, Bart., K.C.V.O., and the hon. secretaries are Dr. Garrod, Dr. Keser, and Mr. D'Arcy Power.

THE second trade exhibition of photographic and scientific apparatus and sundries will be held in the Portman Rooms, on April 27 to May 5 next year. Intending exhibitors should communicate with the Secretary of the Exhibition, 15 Harp Alley, Farringdon Street, E.C.

TO celebrate the centenary of the granting of the charter to the Royal College of Surgeons of England in 1800, the Council propose to apply for a supplementary charter. It is proposed to obtain powers to confer the Fellowship of the College on persons of distinction who are not members. A memorial has been drawn up, suggesting to the Council that a favourable opportunity now presents itself for the satisfaction of that desire which has at various periods during the century, and especially during the last fifteen years, been expressed by a large number of the members of the College—viz. that they should be represented on the Council. It is submitted that "it would be both equitable and politic that the members should have a voice in the conduct of a Corporation of which they are, and always have been, numerically and financially the mainstay." At every annual meeting of Fellows and members (instituted in 1884) this or some similar proposal has been carried practically unanimously, and a petition in its favour was signed by nearly 5000 members and presented to the Privy Council. The Council have twice taken a poll of the Fellows on the question, but on neither occasion has an absolute majority voted against the proposal, though many were in its favour.

THE *Academy* invited its readers to compose an inscription, of not more than forty words, suitable to be engraved upon the statue of Charles Darwin, just unveiled at Oxford. The best inscription was considered to be that submitted by Mr. Edwin Cardross, viz.: "Charles Darwin, the great naturalist, memorable for his demonstration of the law of evolution in organic life, achieved by scientific imagination, untiring observation, comparison, and research: also for a blameless life, characterised by the modesty, 'the angelic patience, of genius.'"

AN interesting survival of the very ancient custom of watching the sun rise at the summer solstice was witnessed on Salisbury Plain on June 21. The *Westminster Gazette* states that on the night preceding the longest day (June 21) there was a large gathering of people from the neighbourhood, and also from other parts, assembled close to the historic circle of stones at Stonehenge, in order to see the sun rise over the Plain. When atmospheric conditions are favourable, those watching from the altar stone in the centre of the circle see the sun apparently poise itself for an instant upon the top of the stone known as the Friar's Heel. This sight is a rare privilege, and as it depends upon a doubtful meteorological condition—a perfectly cloudless sky at the point and time at which the sun rises above the horizon—those watching anxiously scan the sky, alas! in too many instances, to find that their night's vigil on the Plain is barren of result. The last time the phenomenon was witnessed was in 1895.

THE annual general meeting of the Jenner Institute of Preventive Medicine was held at Chelsea on June 23. The report of the Council for the year was read and adopted. The report states that during the year the work of the institute continued to make satisfactory progress. The internal fittings of the Chelsea building are now completed with the exception of the museum, and the various departments are fully equipped and at work. The meeting received with enthusiasm the reference to Lord Iveagh's gift of 250,000*l*. for the promotion of the objects for which the institute was founded. The gratifying announcement was made that Lord Lister had consented to act as chairman of the new governing body that will in future control the affairs of the institute. Dr. Macfadyen's report upon the general work of the institute during the year was read and adopted. During the year the organisation of work in the main laboratories of the institute was completed, and valuable additions made to the stock of scientific apparatus. The foundations of the new wing, which will complete the original plan of the institute, are at present in course of construction. The photographic department is fully equipped, and the necessary illustrations to scientific papers will in future be prepared in this laboratory. At no period has there been a greater body of research work in progress in the institute than at the present moment, and reference is made in the report to the more important investigations being carried on. A number of investigations by Dr. Hewlett and others have been published during the year, and a second volume of the *Transactions* of the institute is going through the press. As regards the courses of instruction, which have been well attended, the aim has been to train the advanced student, as is done in foreign laboratories, with a view to subsequent research work. A notable addition has been made to the departments of the institute by the foundation of the Hansen Laboratory for the study of the practical application of bacteriology to industrial and technical processes. Dr. G. Harris Morris has been placed in charge of this department, which is now at work. Dr. A. Harden's report deals with the work of the chemical and water laboratory during the year. Dr. G. Dean's report on the anti-toxin department describes the improved methods adopted for the preparation of diphtheria anti-toxin and the researches being carried out in connection with tetanus, pneumonia, anti-streptococcic serum, &c.

AT the suggestion of Prof. E. Ray Lankester, Lieut. A. G. Froud has sent us a copy of a report, by Mr. G. T. Prior, upon some fine brown dust collected on board the P. and O. s.s. *Sumatra* during a thunderstorm in the Galita Channel, Mediterranean. The dust contained about 33 per cent. of doubly refractive grains, composed chiefly of carbonates of calcium, magnesium, and iron. After treatment with hydrochloric acid, the insoluble residue was for the most part without influence on polarised light, and consisted mainly of silicate of alumina (clay), with a little organic matter; only a few angular grains of quartz, and one or two very strongly refractive and doubly refractive grains, probably of iron, were observed in this insoluble residue. The dust was thus of the nature of an argillaceous and calcareous sand, and may have been carried by wind from the north of Africa. In his report, Mr. Prior remarks:—"An account by C. V. John, with analysis of fine brown dust which fell in Hungary in February 1896, will be found in *Verh. Geol. Reichsanst.* (ix., 1896, pp. 259–64). This dust, like the above, was characterised by the almost total absence of quartz, and by the presence of grains of transparent amorphous clay material. It differed from the above, however, in not containing any large amount of carbonates. The similarity in chemical composition of this Hungarian dust with that of Nile mud is pointed out, and the suggestion is made that the dust may have been derived from Egypt."

DR. MOTTE, naturalist, 13 rue Royale, Lyons, informs us that the family of a deceased collector have an egg of the Great Auk (*Alca impennis*) among other ornithological objects they desire to sell.

A FEW interesting facts with regard to the kea, or sheep-eating parrot, of New Zealand are related in the July number of the *Leisure Hour* by Dr. F. Truby King. The intense curiosity of these birds is stated to be sufficient to account for the habit of eating sheep acquired by them. Dr. King thinks it is probably a mistake to suppose that the kea designedly makes at once for the kidney fat of the sheep upon which it has pounced. It eats into various parts of the body, though perhaps more often into the region of the kidney, as it is there that the kea gets the firmest stand on the back of the running sheep. This view is strengthened by the fact that the bird prefers double-fleeced sheep—that is, such as have remained a whole season unshorn, on which it obtains a firmer grip.

IN an article on the Gold Measures of Nova Scotia (Canadian Mining Inst., March), Mr. E. R. Faribault remarks that the workable deposits of free gold are confined to the metamorphic rocks of the Atlantic coast, and occupy an area of about 5000 square miles. The gold-bearing rocks are intersected by dykes and large masses of granite which have no connection with the auriferous veins. It is observed, however, that all the rich veins and the large bodies of low grade quartz, with few exceptions, follow the planes of stratification, and occur at well-defined points along the anticlinal axes of the folds. The rocks are regarded as of Lower Cambrian age.

DR. HEPITES, director of the Meteorological Institute of Roumania, has communicated to *Ciel et Terre* of March 1 an interesting summary of the climatology of the Roumanian coast of the Black Sea. Thanks to the observations persistently made by the European Commission of the Danube, there is an uninterrupted series of observations for twenty-two years at Soulina and another series of thirteen years at Constantza, made under the superintendence of the institute. The temperature of the air at both these places is nearly similar; the yearly mean at the latter place is 51°·8. The highest shade temperature was 97°·2 in July, and the lowest −5°·3 in January. The extreme temperatures recorded in other parts of Roumania are 108° at Giurgevo in July 1896, and −32°·1 in January 1893. The rainfall on the coast is comparatively small, the average annual amount at Constantza is 15·7 inches. It is very seldom that the rainfall in any one year exceeds 20 inches; at Soulina during the last thirty years it has twice exceeded 23 inches. Rain falls on an average on 76 days in the year, and is spread fairly equally throughout all the months; snow falls on an average during 12 days in the year.

THE thirteenth volume (for 1897) of the *Analele* of the Meteorological Institute of Roumania has recently been published. In his annual report, the director, Dr. S. C. Hepites, who is now retiring after thirty years of service to the State, gives a history of the meteorological service during the first thirteen years of its working. In 1883 there were only three meteorological, and ten pluviometric, stations in the whole country. There are now a meteorological station of the first order at Bucharest, thirty-eight of the second order, one of the third, and 327 pluviometric stations within an area of 131,400 sq. km. The annual volume, which in the present case contains nearly 800 quarto pages, bears testimony to the value of the work accomplished. Besides the usual meteorological tables, it contains an account of the new magnetic observatory at Bucharest by M. St. Murat, and nine other memoirs, among which may be mentioned those by the director on rain at Bucharest during the last thirty-two years, the rainfall of Roumania in 1897, the magnetic elements of Bucharest, and on the register of earthquakes, eleven in number, felt during the year 1897.

IN the columns of NATURE last autumn, attention was directed by several writers to the phenomenon well known amongst iron-workers that if a bar of steel or iron, heated to a red or white heat at one end, have that end suddenly plunged into cold water, the other end will appear to become hotter. Prof. E. Lagrange, writing in the *Bulletin* of the Belgian Academy (1899, No. 4), describes experiments showing that this effect is quite compatible with the ordinary laws of conduction of heat. The bar in every case is removed from the fire before the stationary point has been reached; the temperature of the unheated end is increasing at the time of removal, and as its rate of change does not vary discontinuously, it continues to increase after removal. When the hot end of the bar is suddenly cooled, Prof. Lagrange finds that the other end attains its maximum temperature sooner, and this maximum is considerably lower than when the hot end is cooled slowly. If, however, the bar is heated until the flow of heat has become steady, no further increase takes place at the other end, whether the hot end is cooled slowly or suddenly, but the unheated end begins to cool at once, and its cooling is more rapid in the second than in the first case.

WHETHER corresponding to the Zeeman effect there exists the reciprocal phenomenon of the production of a magnetic field by a circularly polarised ray has been discussed by Profs. Fitzgerald and Gray in NATURE for January 5 and February 16. Prof. Augusto Righi, writing in the *Atti dei Lincei*, viii. (1), 7, describes his own experiments on the subject. Prof. Righi used columns of vapour of hypo-azotide and of bromine, the illumination being produced by a plane polarised beam of sunlight, between which and the tube two quarter-wave laminæ of quartz oppositely turned were placed. An astatic magnetometer showed no deviation either when the sense of polarisation was reversed by interchanging the quartzes or when the light was cut off, although a magnetic field of 10^{-6} C.G.S. units produced a perceptible deviation. In another note, published in the *Rendiconto* of the Bologna Academy, Prof. Righi describes his determination of the rotatory power of chlorine in a magnetic field. The numerical measure of this effect referred to bisulphide of carbon was found to be 0·000337, and chlorine is thus intermediate between carbonic anhydride and protoxide of nitrogen, whose rotatory powers, as found by Becquerel, are 0·000302 and 0·000393 respectively.

FROM a paper published by Drs. Rabinowitsch and Kempner in the *Zeitschrift für Hygiene* on the milk of tuberculous cows, the chance of infection from the latter appears to be greater than was even supposed. Whereas it has been generally found that cow's milk only contains tubercle bacilli when the udder is affected, or when the animal is in an advanced stage of tuberculosis, the above authors have found the bacilli in milk in the very beginnings of the disease, and without any udder affection, as well as in latent cases where its existence could only be verified by the tuberculin test. The authors point out that it is not sufficient to make one examination only of the milk, and they cite an instance in which, whilst the milk gave a negative result, butter made from the milk derived from the same cow on the same day on inoculation into guinea-pigs resulted in the death of the latter from tuberculosis, whilst an examination of this cow's milk made at a later date revealed the presence of tubercle bacilli. In view of these investigations, the authors are of opinion that the milk of all cows which react to the tuberculin test ought to be regarded with suspicion, and they point out, moreover, the great value which attaches to this test in helping to obtain milk-supplies free from the contagion of tuberculosis.

IT is always with pleasure that we receive a new *Bulletin* of the Madras Government Museum, as we are sure to find therein brightly written and instructive papers on the native races of Southern India by Mr. Edgar Thurston, the superintendent of the Museum. The most important of these little memoirs in the last issue (vol. ii. No. 3) is one on the Kadirs of the Anaimalai Hills. They are a dark-skinned, curly-haired people, short in stature (average 1·577) with a broad span (1·688), deep-chested, and like many mountaineers they rarely walk with a straight leg. The head is narrow (average 72·9), the jaws do not project, and the nose is wide (average 89·8). They thus are good representatives of the ancient population of Southern India. They have one remarkable custom which appears to be unique in the Indian peninsula, and that is the chipping of all or of some of the incisor teeth of both jaws into the form of a sharp-pointed cone.

IN a note on the Dravidian head, Mr. Thurston (*loc. cit.*) states that the average cephalic index of 639 Dravidians belonging to nineteen tribes and castes is 74·1. Out of the total number measured by him only nineteen, or 3 per cent., of the indices exceeded 80, the maximum being 83·7. In a discussion on the Dravidian problem, Mr. Thurston gives only a few original observations, and has collected the opinions of a number of authors, but he does not sum up or give us his own conclusions.

THE origin of life, as developed from a mechanical foundation, forms the subject of a work by Dr. Ludwig Zehnder, of Freiburg, the first part of which has just reached us. After referring to the work of Darwin and his successors, the author tells us in his introduction that there has long been a hope that a direct transition between unorganised and organised bodies would some day be discovered, but that hitherto the gap has not been bridged. Apparently it is his intention to show how the two great groups are at present known to approach one another. The present part treats of Monads, simple cells, and Protistæ.

IN broad contrast to the foregoing may be mentioned a brief paper by M. E. Lefort, published at Lyons under the title of "Fausseté de l'Idée Evolutioniste appliquée au Système Planétaire ou aux Espèces Organiques." The general contention appears to be that every change in nature is due to direct Divine interposition.

A SHORT account of the first voyage of the Prince of Monaco's new vessel, *Princess Alice II.*, appears in the *Comptes rendus*; and a fuller description of the work in northern waters, illustrated by photographs, is published in the Paris *Bulletin du Museum d'histoire naturelle*. The expedition of last year started from Havre in June, and, after a meeting with the Emperor of Germany off the Norwegian coast, worked in Spitsbergen waters till the end of August, returning to Havre about the middle of September. Extended physical and biological observations were made both at sea and on a number of islands in high northern latitudes. The collections will be added to the museum of oceanography recently founded by the Prince at Monaco.

WE have received the first number of *Finland*, an "English journal devoted to the cause of the Finnish people."

Science of June 16 publishes a translation of a criticism of the plans for an International Catalogue of Scientific Literature, contributed to the *Zoologische Anzeiger* by Prof. J. Victor Carus.

A MEETING of the Anatomical Society of Great Britain and Ireland will be held in the Anatomical Schools, New Museums, Cambridge, on Saturday, July 8, commencing at 2 p.m.

MESSRS. J. AND A. CHURCHILL announce that they will shortly publish the following scientific works: A text-book of physics by Prof. Andrew Gray, F.R.S.; the book will be issued in three parts, the first to appear being that on dynamics and properties of matter. A work on medical electricity for the use of students and practitioners, by Dr. W. S. Hedley. A handbook on chemistry and physics, for students preparing for the first examination of the Conjoint Board, by Messrs. Corbin and Stewart.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. L. Smallcombe; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. J. H. Johnston; a Diana Monkey (*Cercopithecus diana*, ♀) from West Africa, presented by Mr. T. N. Loy; a —— Deer (*Cariacus*, sp. inc. ♂) from Tobago, presented by Captain J. Leslie Burr, R.N.; a Stone Curlew (*Aedicnemus scolopax*), European, presented by Mr. D. T. Campbell; six Cormorants (*Phalacrocorax carbo*, juv.) from Scotland, presented by Mr. Percy Leigh Pemberton; a Yellow-crowned Penguin (*Eudyptes antipodum*), a Thick-billed Penguin (*Eudyptes pachyrhynchus*) from New Zealand, a Rock-hopper Penguin (*Eudyptes chrysocome*) from the Falkland Islands; two Elephantine Tortoises (*Testudo elephantina*) from the Aldabra Islands, a Reticulated Python (*Python reticulatus*) from the East Indies, deposited; a Red Deer (*Cervus elaphus*, ♂), born in the Gardens; two Coscoroba Swans (*Coscoroba candida*) from Antarctic America, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 2. 9h. 16m. to 11h. 14m. Transit of Jupiter's Sat. III.
3. 12h. 40m. to 13h. 30m. Occultation of the star D.M. + 21°, 539 (mag. 5·7) by the moon.
3. 14h. 57m. to 15h. 43m. Occultation of the star 32 Tauri (mag. 5·7) by the moon.
5. 15h. Conjunction of Venus and the moon (♀ 1° 0′ south).
6. 10h. Conjunction of Venus and Neptune (♀ 0° 46′ north).
13. 9h. 51m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc 0·955, Mars 0·931.
19. 8h. 6m. to 9h. 17m. Occultation of B.A.C. 5709 (mag. 6·3) by the moon.
19. 8h. 9m. to 9h. 24m. Occultation of 26 Ophiuchi (mag. 6·1) by the moon.
19. 14h. Conjunction of Saturn and the moon (♄ 2° 26′ north).
20. 7h. 39m. to 8h. 41m. Occultation of 7 Sagittarii (mag. 5·4) by the moon.
20. 8h. 4m. to 9h. 15m. Occultation of 9 Sagittarii (mag. 5·7) by the moon.
21. 23h. Mercury at greatest elongation (26° 59′ east).
24. 9h. 26m. Jupiter's Sat. IV. in conjunction with north pole of planet.
28. Tempel's comet (1873 II.) in perihelion.

TEMPEL'S COMET 1899 *c* (1873 II.)—The following ephemeris is contributed to the *Astr. Nach.* (Bd. 149, No. 3574), by M. L. Schulhof.

Ephemeris for 12h. Paris Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	Br.
June 29	20 13 33·4	− 8 35 52	2·525
30	14 51·3	8 56 1	
July 1	16 8·8	9 16 56	
2	17 25·9	9 38 37	
3	18 42·5	10 1 5	2·770
4	19 58·6	10 24 18	
5	21 14·4	10 48 17	
6	20 22 29·7	− 11 13 0	

FIFTH SATELLITE OF JUPITER.—In *Bulletin* No. 10 of the Yerkes Observatory (*Astrophysical Journal*, vol. ix., p. 358), Prof. G. E. Hale gives the measures of Jupiter's fifth satellite which have recently been made by Prof. E. E. Barnard with the 40-inch refractor. The observations were made on five nights during March and April 1898, and on four nights during April and May 1899. The constants determined are as follows:—

Times of east elongation, G.M.T. d. h. m.	East elongation distance. ″
1898 March 2 18 57·80	
1898 March 6 18 36·11	48·14
1898 April 5	48·12
1899 April 25 19 5·26	48·34
1899 May 1 18 32·72	48·29

The different values of the elongation distance are due to the revolution of the line of apsides, which, as Tisserand showed, takes place in a period of five months. The consistency of the measures with the instrument are shown by the plotted curve of the 131 observations of May 1, none of which depart more than 0″·4 of arc from the mean.

The great number of revolutions made by the satellite since its discovery in 1892 render possible an accurate calculation of its period. Using the elongations of September 10, 1892, March 6, 1898, April 25, 1899, and May 1, 1899, the resulting periodic time is found to be

11h. 57m. 22·647s.

OXFORD UNIVERSITY OBSERVATORY.—The twenty-fourth annual report of the Savilian Professor contains an account of the work accomplished from June 1, 1898, to May 31, 1899, and a survey of the condition of the instrumental equipment. The large dome, erected in 1875, has become so defective that plans for a new one have been prepared, the estimated cost being 440*l*. In consequence of disadvantages resulting from the unprotected state of the observatory, the need of a residence is strongly urged. During the year the observatory has been greatly enriched by the acquisition of the library of the late Mr. George Knott. Among the numerous presents received, special mention is made of a long series of early nautical almanacs, extending from 1767 to 1843, kindly given by Mr. Robert Gordon.

The De la Rue astrographic telescope is in good order, 258 plates for the catalogue having been taken during the year. The De la Rue reflector and the Barclay transit circle are both in good order. With the latter an unknown, variable change of collimation error has been traced to the looseness of the object-glass in its cell, this being finally eliminated by cotton wool packing.

No time has been found to proceed further with the photographic transit circle. The four micrometers for measuring the catalogue plates are in general use, one being in charge of Mr. T. J. Moore, of Doncaster, who has measured 61,186 stars with it.

The staple work of the observatory staff has been the measurement and reduction of the plates for the astrographic catalogue, and about half of this is now done, 586 plates out of the 1180 allotted to the observatory having been measured, and 525 completely reduced. In the region of the Milky Way the times of exposure for the plates have been reduced to 3 min., 1 min. and 20 secs., the number of stars even with the smaller exposure being still over 300.

Considerable interest attaches to the investigation undertaken to determine the possible distortion present in a large photographic doublet. Positives from plates taken with the 24-inch Bruce doublet at Arequipa have been lent by Prof. Pickering, and the results of their examination prove that it is possible to get large fields sensibly free from optical distortion. This has a most important bearing on the carrying out of the "chart" work, as it is at present necessary to expose for one hour to obtain a region $2° \times 2°$, whereas the new form of lens would give a much larger region in the same time. For this reason, Prof. Turner has indefinitely postponed the taking of the "chart" plates for the Astrographic Survey.

CAMBRIDGE OBSERVATORY.—Embodied in the *Cambridge University Reporter* for June 16, is the annual report of the Cambridge Observatory from 1898 May 26 to 1899 May 25. With the meridian circle, 2241 observations of 1420 stars have been taken, most of these being repetitions of previous observations for the catalogue.

One hundred and seventy-six observations have been made of the Harrow occultation stars; and, at the request of Dr. Gill, observations of heliometer comparison stars were commenced in March and are still in progress.

In addition, there have been other measurements of standard stars, bringing up the total number of meridian observations to 3616.

The new bent equatorial, to be called the "Sheepshanks equatorial" (see illustrated description in *Monthly Notices*, R.A.S., 1899 January, vol. lix. p. 152) was completed about September 1898, and its adjustment was undertaken by Mr. Hinks. It was soon found that the objective tube had a large flexure, and a new tube is being made. The first trial photographs were unsatisfactory, the disturbing cause being thought to be the air currents in the tube, which is partly open near the joint.

The Newall telescope has been employed on 96 nights during the year, in connection with the Bruce spectroscope, in taking photographs of stellar spectra for determining their velocity in the line of sight; 150 photographs have been obtained, giving material for determining the velocity of 60 stars. Thirty of these are included in the Potsdam list of 51 stars observed from 1888–1891. Preparations are in hand for converting the spectroscope into a powerful 4-prism instrument for detailed examination of a few of the brightest stars. Special series of stellar spectra have been taken to assist in the reduction of the eclipse photographs obtained in India in 1898. For this purpose also attempts have been made to separate scandium salts from the mineral gadolinite.

PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.[1]

I THINK I may fairly assume that every one in this theatre has had their photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted on plate in a solution, of, say pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other means a latent picture is formed, which is rendered visible in precisely the same way as the light pictures are.

The substances which produce on a photographic plate these results, so strongly resembling those produced by light, are, some of them, metallic, while others are of vegetable origin. At first it seemed very remarkable that bodies so different in character should act in the same way on the photographic plate. The following metals—magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth, tin, cobalt, antimony—are all capable of acting on a photographic plate. Magnesium most strongly, antimony but feebly, and other metals can also act in the same way, but only to a very slight extent. The action in general is much slower than that of light, but under favourable conditions a picture may be produced in two or three seconds.

[1] A lecture delivered at the Royal Institution on Friday, May 5, by Dr. W. J. Russell, V.P.R.S.

Zinc is nearly as active as magnesium or cadmium, and is the most convenient metal to experiment with. In its ordinary dull state it is entirely without the power of acting on a photographic plate, but scratch it or scrape it, and it is easy to prove that the bright metal is active. I would say that all the pictures which I have to show you, by means of the lantern, are produced by the direct action of the metal, or whatever the active body may be, on the photographic plate, and that they have not been intensified or touched up in any way. This first slide is the picture given by a piece of ordinary zinc which has been rubbed with some coarse sand paper, and you see the picture of every scratch. Here is a piece of dull zinc on which some circles have been turned. It was exposed to the photographic plate for four hours at a temperature of 55° C. In the other cases, which are on a larger scale, a zinc stencil was polished and laid upon a photographic plate, and you see where the zinc was in contact with the plate much action has occurred. In the other case a bright zinc plate was used, and a Japanese stencil interposed between it and the photographic plate, and a very strong and sharp picture is the result. The time required to produce these zinc pictures varies very much with the temperature. At ordinary temperature the exposure would have to be for about two days, but if the temperature was, say, 55° C., then half to three-quarters of an hour might be sufficient. Temperatures higher than this cannot be used except for very short times, as the photographic plate would be damaged. Contact between the zinc and photographic plate is not necessary, as the action readily takes place through considerable distances. Obviously, however, as you increase the distance between object and plate, so you decrease the sharpness of the picture, as is shown by the following pictures, which were taken respectively at a distance of 1 mm. and 3 mm. from the scratched zinc surface. The appearance of the surfaces of different metals varies, and the following slides show the surface of a plate of bismuth, a plate of lead, and one of aluminium. On the next slide are the pictures produced by similar pieces of pure nickel and cobalt, and it clearly shows how much more active in this way nickel is than cobalt. Many alloys, such as pewter, fusible metal, brass, &c., are active bodies, and in the case of brass the amount of action which occurs is determined by the amount of zinc present. Thus you will see that a brass with 30 per cent. of zinc produces hardly any action on the photographic plate, but when 50 per cent. of zinc is present there is a fairly dark picture, and when as much as 70 per cent. is present a still darker picture is produced. The second class of bodies which act in the same way on a photographic plate are organic substances, and belong essentially to the groups of bodies known as terpenes. In trying to stop the action of metallic zinc, which I thought at the time might arise from vapour given off by the metal, copal varnish was used, but in place of stopping the action it was found to increase it, and this increase of activity was traced to the turpentine contained in the varnish. In experimenting with liquids it is convenient to use small shallow circular glass vessels such as are made for bacteriological experiments, the plate resting on the top of the vessel, and the amount of liquid in the vessel determining the distance through which the action shall take place. The following slide, produced in this way, shows how dark a picture ordinary turpentine produces. All the terpenes are active bodies. Dipentine is remarkably so; in a very short time it gives a black picture, and if the action be continued, the dark picture passes away, and you then have a phenomenon corresponding to what photographers call reversal. The strong smelling bodies known as essential oils, such as oil of bergamot, oil of lavender, oil of peppermint, oil of lemons, &c., are all active bodies, and all are known to contain in varying quantities different terpenes; therefore ordinary scents are active bodies, and this is shown by the following pictures produced by eau de Cologne, by cinnamon, by coffee, and by tea. Certain wines also act in the same way, Sauterne gives a tolerably dark picture, but brandy only a faint one. Other oils than these essential ones are also active bodies; linseed oil is especially so; olive oil is active, but not nearly as much so as linseed oil; and mineral oils, such as paraffin oil, are without action on the photographic plate.

Interesting results are obtained with bodies which contain some of these active substances; for instance, wood will give its own picture, as is shown by the following slides: the first is a section of a young spruce tree, the next a piece of ordinary deal, and the third of an old piece of mahogany. Again, the next slide you will recognise as the picture of a peacock's feather. There is much interest in these pictures of feathers, as they distinguish the brilliant interference colours from those produced by certain pigments; the beautiful blue in the eye of the peacock's feather is without action on the photographic plate. Butterflies' wings, at least some of them, will draw, as you see, their own pictures. Linseed oil, which is a constituent of all printing ink, makes it an active body, and it can, like the zinc and other active bodies, act through considerable distances. In the picture before you the ink was at a distance of one inch from the plate, and the next slide shows what a remarkably clear and dark picture ordinary printing can produce. As the composition of printing ink varies so does its activity, and here are pieces of three different newspapers which have acted under the same conditions on the same plate, and you see how different the pictures are in intensity. Printed pictures, of course, act in the same way; here is a likeness of Sir H. Tate taken from "The Year's Art." The pictures and printing in *Punch* always print well, so does the yellow ticket for the Friday evening lectures at the Royal Institution; also the rude trade-mark on Wills's tobacco, and it is of interest because the red pigment produces a very clear picture, but the blue printing is without action on the plate.

An interesting and important peculiarity of all these actions is that it is able to pass through certain media; for instance, through a thin sheet of gelatin. Here are two plates of zinc; both have been scratched by sand-paper; one is laid directly on the photographic plate, and the other one has a sheet of gelatin, its colour is of no note, laid between it and the sensitive plate; the picture in this case is, of course, not so sharp as when no gelatin is present, but it is a good and clear likeness of the scratches.

Celluloid is also a body which allows the action to pass through it, as is seen in this picture of a piece of perforated zinc, a picture which was produced at ordinary temperatures. Gold-beaters' skin, albumen, collodion, gutta-percha, are also bodies which are transparent to the action of the zinc and the other active bodies. On the other hand, many bodies do not allow the transmission of the action through them; for instance, paraffin does not, and among common substances writing ink does not, as is easily shown by placing ordinary paper with writing on it between the active body and the photographic plate. The active body may conveniently be either a plate of zinc or a card painted with copal varnish and allowed to dry, or a dish of drying oil. The picture of an ordinarily directed envelope shows this opacity of ink well. It is a property long retained by the ink, as this picture of the direction of a letter, written in 1801, shows; also this letter of Dr. Priestley's, dated 1795, and here is also some very faded writing of 1810, which still gives a very good and clear picture. Even if the writing be on parchment, the action passes through the parchment, but not through the ink, and hence a picture is formed.

With bodies which are porous, such as most papers, for instance, the action passes gradually through the interstices, and impresses the plate with a picture of the general structure of the intervening substance. For instance, the following pictures show the structure and the water-mark of certain old and modern writing papers. Some modern writing papers are, however, quite opaque; but usually paper allows the action to take place through it, and combining this fact with the fact of the strong activity of the printing ink, the apparently confused appearance produced on obtaining a picture from paper with printing on both sides is accounted for, as the printing on the side away from the photographic plate, as well as that next to it, prints through the paper, and is, of course, reversed.

I hope I have now given you a clear idea how a picture can be produced on a photographic plate in the dark, and the general character and appearance of such pictures. I now pass on to the important question of how they are produced. Moser suggested fifty years ago that there was "dark light," which gave rise to pictures on polished metallic plates, and lately it was suggested that pictures were produced by vapour given off by the metals themselves; the explanation, however, which I have to offer you is, I think, simpler than either of these views, for I believe that the action on the photographic plate is due to the formation of a well-known chemical compound, hydrogen peroxide, which undergoing decomposition acts upon the plate and is the immediate cause of the pictures formed. The complicated changes which take place on the sensitive plate I have nothing to say about on the present occasion, but I desire to convince you that this body, hydrogen peroxide, is the direct cause of these pictures produced in the dark. Indirect proof has to be resorted to. Water cannot be entirely excluded, for an absolutely dry photographic plate would probably be perfectly inactive, and as long as water is present peroxide of hydrogen may be there also. But what are the conditions under which these pictures are formed? Only certain metals are capable of producing them. This list of active metals which I have mentioned to you was determined solely by experiment, and when completed it was not evident what common property bound them together. Now, however, the explanation has come, for these are the very metals which most readily cause, when exposed to air and moisture, the formation of this body, peroxide of hydrogen. Schönbein showed as long ago as 1860 that when zinc turnings were shaken up in a bottle with a little water hydrogen peroxide was formed, and the delicate tests which we now know for this body show that all the metals I named to you not only can in the presence of moisture produce it, but that their power of doing so follows the same order as their power of acting on a photographic plate. Again, what happened with regard to the organic bodies which act on the photographic plates? I have already mentioned that in experimenting with the metals it was accidentally observed that copal varnish was an active substance producing a picture like that produced by zinc, and that the action was traced to the turpentine present; again, a process very much like groping in the dark had to be carried on in order to determine which were active and which inactive organic bodies, and the result obtained was that the active substances essentially belonged to the class of bodies known to chemists as terpenes. Now a most characteristic property of this class of bodies is that in presence of moisture and air they cause the formation of hydrogen peroxide, so that whether a metal or an organic body be used to produce a picture, it is in both cases a body capable, under the circumstances, of causing the formation of hydrogen peroxide. Passing now to experimental facts, which confirm this view of the action on sensitive plates, I may at once say that every result obtained by a metal or by an organic body can be exactly imitated by using the peroxide itself. It is a body now made in considerably quantity, and sold in solution in water. Even when in a very dilute condition it is extremely active. One part of the peroxide diluted with a million parts of water is capable of giving a picture. It can, of course, be used in the glass dishes like any other liquid, but it is often convenient not to have so much water present; and then it is best to take white blotting-paper, wet it in the solution of the peroxide, and let it dry in the air. The paper remains active for about twenty-four hours; or, what is still better, take ordinary plaster of Paris, wet it with the peroxide solution, and let it set "in a mould" so as to get a slab of it. This slab increases in activity for the first day or two after making, and retains its activity for a fortnight or more. Such a slab will give a good and dark picture in three or four seconds.

To show how similar the pictures produced by the peroxide and those by zinc are, pictures of a Japanese paper stencil, which had been paraffined to make it quite opaque, have been made by both processes, and are shown with other instances in which turpentine was used in the following slides. It is also very easy to obtain good pictures with the peroxide alone of the structure of paper, &c.; see, for instance, this one of a five-pound note and these of lace. Again, the strict similarity between the action of the peroxide and that of the metals and organic bodies is further shown by the fact that its action passes through the same media as theirs does; and here are good pictures formed by the action of the peroxide after passing through a sheet of these substances. How this singular transmission can be explained, I have treated of elsewhere, and time does not allow of my discussing the matter to-night.

There are many ways in which the bright, active zinc surface can be modified. Draw your finger across it, press your thumb upon it, and you stop its activity, as is shown by the picture it will give. Lay a printed paper on the zinc, and let the contact continue for three-quarters of an hour, at a temperature of 55°, then bring the zinc in contact with a sensitive plate, a picture of the printing is formed, but allow the contact between the zinc and printing to continue for eighteen hours at the same temperature, and the picture then given by the zinc is the reverse of the former one. Where the ink has been is now less active than the rest of the plate. Here are slides which show these positive and negative pictures. Another way of modifying the zinc surface is interesting. You have seen that the ordinary zinc surface which has been exposed to air and moisture is quite inactive, but if a bright piece of zinc be immersed in water for about twelve hours, the surface is acted on; oxide of zinc is formed, showing generally a curious pattern. Now, if the plate be dried, it will be found that this oxide is strongly active, and gives a good picture of the markings on the zinc. The oxide evidently holds, feebly combined or entangled in it, a considerable quantity of the hydrogen peroxide, and it requires long drying or heating to a high temperature to get rid of it. Also, if a zinc plate be attacked by the hydrogen peroxide, the attacked parts become more active than the bright metal. Thus, place a stencil on a piece of bright zinc, and expose the plate to the action of an active plaster of Paris slab, or to active blotting-paper for a short time, then, on removing the stencil, the zinc plate will give a very good picture of the stencil. Any inactive body—for instance, a piece of Bristol board or any ordinary soft paper—can be made active by exposing it above a solution of peroxide, or, more slowly, by exposing it to a bright zinc surface. If, for instance, a copper stencil be laid on a piece of Bristol board, and a slab of active plaster of Paris be placed on the stencil for a short time, the Bristol board will even, after it has been removed from the stencil for some time, give a good picture of the stencil. Drying oil and other organic bodies may be used in the same way to change the paper. A curious case of this occurred in printing a coloured advertisement cut out of a magazine, for there appeared printing in the picture which was not in the original. This printing was ultimately traced to an advertisement on the opposite page, which had been in contact with the one which was used; thus this ghostly effect was produced.

I believe, then, that it is this active body, hydrogen peroxide, which enables us to produce pictures on a photographic plate in the dark. There are many other curious and interesting effects which it can produce, and which I should like to have shown you, had time permitted.

I would only add that this investigation has been carried on in the Davy-Faraday laboratory of this institution.

WILLIAM J. RUSSELL.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE second of the two annual conversazioni of the Royal Society was held on Wednesday, June 21, and was attended by a large and brilliant company. Many of the objects of scientific interest exhibited in the various rooms of the Society were the same as were shown at the first (or gentlemen's) conversazione held on May 3, the most important of which were described in NATURE of May 11 (p. 44). In addition to the objects already referred to, the following were among the exhibits.

Mr. C. V. Boys, F.R.S., exhibited for Mr. R. W. Wood, of the University of Wisconsin:—(1) Silvered photographic grating. The grating of 2,000 lines to the inch is a contact print on albumen. It is then silvered and polished while wet. The brilliancy of the spectrum is very great. (2) Diffraction colour photograph (see p. 199). Mr. J. E. Petavel exhibited the molten platinum standard of light.

Mr. W. A. Shenstone, F.R.S., and Mr. W. T. Evans showed experiments on the making of tubes from rock crystal in the oxyhydrogen blowpipe flame.

The Parsons Marine Steam Turbine Co., Ltd., had on view: (1) model of the *Turbinia*, the first vessel propelled by steam turbine engines; (2) model of torpedo boat destroyer of 35 knots guaranteed speed and 10,000 I.H.P.; (3) model of Atlantic liner of 38,000 I.H.P. and 27 knots speed.

Mr. A. A. Campbell Swinton showed experiments with electrolytic contact breakers. Mr. J. W. Swan, F.R.S., exhibited experiments showing effects produced by the action of modifications of the Wehnelt-Caldwell interrupter. Mr. W. R. Pidgeon showed a new influence machine. Mr. Mackenzie Davidson exhibited an apparatus to enable Röntgen ray shadows upon a fluorescent screen to be seen in stereoscopic relief.

Prof. Ray Lankester, F.R.S., exhibited (1) collections of mosquitoes recently received at the Natural History Museum for study in reference to the connection of malaria with mosquitoes; (2) drawings of mosquitoes, by Mr. Ernest E. Austen.

Dr. Patrick Manson showed microscopic specimens showing the development of the parasite of malaria.

Dr. Allan Macfadyen, for the Jenner Institute of Preventive Medicine, exhibited cultures and microscopical specimens of certain pathogenic bacteria.

Dr. Gladstone, F.R.S., showed ancient metals from Egypt, Babylon, and Britain.

The Victoria and Albert Museum for the Seismological Committee of the British Association exhibited a Milne horizontal-pendulum seismograph, with specimen of the seismograms yielded by it.

Prof. Haddon, F.R.S., showed a small collection of polished stone implements from the Baram District, Sarawak, Borneo.

Prof. T. G. Bonney, F.R.S., exhibited diamonds in eclogite. Boulders of eclogite, &c., occur in the "Blue Ground" at the Newlands Diamond Mines, West Griqua Land. Two of these contain diamonds. Thus the diamond cannot have its genesis in the "Blue Ground," nor can the latter, containing true boulders, be an igneous rock.

Mr. Walter Gardiner, F.R.S., and Mr. A. W. Hill showed histological preparations of plant tissues demonstrating the "connecting threads" which traverse the cell walls and establish a means of communication between the several cells.

Dr. F. W. Oliver exhibited a collection of Cingalese Podostemaceæ. The specimens included the majority of the Cingalese representatives of this remarkable family of flowering plants.

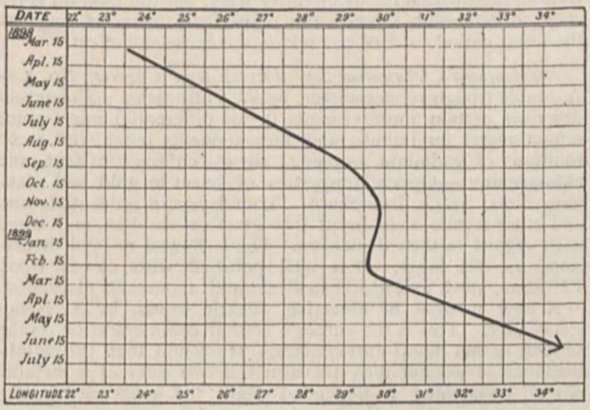
THE RED SPOT ON JUPITER.

I HAVE frequently observed this object during the present apparition of the planet, but always found it exceedingly faint and only visible under good definition. Its aspect is that of a faint dusky stain attached to the northern side of the south temperate belt, and partially filling up the hollow formed in the great southern equatorial belt. With my 10-inch reflector—power 312—the following estimated times of transit were obtained, and I have added the corresponding longitude of the object:—

Date.		Transit time.		Long.
		h. m.		°
1898 November 29	...	19 55	..	31·9
1899 February 2	...	18 39	...	29·5
7	...	17 46	...	29·0
24	...	16 49	...	30·0
26	...	18 27	...	29·9
April 19	...	11 20	...	32·0
26	...	12 3	...	30·8
May 6	...	10 19	...	31·7
8	...	11 58	...	32·3
June 4	...	9 18	...	34·4
6	...	10 57	...	34·8
9	...	8 26	...	34·4
11	...	10 4	...	34·0
14	...	7 32	...	32·9
16	...	9 13	...	34·4
21	...	8 20	...	33·5
23	...	9 58	...	33·1
26	...	7 29	...	33·7

This feature has shown a remarkable variation of motion during the last twelve months. In the winter there was a very decided acceleration of speed, but during the past three months the motion has been again retarded. The acceleration was first noticed here on the morning of February 3, when the marking came to the central meridian seven or eight minutes before its computed time. In the first half of 1898, and again during the last few months, the rotation period of the spot was nearly 9h. 55m. 42s., but for several months in the past winter the rate corresponded very nearly with 9h. 55m. 40·6s., the period employed by Mr. Crommelin in System II. of his ephemerides (*Monthly Notices*, November 1898). But, unfortunately, the precise character of the recent irregularity of motion cannot be determined, Jupiter having been too near the sun for effective observation during several months (August to November 1898).

The following diagram will, however, represent approximately the variation, which amounted to nearly one and a half seconds in the rotation period :—



My observation of 1898 November 29 was probably not very accurate, as the planet was low and very faint in the fog which prevailed. It is, however, in part confirmed by an observation obtained by Prof. G. W. Hough in 1898 December 10, who found the spot in the computed position, and saw no indication of the accelerated rate, which soon afterwards began to operate. In preparing the diagram I have, however, preferred to think that my autumn observation was a little late, as this requires a less sudden and extreme variation in the motion of the spot. This object should be carefully watched until the close of the present opposition, and the times of its transit secured on all possible occasions. There will be little difficulty in continuing observations until the end of August. If the red spot itself is not sufficiently distinct to be well observed when presented on the central meridian, transits of the middle of the hollow or bay in the southern side of the south equatorial belt will answer the purpose equally well.

Since the spot became a very prominent feature in 1878 it has exhibited an increasing rate of rotation, the period rising from 9h. 55m. 37s. to 9h. 55m. 42s. This increase has not been perfectly regular, for the motion has shown many irregularities similar to that which affected it during the past winter. No doubt the time will come when the maximum rate will be reached, to be followed thereafter by a marked shortening of the period. This appears to have been the case in 1859, and there is indication that the cycle of variations extends over a period of about 48½ years; if so, we cannot expect a decided acceleration in the mean rate of the spot until the year 1907 or 1908.

There is every prospect that in a few years we shall be much better acquainted with the surface phenomena of Jupiter, and the variations affecting them, than we are at the present time. A very large number of useful observations were obtained in 1898, and many more are being secured during the present year. Observers are now generally recognising the necessity of accumulating observations of all the visible details of the surface, and determining the velocities of the various and varying currents in which they are situated.

The planet has recently afforded a singularly abundant display of spots and irregularities. Dark and white masses of material are thickly arranged near the equator, and from a partial investigation these appear to be moving rather slower than in 1898, the rate being now 9h. 50m. 25s., as against 9h. 50m. 23⅓s. during the previous opposition. A considerable number of white and dark spots are also distributed along the northern edge of the northern equatorial belt, which give a period slightly less than that of the red spot, but some of these markings are moving much more rapidly than others. The quickest of all is a small dark spot now in long. 145°, which has given a period of 9h. 55m. 15s., or about 27 seconds less than that of the red spot. In other latitudes a vast amount of detail is exhibited, and it is fortunate that the planet is being so sedulously studied by Mr. A. S. Williams, Prof. Hough, Mr. Gledhill, the Rev. T. E. R. Phillips, Captain Molesworth, and other able observers.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness Studentship in Geology has been awarded to Mr. A. L. Hall, Caius, first class in Natural Science Tripos, Part II., 1899.

The following College awards in Natural Science are announced :—

Clare : Scholarships to Cassidy, Goodchild, and F. G. Smith ; Exhibition to H. B. Jackson.

Trinity Hall : Scholarship to H. S. Newbould.

King's : Scholarship to Barger ; Exhibitions to Kewley, Mollison, Matthews, and Cartwright.

Emmanuel : Exhibitions to Walker, Heaton, Nixon, Sutton, Austin.

Mr. G. T. Bennett (Senior Wrangler 1890) has been elected a Senior Fellow, and Mr. H. S. Carslaw (Fourth Wrangler 1894) a Junior Fellow, at Emmanuel College.

At the beginning of the Michaelmas term, the General Board will proceed to elect a University Lecturer in Physical Anthropology for five years, with a stipend of 50*l*. a year. Names must be sent in to the Vice-Chancellor by September 30.

At Caius College, E. P. Widdicombe (Downing) and H. E. Wimperis have been elected to Salomons Engineering Scholarships, and R. H. Yapp (St. John's) to a Frank Smart Studentship for Botany.

At Christ's College, Scholarships for Natural Science have been awarded or continued to Hocking, Howlett, Brown, Gottschalk, Leake, Hoffmann, Fox, Muff, and Cumberlidge.

At Sidney Sussex College, Science Scholarships have been awarded to Bullough, Coales, Colt, Fearnsides, Fyson, and Stenhouse.

SIR W. T. THISELTON-DYER, K.C.M.G., F.R.S., has been elected to an honorary studentship at Christ Church, Oxford.

DR. MAGNUS MACLEAN has been elected Professor of Electrical Engineering in the Glasgow and West of Scotland Technical College.

PROF. FRED W. MCNAIR has been elected president of the Michigan College of Mines. Prof. McNair has been for some years in charge of the department of mathematics and physics.

PROF. A. R. FORSYTH, F.R.S., Sadlerian professor of pure mathematics in the University of Cambridge, has had the honorary degree of LL.D. conferred upon him by the University of Dublin.

THE London School of Economics and Political Science, 10 Adelphi Terrace, W.C., offers the following research studentships, which will be awarded on examination in July : (1) One of 100*l*. a year, for two years, presented by the Hon. Bertrand Russell, Fellow of Trinity College, Cambridge. (2) One of 50*l*. a year, for two years. (3) The "Lucy Rose" studentship of 50*l*. a year, for two years, presented by Mr. Edward Rose—open to women students only. Preference will be given to a woman student sprung from the working classes. The studentships are intended to enable students to become trained investigators, and to promote the execution of definite pieces of original work relating either to past or present economic or political conditions.

THE *Times* states that the Association of Directors and Organising Secretaries for Technical and Secondary Education have addressed a memorial to the Government with regard to the alteration made in the Board of Education Bill in the Standing Committee of the House of Lords at the instance of Lord Spencer. The association entreat the Government to induce the House of Commons to restore Clause 3 (1) to its original shape, on the ground that the term "school supplying secondary education" (used in that clause) is a very wide one, and, if interpreted in the light of the report of the Royal Commission on Secondary Education, must include polytechnics, higher grade schools, science schools, art schools, commercial schools, and agricultural schools. These, it is submitted, are the very types of schools which are being founded or developed all over the kingdom by the county councils, which supply the pressing industrial needs of the day, and demand that guidance and encouragement which it is the object of the Bill to supply.

THE second reading of the Board of Education Bill was agreed to by the House of Commons on Monday. Sir John Gorst, in moving the second reading, explained that the object of the Bill is to enable the Government to create a department of State which may have conferred upon it powers in relation to secondary education. The Royal Commission on Secondary Education recommended that there should be a central authority, a Government Department, in London, to supervise secondary education and local authorities in the country. The opinion of the Government is that the central authority in London must be created and arranged before the local authorities in the country can be usefully set on foot, and it is to organise and arrange a central department in London to exercise the sort of functions recommended by the Royal Commission that this Bill has been brought before Parliament. The Bill proposes the abolition of the existing Committee of Council on Education and to replace it by a Board of Education consisting of the First Lord of the Treasury, the Chancellor of the Exchequer, and the Secretaries of State for various departments, having a President and a Parliamentary Secretary in the same manner as the Local Government Board and the Board of Trade. To this new Board of Education are to be transferred all the powers and functions which are at present exercised by the Committee of Council, so that it will stand in relation to educational matters and the distribution of the science and art grants and technical instruction exactly in the same position, and have exactly the same powers, as the present Education Department possesses.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Othniel Charles Marsh—portrait and obituary notice.—The Camden Chert of Tennessee and its Lower Oriskany Fauna, by J. M. Safford and C. Schuchert. The latter describes in detail a peculiar chert formation discovered by the former.—Recent discovery of rocks of the age of the Trenton formation at Akpabok Island, Ungava, by J. F. Whiteaves. Describes the fossils collected by Dr. R. Bell, of the Canadian Geological Survey, on Akpabok Island, between Ashe Inlet and Fort Chimo, and concludes that they belong to a lower geological horizon than the Hudson River formation as at first supposed.—Studies in the Cyperaceæ, No. 10, by T. Holm. Describes the North American species of *Fimbristylis*, Vahl.—On Roscœlite, by W. F. Hillebrand and H. W. Turner. Roscœlite is a vanadium mica, some specimens of which show a tendency to crystallise in little rosettes. It occurs most frequently embedded in quartz at Placerville, California. It contains 45 per cent. SiO_2, 24 per cent. V_2O_3, 11 per cent. alumina, 10 per cent. potash, 4 per cent. water, and traces of magnesia and ferrous oxide.—Gravitation in gaseous nebulæ, by F. E. Nipher. If R be the radius of a spherical mass of gas of cosmical dimensions, and T its temperature, the product TR is constant. The heat capacity of such a gravitating mass is negative. If heat leaves the gas, it contracts and becomes warmer. The physical condition to be satisfied in order that a central mass or core, having a radius equal to that of the sun, should contain a mass equal to that of the sun, is that its temperature is 20 million degrees Centigrade. The pressure at the surface of this sphere is 366 million atmospheres. The average density of the spherical mass, which is three times the density at the surface of the hydrogen sun, is about 7 per cent. less than the average density of the sun itself, but the nature of the gas is immaterial. In the sun as it is, the rarefied external parts of the solar nebula have parted with their heat, and the temperature throughout the mass has ceased to be uniform. But the abolition of cosmical pressure has almost wholly compensated the fall in temperature of the sun from 20 millions at least to perhaps 10,000 degrees.

Symons's Monthly Meteorological Magazine, June.—Unprecedented frost in the United States in February 1899. In that month 64°·8 were recorded at Camden Town, being 2°·3 higher than any reading recorded in February in London during 104 previous years, while about the same time at New Orleans an equally unprecedented low reading of 7° (25° below freezing) was registered. Prof. Garriott, in charge of the forecast division, states that the most remarkable series of cold waves in the history of the Weather Bureau traversed the United States from the North Pacific to the South Atlantic coasts during the first half of February, damaging crops and fruit in the southern States to the extent of millions of dollars. The cause of this intense cold is ascribed to barometric depressions in the south, combined with a large area of high barometer over British north-west territory.—On a recent recurrence in weather: a lunar or 30-day period, by H. H. Clayton. The author has treated the temperatures observed at the Blue Hill Meteorological Observatory, from July 1898 to February 1899, in the same way as Mr. A. MacDowall has treated the temperatures for the same time observed at Greenwich. The figures show a well-marked period of about thirty days, but the interval is too short to determine whether the period had the exact length of the lunar period, or had any relation of cause and effect.

Wiedemann's Annalen der Physik und Chemie, No. 5.—A double trough refractometer, by W. Hallwachs. The author describes certain improvements in his differential interference refractometer for liquids, and measurements made with it on solutions of cadmium bromide, sugar, chloracetic acid, and chloracetates.—Optical properties of burnt-in gold and platinum films, by G. Breithaupt. Thin layers of gold, platinum, and other metals were burnt into glass or obsidian, and tested with regard to their dispersion. Gold showed normal dispersion, so did brass, when well polished with cotton wool. Platinum, steel, and nickel steel showed anomalous dispersion.—A new method of detecting electric waves, by A. Neugschwender. This is the author's second communication on the subject of his damp anti-coherer. He found that the establishment of conductivity between the two sides of a metallic slit on moistening it depended upon the presence of some metallic salt in the moisture which could be separated electrolytically. Under the microscope the metal so separated out forms a tree-like formation, which suddenly breaks up on the impact of electric waves, thus destroying the conductivity.—Determination of the pitches of Appunn's pipes by optical and by acoustic means, by F. A. Schulze. The author has repeated Appunn's determinations of the pitches of high pipes by the method of revolving mirrors, by Kundt's dust figures, and by Quincke's interference tube. He confirms Stumpf's result that the highest Appunn pipes have pitches assigned to them which are wrong by several octaves.—Determination of high pitches by difference tones, by C. Stumpf. The author defends the trustworthiness of the method of difference tones against Appunn's criticism.—On the refracted wave at so-called total reflection, by W. Voigt. Against Ketteler's criticism the author maintains that there exists a stream of energy parallel to the surface of the second medium in "total" reflection, and that this stream of energy is nothing else than a ray of light.—Thermal insulators, by W. Hempel. This is a comparison of the insulating properties of Dewar tubes silvered on the outer surface of the inner tube, with those of wool and feathers. Eiderdown turns out to be the most effective of the old insulators, as it is capable of maintaining a charge of solid carbonic acid and ether below −66° for an hour and a half, whereas the same charge surrounded by cotton or silk reaches −56° in the same time, and −33° when surrounded by an imperfect vacuum. At the same time, the charge remains below −70° in a Dewar tube, the initial temperature in every case being −79°.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 18.—"Diffusion of Ions into Gases." By John S Townsend, M.A. (Dublin), Clerk Maxwell Student, Cavendish Laboratory, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

In the paper upon this subject the principles of the theory of interdiffusion of gases are applied to the diffusion of ions produced in a gas by the action of Röntgen rays. When a gas is ionised in this way, and then removed from the action of the rays, the conductivity gradually disappears. If there are no electric forces acting on the gas, the loss of conductivity is due partly to the encounters between positive and negative ions, and partly the effect of the surface of the vessel which discharges those ions that come into contact with it.

The ions may be considered as a separate gas (A) mixed with the ordinary uncharged molecules (B), which are unaffected by the rays. When the mixture is passed along a metal tube there is a loss of conductivity, due to the ions coming into contact with the surface. A formula is given for calculating the rate of diffusion of the ions A into the gas B from this loss of conductivity, which was found experimentally. The following values were obtained for the coefficients of diffusion of ions into air, oxygen, carbonic acid, and hydrogen.

It was found that the rates of diffusion of the positive and negative ions differed more when the gas was dry than when it was moist.

Values of κ in Square Centimetres per Second.

Gas	κ for + ions in dry gas	κ for − ions in dry gas	κ for + ions in moist gas	κ for − ions in moist gas
Air	·0274	·042	·032	·035
Oxygen ...	·025	·0396	·0298	·0358
Carbonic acid...	·023	·026	·0245	·0255
Hydrogen ...	·123	·190	·128	·142

From the equation of motion

$$\frac{1}{\kappa}pu = -\frac{dp}{dx} + n\mathrm{X}e$$

(where p is the partial pressure of the ions, n the number of ions per c.c., e the charge on each ion, X the electric force at any point, and u the velocity of the ion in the x direction), it can be seen that when $\frac{dp}{dx} = 0$ the velocity u, due to the electric force X, is $\frac{n\mathrm{X}e\kappa}{p}$.

If the potential gradient is one volt per centimetre, $\mathrm{X} = \frac{1}{300}$ in electrostatic units, and the corresponding value of u is $u_1 = \frac{\kappa e}{300} \cdot \frac{n}{p}$.

Let N be the number of molecules per c.c. in a gas at pressure P, equal to the atmospheric pressure and temperature 15° C., the temperature at which u_1 and κ were determined.

The quotient $\frac{\mathrm{N}}{\mathrm{P}}$ may be substituted for $\frac{n}{p}$ in the above equation, and Ne is therefore obtained in terms of qualities which can be determined experimentally.

$$\mathrm{N}e = \frac{3\ 10^8 u_1}{\kappa}, \text{ since } \mathrm{P} = 10^6 \text{ in C.G.S. units.}$$

Substituting for u_1 the mean velocities given by Prof. Rutherford (E. Rutherford, *Phil. Mag.*, November 1897), and for κ the mean coefficient of diffusion obtained for the dry gases, and the following values of Ne are obtained :—

Air	$\mathrm{N}e_A = 1{\cdot}35\ 10^{10}$
Oxygen	$\mathrm{N}e_O = 1{\cdot}25\ 10^{10}$
Carbonic acid	$\mathrm{N}e_c = 1{\cdot}30\ 10^{10}$
Hydrogen	$\mathrm{N}e_H = 1{\cdot}00\ 10^{10}$

Experiments on electrolysis show that one electrodynamic unit of electricity in passing through an electrolyte gives off 1·23 c.c. of hydrogen at temperature 15° C. and pressure 10^6 C.G.S. units. The number of atoms in this volume is 2·46 N, so that if E is the charge on an atom of hydrogen in the liquid electrolyte

$$2{\cdot}46\ \mathrm{NE} = 1 \text{ electrodynamic unit of quantity}$$
$$= 3\ 10^{10} \text{ electrostatic units.}$$

Hence $\mathrm{NE} = 1{\cdot}22\ 10^{10}$, the charge E being expressed in electrostatic units. Since N is constant, these numbers show that the charges on the ions produced by Röntgen rays in air, oxygen, carbonic acid, and hydrogen are all the same, and equal to the charge on an atom of hydrogen in a liquid electrolyte.

Prof. J. J. Thomson (J. J. Thomson, *Phil. Mag.*, December 1898) has shown that the charge on the ions in oxygen and hydrogen, which have been made conductors by Röntgen rays, is $6\ 10^{-10}$ electrostatic units, and is the same for both gases.

Taking this value for the charge e, the number of molecules in a cubic centimetre of a gas is obtained :

$$\mathrm{N} = 2\ 10^{19}.$$

The weight of a molecule of hydrogen $\frac{\rho}{\mathrm{N}}$ is therefore

$$4{\cdot}5\ 10^{-24} \text{ grammes.}$$

In order to prove that the positive and negative ions have the same charge, the ratio of the coefficients of diffusion must be shown to be equal to the ratio of the velocities. This subject has been investigated by Prof. Zeleny (J. Zeleny, *Phil. Mag.*, 1898), and it was found that the negative ion travels faster than the positive ion in air, oxygen and hydrogen, the ratio of the velocities being 1·24 for air and oxygen, 1·15 for hydrogen, and 1·0 for carbonic acid.

Royal Society, June 15.—"On the Orientation of Greek Temples, being the Results of some Observations taken in Greece and Sicily in the month of May 1898." By F. C. Penrose, M.A., F.R.S.

The orientation of the Cabeirion Temple, near Thebes, of which the angle has been disputed (see p. 46 in my paper of 1897), was remeasured with the theodolite in May 1898, and the previous observations confirmed. An additional example is added from an archaic Temple of Neptune in the Isle of Poros, introducing the employment of the bright zodiacal star Regulus, which I had not before met with.

In Sicily the re-examination of the temples at Girgenti, where, in my former visit, I had relied for azimuth on the sun's shadow and the time, has enabled me to give to the elements some amendments in detail, the only point of consequence being that the orientation date of the temple named Juno Lacinia is brought within the period of the Hellenic colonisation of that city.

The most interesting point in the paper seems to be, that in the case of two Athenian temples, namely, the Theseum and the later Erechtheum—*i.e.* the temple now partially standing—it is shown that the days of those months on which the sunrise, heralded by the star, illuminated the sanctuary coincided exactly, on certain years of the Metonic cycle, with the days of the Athenian lunar months on which three important festivals known to be connected with at least one of those temples were held. The years so determined agree remarkably well with the probable dates of the dedication of those temples ; and in the case of the first mentioned, the festival, which was named The Thesea, seems to leave little doubt that the traditional name of the temple, which has recently been much disputed, is the correct one.

"Collimator Magnets and the Determination of the Earth's Horizontal Magnetic Force." By C. Chree, Sc.D., LL.D., F.R.S., Superintendent of the Kew Observatory. Communicated by the Kew Observatory Committee of the Royal Society.

During the last forty years, there have been examined at Kew Observatory upwards of 100 collimator magnets used in observing the horizontal force and declination.

The "constants" of these magnets—temperature and induction coefficients, and moment of inertia—have been determined at the Observatory, and the tables based on these determinations have served to reduce magnetic observations at a large number of the leading magnetic observatories.

The present paper deals with the data recorded in the Observatory books for the constants specified above, and with other quantities—such as the "permanent" magnetic moment—which are deducible from the records. It determines the mean values of the several quantities for the instruments of the leading English makers, and investigates whether relations do or do not exist between them. It then deduces from the records the probable errors in the values of the several quantities, proceeding on the hypothesis that the methods of determining them are correct. It next examines, from a mathematical standpoint, the accuracy of the formulæ employed in reducing horizontal force observations, and, from a physical standpoint, the possibility of differences between the quantities determined at the Observatory and the quantities actually concerned in horizontal force observations.

The various sources of uncertainty are dealt with, and an attempt is made to ascertain to what extent they may affect the values found for the horizontal force.

The results of the paper are of too technical a character to admit of their being summarised briefly in an intelligible way.

Physical Society, June 23.—Mr. T. H. Blakesley, Vice-President, in the chair.—A paper on the magnetic hysteresis of cobalt, by Prof. Fleming, Mr. A. W. Ashton, and Mr. H. J. Tomlinson, was read by Mr. Ashton. A rectangular sectioned circular ring of cobalt was insulated with silk tape and wound over with four secondary coils put on at quadrantal positions. Over these secondary coils six primary coils were placed, and the ring was submitted to a complete set of magnetic tests with a ballistic galvanometer. From these observations various curves have been plotted, and the results have been compared with a similar set of readings taken on a cast iron ring. A chemical analysis of the cobalt showed that it contained about 1 per cent. of iron and 1 per cent. of nickel. The authors conclude that, although in general form the magnetisation curve for cobalt resembles that of cast iron, its hysteresis exponent is similar to that of annealed soft iron. The absolute hysteresis values corresponding to various maximum flux densities are, however, not very different from those of a typical variety of cast iron. Prof. Everett referred to the fact that the sample of cobalt contained about 1 per cent. of iron, and said that it would be interesting to know how cobalt free from iron would behave. The Chairman said that the hysteresis curves obtained from the step by step method could not be applied to dynamos, because the time taken to perform the cycle altered the shape of the curve. He would like to see the curves for cobalt determined in cases where the cycles were quickly executed.—A discussion on physical tables was commenced by Mr. J. Lupton. Mr. Lupton briefly reviewed some of the difficulties met with in compiling physical tables and in keeping them up to date. He divided them into four classes according to their objects, and criticised several well-known books of constants. He pointed out the danger of leaving out apparently obvious figures, and referred to the necessity for accurate proof reading. Prof. Everett said that in his work he had aimed at giving an idea of the meanings of various numbers, rather than stating them with great accuracy. He drew attention to the difficulty of condensing large series of numbers into a clear and concise table. Mr. Watson said that it was important that the units in which numbers were expressed should be stated at the head of each table. The Chairman having pointed out one or two small points to be attended to in the compilation of tables, the Society adjourned until next October.

Chemical Society, June 15.—Prof. T. E. Thorpe, President, in the chair.—The following papers were read:—On the decomposition of chlorates, with special reference to the evolution of chlorine and oxygen, by W. H. Sodeau. The author concludes that on heating barium chlorate, two reactions proceed simultaneously; (*a*) an exothermic decomposition into chloride and oxygen, and (*b*) an endothermic decomposition into oxide, chlorine and oxygen.—Action of hydrogen peroxide on formaldehyde, by A. Harden. Hydrogen peroxide and formaldehyde react in presence of much soda in accordance with the following equation:

$$H_2O_2 + 2CH_2O + 2NaHO = 2HCO_2Na + H_2 + 2H_2O.$$

With excess of formaldehyde reaction proceeds rapidly, whilst in presence of excess of hydrogen peroxide it proceeds slowly and incompletely. The behaviour of other oxides towards formaldehyde and soda has also been investigated.—Homocamphoronic and camphononic acids, by A. Lapworth and E. M. Chapman. α-Dibromocamphor is rapidly oxidised by nitric acid in presence of silver nitrate, with formation of small quantities of a nitro-compound, $C_{10}H_{14}N_2O_6$, and a tribasic acid, $C_{10}H_{16}O_6$, named homocamphoronic acid; the latter yields on heating first an anhydro-acid, and then a ketonic acid, $C_9H_{14}O_3$, termed camphononic acid.—Action of silver compounds on α-dibromocamphor, by A. Lapworth.—The colouring matter of cotton flowers, by A. G. Perkin. The flowers of the cotton plant, *Gossypium herbaceum*, contain a glucoside, gossypetin, $C_{16}H_{12}O_8$; it is a colouring matter, yields a hexacetyl-derivative, and resembles thujetin.—Experiments on the synthesis of camphoric acid, by H. A. Auden, W. H. Perkin, jun., and J. L. Rose. Ethyl isoamylacetoacetate was converted into ethyl α-isoamyl-ββ-hydroxycyanobutyrate, which on hydrolysis yielded methylhydroxyisoamylsuccinimide; the latter on further hydrolysis yielded the corresponding acid

$$COOH.CMe(OH).CH(C_5H_{11})COOH,$$

from which it was hoped by elimination of water to synthesise camphoric acid. The attempt was not successful.—Methylisoamylsuccinic acid, i., by W. T. Lawrence.—Condensations of anhydracetonebenzil and its analogues with aldehydes, by F. R. Japp and A. Findlay.—Triphenyloxazolone, by F. R. Japp and A. Findlay.—Interaction of phenanthraquinone, acetophenone, and ammonia, by F. R. Japp and A. N. Meldrum.—Furfuran derivatives from benzoin and phenols, by F. R. Japp and A. N. Meldrum.—Interaction of benzoin with phenylenediamines, by F. R. Japp and A. N. Meldrum.—The condensation of ethyl salts of acids of the acetylene series with ketonic compounds, by S. Ruhemann and A. V. Cunnington.—Dextro-ac-tetrahydro-β-naphthylamine, by W. J. Pope. Inactive ac-tetrahydro-β-naphthylamine may be resolved into its optically active components by means of its dextro-α-bromocamphorsulphonate; the pure dextro-compound was thus prepared.—The resolution of racemic tetrahydroparatoluquinaldine into its optically active components, by W. J. Pope and E. M. Rich. Inactive tetrahydroparatoluquinaldine may be resolved into its optically active components by crystallisation with dextro-α-bromocamphorsulphonic acid. — Isomeric salts of hydrindamine containing pentavalent nitrogen, by F. S. Kipping. The author has endeavoured to resolve α-hydrindamine into its optically active components by Pope and Peachey's method with bromocamphorsulphonic acid and by crystallisation with cis-π-camphanic acid; two salts are formed in each case, but the regenerated base is optically inactive.—Synthesis of phenoketoheptamethylene, by F. S. Kipping and Miss L. Hall.—Organic compounds containing silicon, by F. S. Kipping and L. L. Lloyd. The authors have prepared triphenylsilicol, $(C_6H_5)_3$ Si.OH, its acetyl derivative, $(C_6H_5)_3$ Si.OAc, and the corresponding ether, $(C_6H_5)_3Si.O.Si(C_6H_5)_3$.—The velocity of reaction before complete equilibrium, by M. Wilderman.—The ultra-violet absorption spectra of albuminoids in relation to that of tyrosin, by A. W. Blyth.—An explanation of the laws which govern substitution in the case of benzenoid compounds (third notice), by H. E. Armstrong. The author advocates the view that in compounds which ordinarily furnish meta-di-derivatives, the radicle (NO_2, CO_2H, &c.) is not only unattractive and possessed of little or no ortho-para-orienting power, but even exercises an inhibiting influence on these positions.—The colouring matters of dyer's broom and heather, by A. G. Perkin and F. G. Newbury.

Linnean Society, June 15.—Dr. A. Günther, F.R.S., President, in the chair.—The President exhibited a living specimen of a tree-frog (*Polypedates quadrilineatus*) which was introduced accidentally into Kew Gardens with a consignment of plants from Singapore. This is not the first instance of accidental introduction of a tropical frog into the Royal Gardens, Kew. Some five years ago a species of *Hylodes*, from Dominica, appeared in some numbers in several of the propagating-houses, and has evidently reproduced its species since arrival.—Mr. W. Whitwell exhibited: (1) The only known British specimen of *Botrychium matricariaefolium*, A. Braun, gathered in July 1887 on the seashore at Stevenston, Ayrshire (*Journ. Bot.*, 1898, pp. 291-297). (2) An undescribed variety of *Asplenium Ruta-muraria*, Linn., from an old wall on Dartmoor, about five miles from Plympton. (3) A specimen of rye with two ears on the same stalk, gathered at Romsey, Hants.—Mr. Robert T. Günther read a paper on the natural history of Lake Urmi in N.W. Persia, the neighbourhood of which he had explored during the autumn of last year. The collections which he had made there had been worked out by a number of specialists, each of whom had furnished a report on the specimens submitted to him. In many of the groups (notably amongst the fishes) several new species were described; and a good deal of interest centred in the skull and horns of a wild sheep which had been picked up on Koyun Daghi, the largest island in Lake Urmi. Although no living wild sheep were observed there during the traveller's short visit, small herds were reported to exist, the island, with lofty and precipitous hills, being apparently well adapted to their requirements. The head in question, that of an adult ram, unlike the typical *Ovis orientalis* found in Northern Persia and Armenia, more nearly approached that of *Ovis ophion*, the mufflon of Cyprus, a curious and unexpected resemblance.—Dr. A. B. Rendle read a paper entitled "A systematic revision of the genus *Najas*," a primitive genus of Monocotyledons containing about thirty known species, generally distributed in both Old and New Worlds, and consisting of submerged herbs, often of great delicacy, growing in mud in fresh or brackish water.

Royal Meteorological Society, June 21.—Mr. F. C. Bayard, President, in the chair.—Dr. R. H. Scott, F.R.S., read a paper on the heavy falls of rain recorded at the seven observatories connected with the Meteorological Office during the twenty-eight years 1871-98. The data has been derived from the records of the Beckley self-recording rain gauges at the following places:—Valencia, Armagh, Glasgow, Aberdeen, Falmouth, Stonyhurst, and Kew. These records have been tabulated for each hour, and it is from these hourly tabulations that Dr. Scott has extracted the heavy falls. He finds that Falmouth has the greatest frequency of heavy falls, the next station being Valencia, and then Stonyhurst. The most exceptional fall during the whole period was at Glasgow at five p.m. on August 11, 1895, when as much as 0·80 in. was collected in ten minutes. The information given in this paper is likely to be of much service to engineers who want to know the rate at which rain sometimes falls in short periods.—A paper by Mr. J. Baxendell, describing his new self-recording anemoscope, was read by the Secretary. This instrument, which records the direction of the wind on an open scale, has been in use at Southport for more than a year, and works very satisfactorily. The vane, which is an exceedingly light, but large double-bladed, one, is sensitive even in light airs, and is steady in the strongest gales. The records from this anemoscope, which were exhibited at the meeting, were very clear and of an interesting character, and showed the instrument to be a valuable companion to the Dines pressure tube anemometer.—A paper, by Mr. R. C. Mossman, on the average height of the barometer in London, was also read by the Secretary. Some years ago Mr. H. S. Eaton worked out the mean monthly and annual height of the barometer in London for one hundred years. Mr. Mossman has carried on this discussion for a further period of twenty years; but he finds that the results for the one hundred and twenty years are practically identical with those for one hundred years.

Zoological Society, June 20.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—Mr. W. E. de Winton made some remarks on a small collection of mammal-skins from British Central Africa, which had been transmitted to Mr. Sclater by Mr. Alfred Sharpe, C.B. Mr. de Winton also exhibited the mounted heads of a male and female red-flanked Duiker (*Cephalophus rufilatus*, Gray), collected by Mr. J. F. Abadie in the Borgu country of the Niger district; and the skull of a male of the same species obtained by Captain W. Giffard near Gambaga, in the back country of the Gold Coast.—The Hon. Walter Rothschild read a memoir on the cassowaries, which contained notes on and an enumeration of the species and geographical races of these birds.—Mr. C. W. Andrews gave a description of a new type of bird, the skull and pelvis of which had lately been discovered by Mr. W. H. Shrubsole, enclosed in a nodule in the London clay of Sheppey.—A communication from Mr. J. Y. Johnson treated of the antipatharian corals of Madeira, and of a specimen from the West Indies in the British Museum.—A communication was read from Mr. Stanley S. Flower, containing notes on the Proboscis monkey (*Nasalis larvatus*) made on a young male example of this animal which had lived for a short time in the Egyptian Zoological Gardens at Ghizeh, Cairo.—A communication from Mr. Alexander Sutherland on the temperature of the Ratite birds was based on observations made on specimens of birds of this family in the Society's Gardens.—Mr. G. A. Boulenger, F.R.S., read a paper on the American Spade-foot (*Scaphiopus solitarius*, Holbrook), in which he pointed out that this frog had affinities with both *Pelobates* and *Pelodytes*, and that these three genera together formed one natural family, viz. the *Pelobatidae*.—Mr. W. L. H. Duckworth read a paper containing an account of the female chimpanzee, known as "Johanna," living in the menagerie of Messrs. Barnum and Bailey. The history and habits, diet in captivity, intellectual attainments, physical proportions, and appearance of this ape were dealt with in the paper, as also was the question of species, the author regarding the specimen as allied to the chimpanzees rather than to the gorilla.—A communication from Mr. R. Lydekker gave an account of a new species of Kob antelope (specimens of which had recently been received in a collection from Sierra Leone), under the name of *Cobus nigricans*. Mr. Lydekker also drew attention to skins of a Kob from Barotseland, recently received at the British Museum, which he had identified with *C. senganus*. The specimens of the latter form he stated differed so slightly from the type of *C. vardoni* that he was inclined to regard them as not worthy of specific rank, and to refer them to a subspecies which he proposed to call *C. vardoni senganus*.—Mr. Lydekker also sent a description of a specimen of a leopard from the Caucasus, belonging to the collection of Prince Demidoff, which differed in several respects from the common leopard, and which he proposed to regard as a subspecies under the name of *Felis pardus tulliana*.—A third communication from Mr. R. Lydekker related to the former existence of a Sirenian of some kind in St. Helena, which had been noticed by former observers in that island, but to which no reference had been made by recent authors.—Mr. F. E. Beddard, F.R.S., read a paper on the brain of the Capybara (*Hydrochoerus capybara*) based on examination of specimens in the Society's Gardens.—Mr. Beddard also read a paper, prepared by himself and Miss Sophie M. Fedarb, containing notes on the anatomy of the worms *Perichaeta biserialis* and its variations and *Trichochaeta hesperidum*.—Dr. Woods Hutchinson read a paper on the zoological distribution of tuberculosis from observations made mainly in the Society's Gardens. Of 215 autopsies made in the prosector's room during the past six months, 49 presented the lesions of tuberculosis, *i.e.* 25·3 per cent. of the mammals and birds. This mortality fell most heavily upon the ruminants and gallinæ, and least so upon the carnivores and raptors. Race or family appeared to exert little influence upon susceptibility, mode of housing only a small amount, and food and food-habits much more. A close correspondence appeared to exist between immunity and the relative size of the heart in both birds and mammals.—A communication was read from Dr. A. G. Butler containing an account of a small collection—consisting of nineteen specimens—of butterflies sent home from Muscat by Lieut.-Colonel A. S. G. Jayakar.—Dr. J. W. Gregory read a paper containing an account of the West Indian species of corals of the genus *Madrepora*.—A communication was read from Marquis Ivrea on the black roedeer of Hanover.

EDINBURGH.

Mathematical Society, June 9.—Dr. Morgan, President, in the chair.—The following papers were read:—Systems of circles analogous to Tucker circles, part iii.; systems of conics connected with the triangle; systems of spheres connected with the tetrahedron, Mr. Third; "La perspective d'une conique est une conique" (démonstration élémentaire), M. L. Leau.

PARIS.

Academy of Sciences, June 19.—M. van Tieghem in the chair.—On a class of isothermic surfaces connected with the deformation of surfaces of the second degree, by M. Gaston Darboux. A further development of the subject dealt with in a previous note.—On the determination of the integrals of the equations to partial derived functions of the second order by their values on a closed curve, by M. Émile Picard.—Late watering of the vine, by M. A. Müntz. Towards the end of a dry season the growth of the grapes is impeded and small yields are obtained, although the wine produced is often of higher quality. Nevertheless, this increased value does not compensate for the diminished quantity, and artificial watering is therefore resorted to. The author has experimented on the effects of this practice, and finds that the grapes thus treated increase in weight to the extent of 25 to 30 per cent. as compared with the untreated fruit. Part of this increase is due to simple absorption of water, but not the whole, since there is a notable increase in the sugar and vegetable acids. It is noteworthy that delayed watering causes a retrogression in the ripening process, the relative proportions of the sugar and acids becoming what they were at an earlier part of the year.—Note on the toxicity of the urine of children, more especially in cases of appendicitis, by MM. Lannelongue and Gaillard. The toxicity of the urine of normal children is inferior to that of the urine of adults, but is largely increased in cases of acute appendicitis. The colour of the pathological fluid is also more marked, and the density and amount of extractives present are greater.—Electromotive force produced in a flame by magnetic action, by M. R. Blondlot. If two platinum wires are placed symmetrically at the opposite edges of an ordinary gas flame and connected with a capillary electrometer, only a feeble oscillatory movement of the mercury is noticed, but a steady deflection is produced when the flame is placed between the poles of an electro-magnet. This phenomenon is doubtless due to electromagnetic induction, the effect of the heated gases constantly ascending in the magnetic field being the production of an electromotive force the direction of which is normal both to the lines of force and to the direction in which the gases are moving.—Influence of the manner of introduction on the therapeutic effects of antidiphtheritic serum, by M. S. Arloing. From the experiments described it appears that with the dog the therapeutic effect of the serum is more marked when it is introduced into the blood instead of into the connective tissue, whereas with the guinea-pig the reverse is the case.—Observations made at the Bordeaux

Observatory on the partial eclipse of the sun, June 7, by MM. Féraud, Doublet, Esclangon and Courty.—On some anomalous surfaces applicable to a plane, by M. H. Lebesgue. The author shows that developable surfaces are not the only surfaces which are applicable to a plane.—On the calculation of the integrals of differential equations by the method of Cauchy-Lipchitz, by M. Paul Painlevé.—Comparison of the velocities of propagation of electromagnetic waves in air and along wires, by M. C. Gutton. The two velocities in question have been compared by a more exact method than those hitherto employed, and their equality verified to within 1 in 200.—Electrolytic action observed in the neighbourhood of a Crookes' tube, by MM. H. Bordier and Salvador. When an electrolytic cell consisting of two plates of copper or zinc immersed in a solution of copper or zinc sulphate is connected with a delicate galvanometer and placed in proximity to a Crookes' tube in action, a notable polarisation of the electrodes of the cell is observed. The effect is not due to the action of the X-rays, but is caused by a secondary, dark discharge from the anode and kathode of the tube, which is equivalent to a current of high electromotive force but of feeble intensity.—On magnet steels, by M. F. Osmond. Experiments on the magnetic properties of steels containing varying amounts of manganese and of nickel.—Researches on the vapours emitted by the two varieties of mercuric iodide, by M. D. Gernez. Experiments are described which show that the vapour of mercuric iodide, whatever its origin, is capable of condensing to form, at the same temperature, either the red or the yellow crystals of the compound, according as either variety is employed as a starting point for crystallisation. The condition of the vapour is, in fact, analogous to that of melted sulphur, from which three forms of crystals may be obtained at will according to the form of the crystal introduced as a nucleus.—Remarks on the oxides of sodium and on the chemical function of water as compared with that of hydrogen sulphide, by M. De Forcrand. The author discusses the heats of formation of the oxides of sodium, as determined by himself and by other observers, and endeavours to show that the two hydrogen atoms in the molecule of water are distinctly different in function, whereas in hydrogen sulphide they are of equal value. Water is therefore to be considered as an unsymmetrical, hydrogen sulphide as a symmetrical, compound, as may be indicated by the formulæ H—OH and H—S—H respectively.—On the decomposition of carbonic oxide in the presence of metallic oxides, by M. O. Boudouard. The experiments described in previous communications have been extended to a temperature of 800° C.; the metallic oxides employed were those of cobalt, nickel, and iron. The decomposition is a function of the time, the amount of carbonic anhydride formed increasing in a regular manner until the limit, at 800°, of 7 per cent. is reached. The velocity of the reaction is much greater at 800° than at 650°.—On the decomposition of carbonic anhydride in the presence of carbon, by M. O. Boudouard. An extension of previous researches on this reaction. The limiting composition of the gaseous mixture at 800° is 93 per cent. of carbonic oxide and 7 per cent. of carbonic anhydride. At 925° there still remained 4 per cent. of carbonic anhydride.—On a lower homologue of citric acid, by M. Augustin Durand. By treating the sodium derivative of ethylic oxaloacetate with hydrocyanic acid and hydrolysing the cyanhydrin thus produced, the authors have obtained a new acid of the composition

$$COOH.CH_2.C(OH).(COOH)_2.$$

Experiments are in progress for the preparation of other homologues of citric acid.—On Morren's glands in European *Lumbricoides*, by M. Édouard de Ribaucourt. On the fall of leaves and the cicatrisation of the wound, by M. A. Tison.—The upper layers of the Jurassic soil in Bas-Boulonnais, by M. Munier-Chalmas.—Crystallisation of blood-albumin, by Mlle. S. Gruzewska. Abundant crystalline deposits of albumin were obtained from the blood of the guinea-pig by employing a low temperature and working with solutions almost saturated with ammonium sulphate.

NEW SOUTH WALES.

Royal Society, May 3.—The President, G. H. Knibbs, in the chair.—The following gentlemen were elected officers for the current year:—President, W. M. Hamlet; Vice-Presidents, Prof. Anderson Stuart, Charles Moore, Prof. T. W. E. David, Henry Deane; Hon. Treasurer, H. G. A. Wright; Hon. Secretaries, J. H. Maiden, G. H. Knibbs.—The theme of the anniversary addres delivered by the President, Mr. G. H. Knibbs, was the influence of science upon civilisation.

AMSTERDAM.

Royal Academy of Sciences, May 27.—Prof. H. G. van de Sande Bakhuyzen in the chair.—Prof. Kamerlingh Onnes presented, for publication in the *Proceedings*, a paper by Dr. L. H. Siertsema, entitled "Measurements of the magnetic rotation of the plane of polarisation in oxygen at various pressures." The magnetic rotation in oxygen was measured in the same way as was formerly done in the case of pressures of 97, 73, 49 and 38 atmospheres, and at these pressures it was found to be proportional to the density of the gas.—Prof. van Bemmelen presented, on behalf of Dr. F. A. H. Schreinemakers, for publication in the *Proceedings*, a paper entitled "On the system water, phenol, acetone."—Prof. Lobry de Bruyn communicated the results of the inquiries of Prof. Holleman, who has determined how, on the nitration of benzoic acid and its methyl and ethyl esters, the proportion of the quantities of the three isomeric mononitro-derivatives, which are formed at the same time, varies with the temperature (−30°, 0° and +30°).—Prof. van de Sande Bakhuyzen presented, on behalf of Mr. H. F. Zwiers, a paper on the system of Sirius according to the most recent observations.

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