THURSDAY, NOVEMBER 10, 1898.

AN IRISH ALGEBRA.

The New Explicit Algebra in Theory and Practice: for Teachers and Intermediate and University Students. By James J. O'Dea, M.A., formerly Professor of Mathematics, Natural Philosophy, and English Literature in St. Francis' College, Brooklyn, New York, and St. Jarlath's College, Tuam. Parts I. and II. Pp. x + 616, liv. (Longmans, Green, and Co., 1897, 1898.)

WHATEVER may be thought of the body of this work, there can be no doubt that the preface, at any rate, is remarkably explicit.

"The 'Explicit Algebra' is the result of the Author's earnest desire to facilitate, as much as possible, the labour of masters and students in this department of Mathematics, and to enable them to obtain the maximum results at the minimum expenditure of time and trouble."

Again,

"The Author has spared neither time, nor labour, nor expense in his effort to make the work every way worthy of the object for which it has been intended: namely, as a theoretical and practical text-book on Algebra for all grades of Intermediate Education, University Matriculation (Pass and Honours), and First, Second, and Third Class Teachers."

Finally, having doubtless observed that a certain proportion of reviewers derive the substance of their remarks from authors' prefaces, Mr. O'Dea thoughtfully provides us with a well-balanced appreciation of his treatise ready to our hand.

"The leading features of the 'Explicit Algebra' are fulness of detail, without being uselessly exhaustive; lucidity and conciseness of statement; brevity and neatness in the manipulation of examples, which are numerous and varied, together with copiousness and variety of exercises methodically arranged, while the disposition of the various portions of the work considered as a whole is in strict logical sequence."

In order that the reader may estimate for himself the justification of this modest prologue, we hasten to give a few illustrations.

Page 1, Definitions 3, 4, 5:

"The Symbols of Quantity are the letters a, b, c, d, v, w, x, y, z. These symbols are used to represent numbers."

"An Algebraic Quantity is one that is expressed in algebraic language, and is supposed to be known or unknown."

"A Known Quantity is that which contains a given number of units of the same kind, and is represented by the leading letters a, b, c, d."

Here is fulness of detail, without being needlessly exhaustive!

Page 12 (the last of three pages devoted to addition):

"N.B.—When dissimilar terms which are to be added have a common literal factor, which is called the Unit of Addition, this factor may be annexed to the algebraic sum of the others.

"Example 5. Determine the algebraic sum of

$2a - \sqrt{b} + c,\ 3c - 4\sqrt{a} + b,\ 3a + d - 2\sqrt{c},\ m + n - 3\sqrt{a}.$

"Arrange thus:

$$\begin{array}{r} 2a - \sqrt{b} + c \\ -4\sqrt{a} + b + 3c \\ 3a + d - 2\sqrt{c} \\ -3\sqrt{a} + m + n \\ \hline (5\sqrt{a} - 7)\sqrt{a} + (\sqrt{b} - 1)\sqrt{b} + (2\sqrt{c} - 1)2\sqrt{c} + d + m + n." \end{array}$$

Considering that "literal" and "factor" have not been explained, that nothing has been said about surds except a scrappy definition of the "Sign of Evolution" only intelligible to those who know what a root is, and that the student has actually been left to himself to find out that $2a$ is the product of 2 and a, this is a good sample of Mr. O'Dea's ideas of logical sequence. As another illustration, take the fact that the pupil has no opportunity of practising the use of symbolical language intelligently until he reaches problems on simple equations, p. 165.

The proportion of theory to practice (and such practice!) in this remarkable book is perhaps one to twenty, on a generous estimate. Here are tastes of the author's quality, when he digresses for a time into the barren wilds of theory.

"When an algebraic expression containing x is divided by $x - a$, the remainder is the same as that which results from substituting a for x in the original expression.

"Proof: Let the expression $ax^3 + bx^2 + cx + d$ be divided by $x - a$ until the remainder R, does not contain x, and let the quotient be represented by Q. We then have

$$\frac{ax^3 + bx^2 + cx + d}{x - a} = Q + R;$$

$$\text{"}\therefore\ ax^3 + bx^2 + cx + d = Q(x - a) + R.$$

"This relation holds for *all* values of x. Hence, since R does not contain x, it will undergo no change whatever value be assigned to x. Substituting a for x, therefore, we get

$$\begin{aligned} a^4 + a^2b + ac + d &= Q(a - a) + R \\ &= Q \times 0 + R = R. \end{aligned}$$

Thus,

$$R = a^4 + a^2b + ac + d.$$

This principle is called the Residual Theorem."

Observe here the charming vagueness of an "algebraic expression"; the ingenious substitution of R for $R/(x - a)$, which is not a misprint, because the same thing is done three times on a previous page; and lastly the use of the same symbol Q to represent two entirely different things, namely the original quotient, and its value when a is put for x.

Here is the "demonstration" of one case of the rule of signs in multiplication:—

$$\begin{aligned} \text{"} - a \times - b &= - a \times m \text{ (assuming } m = -b) \\ &= a \times -1 \times m = a \times - m \\ &= a \times -(-b) = a \times b = ab; \\ \therefore - a \times - b &= + ab." \end{aligned}$$

The *petitio principii* in the second line would be hard to beat.

As might be expected, Mr. O'Dea's discussion of the theory of indices affords a magnificent display of his peculiar gifts of "conciseness, lucidity, logical sequence," and the rest of it. To give one instance, on p. 37 we have

$$\begin{aligned} \text{"}\frac{a^m}{a^n} &= \frac{a \times a \times a \ldots (a \text{ being taken } m \text{ times})}{a \times a \times a \ldots (a \text{ being taken } n \text{ times})} \\ &= a \times a \times a \ldots (a \text{ being taken } m - n \text{ times}) \\ &= a^{m-n}:\text{"} \end{aligned}$$

and this is immediately followed by

"Proposition IV.—The reciprocal of any quantity with a positive exponent is equal to the same quantity with an equal exponent taken negatively.

"Proof:

$$\frac{1}{x} = \frac{x}{x^2} = x^{1-2} = x^{-1}.$$

"So, too,

$$\frac{1}{x^3} = \frac{x^2}{x^5} = x^{2-5} = x^{-3},$$

and

$$\frac{1}{x^m} = \frac{x^n}{x^{m+n}} = x^{n-m-n} = x^{-m}.$$

"This is a very useful principle, and should be carefully attended to." This "proof" is repeated later on (p. 253), and the rest of the chapter on indices, so far as theory goes, is of a similar kind.

To give anything like a full account of the contents of this book, its utter absence of plan or proportion, its preposterous and antiquated arrangement, its shallow pretence of "theory," and its innumerable misleading and even erroneous statements, would take up too much space. It does not much matter where we look. "If one root of a quadratic equation be imaginary, the other will also be imaginary," nothing being said as to the reality of the coefficients; "now the greater the value of n, the smaller does r^n become. Hence (!), when n becomes indefinitely great, r^n will become indefinitely small." "Sum (1) to n terms, and (2) to infinity the series $1 + 3x + 5x^2 + 7x^3 + \ldots$," where neither in the question, nor in the solution, is any restriction imposed on the value of x. "Let x = circumference of fore-wheel," &c., concluding with "$x = \frac{504 - 156}{29} = 12$ feet." "Find the values of x, y and z from the simultaneous equations

$$x = a(y + z);\ y = b(z + x);\ z = c(x + y),$$

and prove that $ab + ac + bc + 2abc = 1$"; "the only four factors of 30 are 1, 2, 3, and 5,"—so much for its accuracy in detail. The primary definitions and the four fundamental rules are disposed of in fifty pages, "imaginary quantities" in ten, two of which are taken up by playing tricks with the complex cube roots of unity, while half a page goes to a misleading "demonstration" that $\sqrt{-a} \times \sqrt{-b} = -\sqrt{ab}$; fifty pages are occupied by chapters on indices, surds, and simple equations involving radicals, very inaccurate and choked by the usual fantastic examples; seventy pages are assigned to ratio, proportion, variation, and progressions: such is Mr. O'Dea's conception of the relative importance of the different items of his programme. "Elementary Factoring" (all jumbled up) will be found on pp. 57–73; quadratic equations are deferred until p. 319:—logical sequence, forsooth, requires the precedence of Fractions, Involution, Evolution, Indices and Surds, and the substance is sacrificed to the shadow accordingly. Of graphical methods or illustrations there is not a trace: there is not a single geometrical figure in the book; the bearing of algebraical sign upon the "sense" of geometrical and physical quantities is absolutely ignored; and nothing is said about the nature or properties of logarithms. Not only is it possible for a clever boy to work through the whole of this book, and be as ignorant of the theory of algebra as when he began; he will be totally unacquainted with those elementary practical things which are most important for him if he wishes to apply his knowledge to engineering or to physics.

The book is avowedly written to help teachers to obtain "results": that is, to exploit their unhappy pupils for the purpose of scoring in examinations, and so getting grants, or scholarships or some other kind of profit. A method is recommended because it will impress an examiner more favourably, and earn a greater number of marks: the student's attention is directed to this or that, not because it is important in itself, but because the candidate is very likely to be asked a question about it; and an enormous amount of misplaced ingenuity is wasted upon the solution of ridiculous and fantastic questions which ought never to have been set.

It would not be fair to lay the whole blame for all this upon Mr. O'Dea. Like the poor Irish schoolboys, he is the victim of a most iniquitous system: that "payment by results" which warps and corrodes every branch of primary and intermediate education in Ireland. That this plan was originally adopted with the best intentions may be admitted; but it is a disgraceful scandal that it should be continued in Ireland, when it has been (reluctantly enough, it is true) abandoned in Great Britain. The evils of it have been exposed again and again; it has been denounced unanimously by all true teachers who have seen how it works; it puts a premium upon wrong methods, it encourages quackery and cruelty, it destroys sympathy between master and pupils, and the "results" which it produces are a delusion and a sham. It is heart-breaking to think of whole generations of clever, docile Irish lads condemned to the soul-destroying slavery which this rotten system perpetuates. And the evil is intensified when, as in the case of mathematics, the examinations for which the pupils are prepared are thoroughly unsatisfactory. Among the examples contained in this book are the following:—

(1) Simplify

$$\frac{b^2c^2}{(a-b)(a-c)} + \frac{c^2a^2}{(b-c)(b-a)} + \frac{a^2b^2}{(c-a)(c-b)}$$

(Preparatory Grade.)

(2) If $a = 9$, $b = 5$, $c = 2$, $d = 8$, find the value of

$$\frac{c}{\sqrt{a}} + \frac{1}{15}\left(\frac{b}{2}\right)^3 - \frac{3}{40}\,c^2 - 2\tfrac{1}{3}\sqrt[3]{\frac{1}{d^2} - \frac{ad}{bc^5}}$$

(Preparatory Grade.)

(3) Determine the value of

$$\{x^2 + (a+b)x + ab\}(x^3 + ax^2 + abx + a^2b) - (a^2 + x^2)(x - b)$$

when $x = -a$. (Junior Grade.)

(4) If $a + b + c = 0$, find the value of

$$\frac{b+c}{bc}(b^2 + c^2 - a^2) + \frac{c+a}{ca}(c^2 + a^2 - b^2) + \frac{a+b}{ab}(a^2 + b^2 - c^2)$$

(First Class Teachers.)

(5) If

$$x = \tfrac{1}{2}\left\{\left(\frac{a}{b}\right)^{\frac{1}{2}} - \left(\frac{b}{a}\right)^{\frac{1}{2}}\right\}$$

show that

$$\frac{2a(1 + x^2)^{\frac{1}{2}}}{x + (1 + x^2)^{\frac{1}{2}}} = a + b$$

(Middle Grade.)

(6) Show that the expression

$$\frac{(x+2)^{\frac{1}{2}}}{(x-2)^{\frac{1}{2}}}\left\{\frac{4}{(x^2 - 1)(x^2 - 4)^{\frac{1}{2}} + (x^2 - 3)x + 2} - 1\right\}$$

is equivalent to the fraction $\frac{1 + x}{1 - x}$ (Senior Grade.)

Of these (1) is far too hard for any preparatory grade; (2) is a fine derangement of symbols, wholly unlike anything that occurs in practice (properly so called); (3) is a miserable trap, presumably set for the purpose of inducing the candidates to waste half an hour in working out the products; in (4), if you guess that "the" value is 0, and are handy with your dodges, you will score heavily, otherwise ——!; (5) and (6) speak for themselves. Other examples, equally absurd, may be found by the dozen in the "Explicit Algebra"; in fact, if Mr. O'Dea has made a fair selection, it may be inferred that the Irish Government papers in algebra are occasionally very far from being suitable for the purposes for which they are supposed to be designed. How can teachers, working for a grant, be expected to teach algebra rationally, when the test that is applied to their pupils consists of a silly medley of questions, some threadbare and stereotyped, and others merely puzzling and artificial; while, with the exception, perhaps, of a couple of problems to be solved by equations, no attempt is made to gauge the candidate's reasoning powers?

Meanwhile My Lords the Commissioners of National Education in Ireland refuse to budge, in spite of the overwhelming verdict of competent opinion, nay in defiance of the unanimous protest of their own inspectors (see the *Manchester Guardian* for September 19, p. 7). No doubt their precious system works smoothly enough from their point of view; the papers are set on traditional lines, the marks obtained are neatly tabulated, and the grants and scholarships impartially distributed accordingly; how can any one, they may ask, reasonably object to such an obviously fair and practical procedure? And so the costly, wasteful, and inefficient machinery continues to grind; for all the world like a mill devised to scatter the flour and preserve the husk and bran.

G. B. M.

CLASSIFICATION OF THE VERTEBRATA.

Syllabus of Lectures on the Vertebrata. By Prof. E. D. Cope. Pp. xxxvi + 136. (Philadelphia: University of Pennsylvania, 1898.)

A Classification of Vertebrata, Recent and Extinct. By Dr. H. Gadow. Pp. xvii + 82. (London: Adam and Charles Black, 1898.)

AN almost pathetic interest attaches to the former of these works, since it is the last scientific communication which Prof. Cope was able to make to the world, and was sent to press only a few days before his death. Its passage through the press was supervised by Prof. Osborn, who has added, by way of an introduction, an account of the life and works of the late Professor. The "Syllabus of Lectures," as it now appears, is a classification of the Vertebrata slightly expanded, and constitutes an elaboration of the scheme which Prof. Cope propounded some years ago in the *American Naturalist*.

The fertility which Prof. Cope has always exhibited for inventing new names is here seen to perfection, though it will probably be regarded with some consternation by the rising generation of students. Tables are given showing the stratigraphical range of the chief divisions, and the illustrations, though many of them crude, are a useful addition.

Ichthyologists who are conversant with Prof. Cope's works will not be surprised to find the Ostracoderms grouped with the Cyclostomes, but the definite inclusion of the Tinamous with the Ratite birds will find little support among ornithologists. Many of the expressions used are ambiguous, and even misleading. The urostyle of the Anura, being situated behind the sacral vertebra, cannot be formed of united *lumbosacral* vertebrae (p. 43), and the statements concerning the absence of median fins in Batrachia (p. 12), and the freedom of the palatopterygoid arch in the Dipnoi (p. 17), require explanation.

The editing of the work, moreover, is not above criticism, *Serpentes* and *Ophidia* occurring indifferently, and on the same page, as the ordinal name of the snakes (p. 75). The oldest multituberculate mammals are said to occur in the "Trias of South Africa in the Karoo Beds," (p. 103)—evidently a tacit reference to *Tritilodon*—and yet Tritilodon is classed with the Gomphodont reptiles on page 65.

Dr. Gadow's book is more likely to find favour with European students, the names given to the groups being more familiar. The convenience of the reader is studied by leaving the left-hand pages blank for annotations. The geological range of the extinct forms, and the geographical distribution of the recent ones are given; and the glossary, showing the derivation of most of the Latin and Greek names, is both useful and accurate.

Dr. Gadow appears to be chary of accepting taxonomic innovations, yet loath to ignore them, and the result is not unfrequently incongruous. He does not support Cope so far as to place the Ostracoderms with the Cyclostomes, but creates for them a new and unnecessary super-class, the "Hypostomata" (p. 4), equal in value to, and intermediate between, the Cyclostomes and the Gnathostomes. And again, while not bold enough to follow Hubrecht in including *Tarsius* with the apes, he yet goes so far as to give it a sub-order all to itself (p. 53).

The diagnoses are not always full enough to be effective (that of the Prosauria, p. 17, not excluding the Geckoes); and even the most elementary student of zoology will object to the statement (p. 43) that the tibia and fibula are separate in the rabbit.

The book, however, in spite of some blemishes, will prove a useful addition to the student's library.

OUR BOOK SHELF.

First Principles of Electricity and Magnetism. By C. H. W. Biggs. Pp. 481 + xv. (London: Biggs and Co.)

THIS book is intended, it is stated in the author's preface, for beginners in practical work, and is an expansion of a series of papers which appeared in the *Electrical Engineer*. The author considers it necessary to lead off with a chapter on atoms, molecules, mass, force, weight (and the fundamental units), work and energy. The idea evidently is to convey to the beginner information in a more or less familiar and chatty style, and the book is certainly readable. We wish we could say that the information was always quite correct. As containing examples of well-meant but inaccurate statements, we may refer to the explanation (?) of the different gravitational attractions in the same mass at different points of the earth's surface. The account of the effect of the flattening at the poles leaves much to be desired, and the effect of centrifugal force is not even mentioned.

Again, on p. 21 we have "unit acceleration as in scientific calculations, usually 1 centimetre per second. In many practical calculations it is 1 foot per second." Whatever may figure in practical calculations, it is certain that neither of these is scientifically an acceleration at all. Also, though we have no wish to be hypercritical, there is something quaint about the equation

"$150 \times 25 = 3750$ poundals."

When Mr. Biggs comes to electrical matters he is happier. His descriptions of hydrostatic analogies may help some readers, *e.g.* the inquiring town councillor, to form an idea of "electrical pressure," though we fear the notion may linger that it is really a kind of pressure.

But when he gets to Ohm's Law, Mr. Biggs says, after arriving at the result $C \propto E/R$, "In the early part of this century, Prof. Ohm proved more than this with steady continuous currents, not only that $C \propto E/R$,but that $C = E/R$, or expressed numerically in practical units, amperes $= \frac{\text{volts}}{\text{ohms}}$." How Prof. Ohm "proved" this Mr. Biggs has not divulged, and it would be interesting to know. We had thought, innocently, that the *equality* of C to E/R was an affair of choice of units, and not of proof at all.

The cuts in the book are numerous, but, except a few here and there, are badly printed. The figure, on p. 185, of a long thin gentleman (in a rather modern dress) extended along a rod inside what looks like a stone coffin several sizes too big for him, at first sight startled us. Underneath, in black type, was the legend, "A Stretch of the Imagination"! but this, we found, referred to the following paragraph, which, curiously enough, deals with elastic threads.

The latter and really practical part of Mr. Biggs' book may be of service to some readers. It contains a good deal of useful information, conveyed in Mr. Biggs' genial, if a little conscious, style. But we should counsel a really earnest student, and especially a beginner, to choose a text-book in which a more serious attempt is made to grapple with the real difficulties of the subject.

Medical Diseases of Infancy and Childhood. By Dawson Williams, M.D., F.R.C.P. (Lond.), Physician to the East London Hospital for Children, Shadwell. Pp. xiv + 634. Plates 18; figures 18. (London: Cassell and Co., Ltd., 1898.)

THE book before us, which is correctly described by the author as a handbook, is intended "to act as a guide to clinical study" to young practitioners of medicine, and those who have not previously paid much attention to the subject. After introductory chapters treating of growth, clinical examination and food, the author proceeds to consider the individual diseases of children, and to indicate how the pathological processes, and their accompanying clinical phenomena, are different in children and adults. It would, of course, be impossible in a short notice like the present to give an account of the varied and practical information contained in Dr. Williams's book. Under the heading of diphtheria, the results of the antitoxin treatment, as culled from the statistics of the Metropolitan Asylums Board and the American Pediatric Society, are given, the author rightly observing that the statistical figures are actually less favourable than the reality. The interesting subject of the effect of the antitoxin treatment upon the complications of diphtheria, so often of such importance in children, is also discussed. Cretinism and its treatment by administration of the thyroid gland is considered. Hepatic disease in children, often a subject of considerable difficulty to the practitioner, is well treated. A list of prescriptions, a few invalid cooking receipts, and a good index conclude the volume. The book will unquestionably be of use to the general practitioner and the student, and, while not capable of replacing the larger text-books on the diseases of children, will form a most valuable supplement to the various treatises on general medicine. F. W. T.

A Text-book of General Botany. By Carlton C. Curtis, A.M., Ph.D., Tutor in Botany in Columbia University. Pp. viii + 359. (New York, London, and Bombay: Longmans, Green, and Co., 1897.)

DR. CURTIS has added another to the existing long list of intermediate botanical text-books. His book is readable, and on the whole a fairly good one, and the number of new illustrations it contains at once impress the reader in its favour. Opening with a general account of anatomy, he devotes the second chapter to physiology. But the great bulk of the book (p. 87–340) is given up to systematic and morphological matters. A very short sketch of palæobotany, together with an index, conclude the work. The general treatment is based on the type system, and Dr. Curtis has done well in showing how this much abused method lends itself in reality very well to a connected exposition of the taxonomic parts of botany. Unfortunately, perhaps inevitably, the text is rather scrappy in many places, although this is partly atoned for by the fulness of the many laboratory exercises which are distributed through the book.

We have noticed a rather considerable number of misprints scattered through the pages; these will doubtless disappear in a future edition, which is almost sure to be called for, since the book, if used as an adjunct to the laboratory in the sense intended by its author, supplies a distinctly felt need for a guide suitable for intermediate students.

Domestic Hygiene. By Arnold W. Williams, M.B. C.M. (Edin.), D.P.H. (Lond.). Pp. 175. (London: George Bell and Sons, 1898.)

The Teacher's Manual of Object Lessons in Domestic Economy. Vol. ii. By Vincent T. Murché. Pp. viii + 334. (London: Macmillan and Co., Ltd., 1898.)

Lessons in Domestic Science. Part ii. By Ethel R. Lush. Pp. 77. (London: Macmillan and Co., Ltd., 1898.)

THESE three volumes all deal worthily with matters included in the science of health, and they will all assist in extending a knowledge of the laws of life. Dr. Williams's manual contains the substance of lectures delivered by the author at many rural and urban districts on the causes and prevention of disease and co-related subjects affecting the public health. The book will be found of service to technical instruction classes and others of a similar kind.

Mr. Murché's book is "adapted to meet the requirements of the Education Department in the Class Subject of Domestic Economy as laid down in the Code for 1898." It contains notes and hints for teachers who have to teach domestic economy to Standards III. and IV. of public elementary schools. In the former standard, the children are expected to know something of the materials used in clothing and the materials used in washing; in the latter standard, they are taught simple facts concerning the use and sources of food, the hygiene of clothes, and laundry-work. Mr. Murché's books have all been received by favour with teachers engaged in elementary schools, and the present volume will doubtless have the same welcome extended to it.

Domestic science is a new subject recently adopted by the Education Department. It differs from domestic economy in the fact that principles rather than processes are dealt with. The parts of the subject included in Miss Lush's booklet refer to the functions and preparation of food, and the dwelling. A course such as t provides educates as well as interests the pupils.

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.*]

The Origin of the Aurora Spectrum.

IN your issue of June 16, Prof. Schuster calls attention to the fact that the wave-length of the aurora line nearly coincides with the wave-length of the bright green line in the spectrum of krypton. Prof. Ramsay and Dr. Travers give the wave-length of this line as 5566·3. I find it to be 5570·40 (Rowland's scale), which brings the line close to the mean of the best determinations of the aurora line. According to Scheiner ("Die Spectralanalyse der Gestirne") the best measures, when reduced to Rowland's scale, are:—

Ångström ...	5568	Huggins ...	5572
Vogel	5572	Copeland ...	5573
Vijkander ...	5573	Gyllenskiöld	5569
Lemström ...	5570		

Mean 5571·0.

To this must be added Campbell's determination at Mount Hamilton: 5571·6 (see translation of Scheiner's "Sp. d. Gest." by E. Frost, p. 326).

Considering the difficulty of measuring the aurora line, I think the difference is not too large to be compatible with the identity of the lines. Satisfactory evidence might be gained, if the other krypton lines could be observed in the spectrum of the aurora. I subjoin the mean of four different determinations of the yellow and green krypton lines. They were photographed on orthochromatic plates, together with lines of mercury, sodium and argon, which served as standards.

	Mean error.	Ramsay and Travers.
5562·35 ...	0·03 ...	5557·3
5570·40 ...	0·03 ...	5566·3
5871·10 ...	0·03 ...	5866·65

Hannover, Technische Hochschule, November 2. C. RUNGE.

The Boring at Funafuti.

FURTHER information has been received this week from Prof. David, of Sydney, as to the progress of the boring at Funafuti. On September 6 it had reached a depth of 987 feet, passing through a hard dolomite-like coral rock, apparently similar to that mentioned previously as occurring below about 700 feet. Boring in the bed of the lagoon from the deck of H.M.S. *Porpoise* had been continued; the one mentioned in your last number was carried through sand, composed of fragments of calcareous organisms in which broken pieces of coral became commoner in descending, to a depth of 144 feet in the bed-rock of the lagoon, or in all 245 feet below sea-level. There progress was stopped by hard coral rock, which could not be pierced, because the great length of unsupported pipe (about 120 feet) made driving impossible, and the loose stuff above prevented them from applying another device. Captain Sturdee, though unable to stay much longer at the island, contrived to move the *Porpoise* about 90 feet nearer to the centre of the lagoon, where another boring was made at about the same depth. This was carried through 80 feet of sand, as before, which was then succeeded by a rather hard coral gravel; the lumps varying up to the size of a man's fist. It was pierced to a depth of 33 feet, when the time limit was reached, and the work was necessarily abandoned. The results, however, are most interesting, and our friends in Sydney may be congratulated on the success of boring so far in a depth of a hundred feet of water. When letters left the island the main bore was still progressing, though the supply of diamonds was nearly exhausted, so that there seems every hope that it will be carried below a thousand feet. But what has been already accomplished will be an immense addition to our knowledge of atolls.

T. G. BONNEY,
Vice-Chairman of the Coral Reef Committee of the Royal Society.

Asymmetry and Vitalism.

It seems to me that Prof. Japp has not understood the purpose of my reference to "the formation of hematite nodules and flints in chalk." I instanced this simply as showing that segregation slowly takes place notwithstanding great restraints, such as that which a chalk-stratum offers; and my argument was that if segregations of hematite and flint take place in long periods notwithstanding such great restraints, it may reasonably be inferred that segregations of such slightly-different molecules as those of dextro- and laevo-protein would gradually take place under the slight restraints offered by a colloidal substance like protein. Unless due time is given, nothing can be expected.

Prof. Japp thinks I do not "quite realise to what extent enantiomorphous molecules are alike." He says that the two classes of molecules differ only as right and left hands differ. That seems to me a sufficient difference to determine segregation. There must be different *attitudes* in relation to incident forces. Can it be held that differences of attitude have no effects? The members of a mixed mass of molecules differing in their attitudes could not react in absolutely the same manner upon incident forces; and it may be inferred that their differential reactions will produce differential motions.

But Prof. Japp's fundamental fact seems to me to furnish an answer to his criticism. The basis of his argument is that these groups of right-handed and left-handed molecules severally produce rotation of a polarised ray in different directions. If they thus act differently upon the ray when they form an aggregate, they must act differently upon it when existing individually. Though in a mixed aggregate their respective actions on the ray cancel one another, yet each molecule of either kind will be acted upon and will react differently from each molecule of the other kind, and their reactions will *not* cancel one another. Hence there will be initiated those differences in their behaviour which cause segregation. If in a state of nature they are under some conditions subject to polarised rays, the implication seems to be that this result will take place. HERBERT SPENCER.

Brighton, October 29.

I DO not understand how Mr. Herbert Spencer can imagine that the action of plane-polarised light (a form of energy which is merely polar—not asymmetric) can possibly effect the separation of enantimorphs. As I pointed out in my former letter, nothing short of an asymmetric influence could do this.

Speaking of enantiomorphous molecules, Mr. Spencer says: "There must be different *attitudes* in relation to incident forces. Can it be held that differences of attitude have no effects?"

There will undoubtedly be differences in the effects; but, owing to a peculiarity in the behaviour of enantiomorphs under the influence of symmetric forces, these differences will not be apparent in the final result. Thus, if we subject dextro-tartaric acid and laevo-tartaric acid separately to the action of heat, both will decompose at the same temperature and at the same rate, and will yield the same products in the same relative amounts. There is a "difference of attitude," and there will be a difference in the "effects," so far as in the one case some of the right-handed acid becomes left-handed, whilst in the other, some of the left-handed acid becomes right-handed; and in both cases, by similar inverse changes, stopping short, however, half-way, some mesotartaric acid is formed. But in both cases the final result is the same: namely, the establishing of an equilibrium represented by an optically inactive mixture of racemic acid with a little mesotartaric acid. There is a difference in the two *changes*—a difference which our knowledge of the opposite asymmetry of the two initial compounds enables us to read into the processes, thus saving Mr. Spencer's general proposition; but there is no difference in the *results*. But it is quite evident, from what Mr. Spencer has written about the separation of enantiomorphs, that it is in the results that he expects to find a difference; and here he will be disappointed, so long as symmetric influences only are brought to bear on enantiomorphs. Under such influences, just as in the foregoing case, *there occur two changes of inverse character, conditioned by, and exactly balancing, the inverse character of the two enantiomorphs, so that the final result is the same for both enantiomorphs.* This is what Mr. Spencer overlooks. He does not perceive that a uniform force acting upon two enantiomorphs may be modified by them so as to act in two opposite asymmetric modes. He must interpret his third "abstract proposition" and its corollary

(NATURE, vol. lviii. p. 592, col. 2) so as to include these special cases.

Similar considerations would apply to the action of polarised light on a mixture of enantiomorphs. The most that could occur would be the production of an equal rotation of enantiomorphous molecules in opposite senses, corresponding with their opposite asymmetry. That would not cause separation.

Again, take Mr. Spencer's first "abstract proposition" (*loc. cit.*), which runs: "Like units subject to a uniform force capable of producing motion in them, will be moved to like degrees in the same direction." How does he reconcile this statement with the fact that enantiomorphs have the same heat of formation: *i.e.* that the same atoms are moved by the same amounts of energy, not in the same direction, but in directions of opposite asymmetry, so as to form two asymmetrically distinct compounds?

I probably do Mr. Spencer no injustice if I assume that in 1862, when he formulated these "abstract propositions," he was not acquainted with the theory of molecular asymmetry, which at that time was not generally current, even among professed chemists. And if I might do so without offence, I would suggest that he should read the portion of Van 't Hoff's "Arrangement of Atoms in Space" (second edition) dealing with the question of molecular asymmetry, especially the section which describes the character of the isomerism due to the asymmetric carbon atom. He may then be able to recast his "abstract propositions" so as to include, at least more explicitly, the formation and behaviour of enantiomorphous molecules under symmetric influences.

F. R. JAPP.

The Univeısity, Aberdeen, November 2.

I AM not sure that much is to be gained by continuing this discussion further, but perhaps I may be permitted to add something to my first criticism of Prof. Japp's standpoint in view of his communication in last week's NATURE.

The statement of Prof. Japp's, which I specially criticised, was the following (where I italicise the words to which I wish to draw particular attention):—But the *chance* synthesis of the simplest optically active compound from inorganic materials is *absolutely inconceivable*.

To this I replied and still reply, it is *not* absolutely inconceivable. An optically active compound means merely a preponderance of one kind of enantiomorph, and *chance* will always produce this, given enough trials and length of time to make them. Prof. Japp twits me with the ineffectiveness of twenty molecules, but I spoke not of twenty molecules, but of twenty coins, in order to bring home to Prof. Japp what a deviation from the average in the theory of chance really means. The probability of a deviation of 5000 in 1,000,000 molecules is easily calculated, and such a deviation is quite "conceivable," even if it be very infrequent. A deviation of 5000 in 1,000,000 molecules would give an optically active solution, whether sufficiently intense to be observed by the means at our disposal is another question. The statement that on the theory of *chance*, an optically active compound is *absolutely inconceivable* is, I take it, absurd. It may be very *improbable*, but this is not the term used by Prof. Japp.

Prof. Japp writes in his letter: "Prof. Pearson's twenty non-living asymmetrical molecules formed by the chance play of mechanical forces, would, so far as experiment informs us—although I freely admit that mere negative results are not conclusive—have no more influence on the asymmetry of other molecules formed in their neighbourhood than one toss of a coin has upon another toss." I reply that I think experiment shows they *have*. It is possible in Jungfleisch's process to get crystals which are purely right- or left-handed up to the size, say, of half an inch, sufficiently large for picking out. Now I take it that it is chance which produces a slight majority of one type of enantiomorphs at one or other point, and what I have termed "breeding," which encourages the collection of that type at the given centre until we get crystals purely right- or left-handed up to a size of half an inch. That a number of molecules of one kind, such as are required for these crystals, should be frequently formed, is totally opposed to the theory of *chance*, but I take it that a slight chance preponderance sets the "breeding" going.

Take a dish of such crystals and throw them out at random, and they scatter in all directions; one such crystal coming into a few drops of fluid forms an optically active medium consisting of enantiomorphs of one kind only. Thus even a total disappearance of one kind of enantiomorphs is not impossible, or "absolutely inconceivable" on the theory of *chance*. Prof. Japp speaks of the "vague and elastic" way in which I speak of the "breeding" process—I notice that Prof. Errera also uses the phrase "asymmetry begets asymmetry as life begets life." Let us confine the term then, for the present, simply to the process (of which so far the mechanism is unintelligible) by which chance having given a slight local preponderance of one type of enantiomorph, a group of the same type, visible and touchable, is formed there. It is perfectly conceivable that this is only a visible representation of the process by which living asymmetry selects its like, even in a non-crystalline compound. It is only the mechanism which is vague, not the fact.

Prof. Japp really complains in his address that an "eminent physicist" should say that an explanation of rotatory polarisation is still wanting. It is still wanting, because no *kinetic* theory, which is what a physicist requires, can be provided by what is after all only a geometrical *schema* of the chemist. Prof. Japp now writes that every chemist recognises that it is only a geometrical hypothesis, and he did not think so obvious a qualification needed statement to an audience of chemists. Then why, I ask, should Prof. Japp go out of his way to say that the theory was unknown outside the circle of organic chemists, and cite the "eminent physicist" as an example of such ignorance?

The fact is, that the moment we look at Prof. Japp's tetrahedron atoms, Figs. 1 and 2 of his paper, as *dynamical* systems, the right-handed and left-handed molecules do not respond in the same manner to symmetrical forces. The atoms not being identical, the centroid will not necessarily be the centroid of the tetrahedron; say, it is somewhat nearer to Z′ than H. Now whirl a thin cylindrical sheet of optically inactive mixture round the axis of the sheet, left- or right-handed rotation is indifferent; the left-handed tetrahedra will not be in *stable* equilibrium relatively to the centroid of the molecule in the same position as the right-handed. Consequently the former will all set, say, their X′ angle inwards, and the latter outwards: or at least some similar like difference of positions will differentiate like from unlike enantiomorphs. Now let a strip of the cylindrical surface be placed horizontally and allowed to fall, say, through a viscous fluid, the resistance to a tetrahedron going X′ foremost, may well be greater or less than one going HZ′Y′ foremost, and if so the left-handed molecules will be separated ultimately from the right. All this is purely hypothetical, but I introduce it because Prof. Japp asserts that it is "impossible" for any mechanical (symmetrical) forces to constantly select one of two opposite forms. I reply that the impossible is conceivable, if he will treat his molecules not as geometrical *schemas*, but as dynamical systems.

One last word. Prof. Japp refers in his address to a "vital force" which does not disobey the law of energy, but is purely *directive* of motion. I have seen such an idea several times mooted. The question is not, however, if something called vital force obeys the law of the conservation of energy, for the principle of energy *never* fully defined any motion, something else is also directly or tacitly assumed. In itself it only leads to *one* equation, not sufficient to describe any motion. The problem is whether "vital force" obeys *all* the laws of motion—for example the conservation of momentum, angular and linear, which it could hardly do if it changed the direction of motion. I am quite unable to realise why some chemists and physicists seem to think a disregard for the conservation of momentum less miraculous than a disregard for the conservation of energy. I do not see why the less important principle should be made more of a fetish than the wider reaching principle. If "vital force" does obey all the laws of motion, then it can only be a rather bad name for some piece of mechanism, to which the most ardent supporter of a mechanical theory of the universe (such as Büchner or Moleschott, not I) could not possibly object.

KARL PEARSON.

University College.

WHILST Prof. Japp is to some extent justified in saying that all his critics "seem to be moving in that unreal world where a fount of type, if jumbled together sufficiently often, ends by setting up the text of *Hamlet*," still it must be borne in mind that he himself provoked a discussion in such an imaginary region by raising the question as to the possibility of producing, without the interference of a living agency, an optically active substance unaccompanied by its enantiomorph. The possibility of such an occurrence has been pointed out by Profs. Karl Pearson and Fitzgerald, and is of course open to no doubt. Indeed, to use Dr. Japp's own simile, it must be conceded that if the type were jumbled an infinite number of times, it would lead not only once but an infinite number of times also to the text of *Hamlet* being set up! In the matter of the synthesis of asymmetric molecules throughout the past history of the earth we are, it is true, not dealing with an infinite number of events, but still with a number of an extremely high order, and in the course of this enormously long series of events such an exceptional occurrence as the exclusive production of a considerable aggregation of similarly asymmetric molecules may have taken place. This Prof. Japp himself appears to recognise, but he does not admit that such an aggregation of asymmetric molecules can by "breeding" add to the number of asymmetric molecules which are unaccompanied by their enantiomorphs, and he has disposed of the vague suggestions of such breeding advanced by his critics. He appears to me, however, to have overlooked one possible way in which such breeding can occur. If we take an asymmetric molecule containing for simplicity a single asymmetric carbon atom, and by purely chemical synthesis generate a second asymmetric carbon atom in the molecule, the new carbon atom may, as we know from the researches of Emil Fischer, always have the same asymmetry, to the exclusion of its enantiomorphous arrangement. But these asymmetric molecules containing two asymmetric carbon atoms might by purely chemical processes be broken down so that each yielded two molecules containing an asymmetric carbon atom apiece. Each of these two resulting molecules with their single asymmetric carbon atom would now be ready to go through a similar cycle of changes which would result in four molecules, each containing a single asymmetric carbon atom, and so on. In this manner an indefinitely large number of asymmetric molecules, unaccompanied by their enantiomorphs, might be bred from a single one without the interference of any asymmetric agency, living or otherwise.

It appears to me also quite possible that the asymmetry of solar radiation may originally have determined the exclusive synthesis of one enantiomorph, and that the latter was in some way or other utilised in the evolution of the first organism, by which then this particular enantiomorphism was further transmitted indefinitely. This is an entirely different idea from that which led Pasteur to try his celebrated but abortive experiments on plants in the hope that by reversing the asymmetry of the sun he would obtain the vegetable asymmetric products of the reverse sign to that which they normally possess. When Pasteur became a biologist as well as a chemist, he rapidly realised that the asymmetric influences present in the germ of life itself far outweigh the asymmetric influence of solar radiation in determining the formation of one enantiomorph to the exclusion of its fellow. It has indeed always appeared to me highly remarkable that Pasteur should have embarked on these particular experiments at all, inasmuch as the negative answer to his inquiry is already given by nature; for, as Prof. Japp points out, the asymmetry of solar radiation in the northern is the reverse of that in the southern hemisphere, whilst the asymmetric vegetable products in both hemispheres are identical and not enantiomorphous. PERCY F. FRANKLAND.

Mason University College, Birmingham, October 31.

The November Meteors.

PROF. J. COUCH ADAMS, in his classical investigation into the dynamics of the great Leonid swarm, employed Gauss's method in determining the perturbations of the surrounding planets upon these meteors. Gauss's method furnishes the average amount of each perturbation, and although this was sufficient for the immediate object which Prof. Adams had in view, it has appeared desirable to penetrate more deeply into the problem.

With this end in view the actual perturbations during the 33¼ years of the present revolution are being computed under the direction of Dr. Downing, F.R.S., the Superintendent of the Nautical Almanac, the calculations being made for meteors occupying a definite position in the stream, viz. that through which the earth passed in 1866. This computation will be completed within the next few days; and as the result, so far as the motion of the node is concerned, can be made the basis of an attempt to forecast the times of the greater showers—one of which may possibly present itself next week—it seems desirable that this use shall be made of the work which is being done.

The greater Leonid showers are occasioned by the earth passing through the stream of ortho-Leonids, *i.e.* those numerous Leonids which revolve round the sun in nearly identical elliptic orbits. There are other Leonids moving in orbits that sensibly differ from the ortho-orbit, and these may be called clino-Leonids. Some of the clino-Leonids encounter the earth in rather scattered formation every year, but the ortho-Leonids are a dense procession of meteors advancing along nearly coincident paths and occupying only a portion of the orbit at any one time.

It is just possible that the front of this procession may extend far enough forward for the earth to encounter it this year, and we are almost certain to pass through the stream in the Novembers of next year and of one or two of the following years. On each such occasion the earth receives a downpour of meteors which lasts for so few hours that those observers only who are fortunate enough to be on the advancing side of the earth can witness the marvellous display.

If there is one of these greater showers this year; if the meteors that shall constitute it traverse the same orbit as did those that the earth encountered in 1866; and if the advance of the node since 1866 were the same as that assigned by Gauss's method: then would the middle of the shower of this year occur at the time

1898 November 14d. 5h.

But the computation which is being made under Dr. Downing's direction shows unmistakably that the last of these conditions has not been fulfilled, that on the contrary the perturbations during this revolution, especially those arising from Jupiter and Saturn, have been far above the average.

Now all the calculations which have been made refer to meteors situated at what we may call Station A in the procession, by which is meant that part of the stream through which the earth passed in 1866. This part of the stream will not return to the node—the point of intersection between the meteoric orbit and the earth's orbit—till the end of January 1900. Accordingly Station B, which the earth will encounter this year, is situated in the procession about a year and a quarter in advance of Station A.

The relative positions of the disturbing planets and the meteors make it almost certain that meteors B have suffered perturbations during the current revolution, which sensibly differ from those affecting meteors A; but the difference is probably not very large. Again, they may have started along slightly different orbits. And, thirdly, Adams's orbit can only be relied on as approximate, since it is based on an insufficient determination of the radiant.

On these accounts there is risk of error in applying to meteors B, the results obtained in the case of meteors A.

With these reservations we may venture to make the correction; and accordingly it is intended as soon as the computer's work is sufficiently advanced, to send to the daily papers (since NATURE will be published too late) an announcement of the amount of the correction found in the case of meteors A. It will probably correspond to an epoch, several hours, possibly more than a whole day, later than that calculated on the average shift of the node.

If when the correction is published it is applied to the date given above, viz. to 1898 November 14d. 5h. (5 o'clock in the afternoon of Monday the 14th instant), it will furnish the best attempt which the data at our disposal seem to permit, to assign the time of the great shower if such an event occurs this year. It will be understood that this can only be offered as a prediction with the important reservations enumerated above.

Everything as yet known seems to betoken that the true time will prove to be many hours later than 5 o'clock on Monday afternoon, so that if one of the great meteoric showers reaches the earth this year it may perhaps happen on Monday night after half-past ten, or on Tuesday night after the same hour, in either of which events it will be visible from all stations on this side of the earth where the sky is not clouded.

G. JOHNSTONE STONEY.

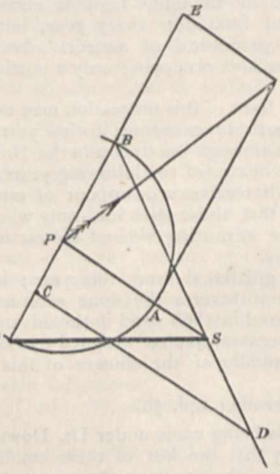
8 Upper Hornsey Rise, N., November 6.

Construction for the Direction of a Magnetic Line of Force.

IN Prof. Gray's review of Riecke's *Lehrbuch*, a construction for the direction of the line of force at any point, due to a short magnet, is given.

If the magnet be long, then the following construction holds:

Let N and S be the two ends of the magnet and P the point, nearer, say, to N than to S. Take A in PS and B in NP produced, so that PA = PB = PN. Take C in BN, so that BC measured towards N equals PS. Draw CD parallel to PS, D being in the line BS. Measure PE away from N, so that PE = CD. The diagonal PT of the parallelogram AE is the direction required.



J. H. VINCENT.
Cavendish Laboratory, Cambridge.

THE determination of the direction of the resultant force, at any point, due to a long, thin magnet, is of some importance as a laboratory exercise, and it is necessary to be able to compare the direction which a small needle takes up in its field with the theoretical direction. For such an exercise the bar should be a long, thin magnet as nearly uniformly magnetised as possible. For this case Mr. Vincent's construction gives the theoretical direction very neatly.

The direction may also be found by dividing the line NS externally, at a point R, say, in the triplicate ratio of NP to SP. The line joining R to P is the direction sought. This construction can be made with only a parallel ruler.

My friend Mr. G. B. Mathews has pointed out to me that this construction may be very conveniently used to draw the whole family of curves. For describe a circle through P dividing NS internally and externally in the ratio of NP to SP. The lines joining any point on this circle with N and S are in this ratio. Hence the direction of the force at each point of the circle is the line joining it with R. Thus, by a succession of circles and corresponding positions of R, the whole series of curves can be laid down.

The following method is perhaps not so good, but is also very easy to remember. A diagram is not necessary. Describe a circle touching the line NP at N, and cutting the line SP produced beyond P in the points H, K, of which H is the nearer to P. From P towards N lay off a distance PL equal to PH, and through L draw a circle touching SP at S and cutting PN, produced, if necessary, in M. The diagonal passing through P of the parallelogram described on PK, PM as adjacent sides is in the direction of the line of force at P.

When either of the angles SNP, NSP is very obtuse, the last construction should be carried out by drawing the circles so as to give equal segments PH, PL both lying on the side of P towards NS. Then a distance PK' = PK can be laid off along SP produced, and the parallelogram described on PK', PM as adjacent sides. There are probably a great many ways of solving this problem: I have hit upon three other distinct methods, which I will not take up space with describing here. I may mention also that I have given a simple method of laying down successive points on a line of force in my "Magnetism and Electricity," vol. i. p. 14, figs. 12 and 13.

The construction for the direction of the force due to a short magnet, described in my review of Prof. Riecke's book, was given by Hansteen ("Magnetismus der Erde," s. 208), and again by Gauss ("Vorschriften," &c., Werke Bd. 5, s. 435). It is to be found in Prof. Chrystal's article on "Magnetism" in the "Encyclopaedia Britannica," and in my treatise on "Absolute Measurements," vol. ii.

A. GRAY.

THE CHEMISTRY OF THE STARS.[1]

WHEN, on returning from India, I found that you had during my absence done me the honour of unanimously electing me your President, I began to cast about for a subject on which to address you. Curiously enough, shortly afterwards an official inquiry compelled me to make myself acquainted with the early doings of the Royal Commission of the Exhibition of 1851, on which I have lately been elected to serve, and in my reading I found a full account of the establishment of your Institute; of the laying of the foundation-stone by the late Prince Consort in 1855, and of his memorable speech on that occasion. Here, I thought, was my subject; and when I heard that the admirable work done by this and other local institutions had determined the inhabitants of this important city and neighbourhood to crown the edifice by the foundation of a University, I thought the matter settled.

This idea, however, was nipped in the bud by a letter which informed me that the hope had been expressed that I should refer to some branch of astronomical work. I yielded at once, and because I felt that I might thus be able to show cause why the making of knowledge should occupy a large place in your new University, and thus distinguish it from other Universities more or less decadent.

The importance of practical work, the educational value of the seeking after truth by experiment and observation on the part of even young students, are now generally recognised. That battle has been fought and won. But there is a tendency in the official direction of seats of learning to consider what is known to be useful, because it is used, in the first place. The fact that the unknown, that is the unstudied, is the mine from which all scientific knowledge with its million applications has been won is too often forgotten.

Bacon, who was the first to point out the importance of experiment in the physical sciences, and who predicted the applications to which I have referred, warns us that "lucifera experimenta non fructifera quaerenda"; and surely we should highly prize those results which enlarge the domain of human thought and help us to understand the mechanism of the wonderful universe in which our lot is cast, as well as those which add to the comfort and the convenience of our lives.

It would be also easy to show by many instances how researches, considered ideally useless at the time they were made, have been the origin of the most tremendous applications. One instance suffices. Faraday's trifling with wires and magnets has already landed us in one of the greatest revolutions which civilisation has witnessed; and where the triumphs of electrical science will stop, no man can say.

This is a case in which the useless has been rapidly sublimed into utility so far as our material wants are concerned.

I propose to bring to your notice another "useless" observation suggesting a line of inquiry which I believe sooner or later is destined profoundly to influence human thought along many lines.

Fraunhofer at the beginning of this century examined sunlight and starlight through a prism. He found that the light received from the sun differed from that of the stars. So useless did his work appear that we had to wait for half a century till any considerable advance was made. It was found at last that the strange "lines" seen and named by Fraunhofer were precious indications of the chemical substances present in worlds immeasurably remote. We had, after half a century's neglect, the foundation of solar and stellar chemistry, an advance in knowledge equalling any other in its importance.

[1] An inaugural address delivered at the Birmingham and Midland Institute on October 25, by Sir Norman Lockyer, K.C.B., F.R.S., President.

In dealing with my subject, I shall first refer to the work which has been done in more recent years with regard to this chemical conditioning of the atmospheres of stars, and afterwards very briefly show how this work carries us into still other new and wider fields of thought.

The first important matter which lies on the surface of such a general inquiry as this is that if we deal with the chemical elements as judged by the lines in their spectra, we know for certain of the existence of oxygen, of nitrogen, of argon, representing one class of gases, in no celestial body whatever; whereas, representing other gases, we have a tremendous demonstration of the existence of all the known lines of hydrogen and helium.

We see then that the celestial sorting out of gases is quite different from the terrestrial one.

Taking the substances classed by the chemist as non-metals, we find carbon and silicium—I prefer, on account of its stellar behaviour, to call it silicium, though it is old-fashioned—present in celestial phenomena; we have evidence of this in the fact that we have a considerable development of carbon in some stars and an indication of silicium in others. But these are the only non-metals observed. Now with regard to the metallic substances which we find, we deal chiefly with calcium, strontium, iron and magnesium; others are not absolutely absent, but their percentage quantity is so small that they are negligible in a general statement.

Now do these chemical elements exist indiscriminately in all the celestial bodies, so that practically, from a chemical point of view, the bodies appear to us of similar chemical constitution? No, it is not so.

From the spectra of those stars which resemble the sun, in that they consist of an interior nucleus surrounded by an atmosphere which absorbs the light of the nucleus, and which therefore we study by means of this absorption; it is to be gathered that the atmospheres of some stars are chiefly gaseous, *i.e.* consisting of elements we recognise as gases here, of others chiefly metallic, of others again mainly composed of carbon or compounds of carbon.

Here then we have spectroscopically revealed the fact that there is considerable variation in the chemical constituents which build up the stellar atmospheres.

This, though a general, is still an isolated statement. Can we connect it with another? One of the laws formulated by Kirchhoff in the infancy of spectroscopic inquiry has to do with the kind of radiation given out by bodies at different temperatures. A poker placed in a fire first becomes *red*, and as it gets hotter, *white*, hot. Examined in a spectroscope we find that the red condition comes from the *absence* of blue light; that the white condition comes from the gradual addition of blue as the temperature increases.

The law affirms that the hotter a mass of matter is the further its spectrum extends into the ultra-violet.

Hence the hotter a star is, the further does its complete or *continuous* spectrum lengthen out towards the ultra-violet, and the less is it absorbed by cooler vapours in its atmosphere.

Now to deal with three of the main groups of stars, we find the following very general result:—

Gaseous stars ...	... Longest spectrum.
Metallic stars ...	... Medium spectrum.
Carbon stars ...	... Shortest spectrum.

We have now associated two different series of phenomena, and we are enabled to make the following statement:—

Gaseous stars ...	... Highest temperature.
Metallic stars ...	... Medium temperature.
Carbon stars ...	... Lowest temperature.

Hence the differences in apparent chemical constitutions are associated with differences of temperature.

Can we associate with the two to which I have already called attention still a third class of facts?

Laboratory work enables us to do this. When I began my inquiries the idea was, one gas or vapour one spectrum. We now know that this is not true; the systems of bright lines given out by radiating substances change with the temperature.

We can get the spectrum of a well-known compound substance—say carbonic oxide; it is one special to the compound; we increase the temperature so as to break up the compound, and we then get the spectra of its constituents, carbon and oxygen.

But the important thing in the present connection is that the spectra of the chemical elements behave exactly in the same way as the spectra of known compounds do when we employ temperatures far higher than those which break up the compounds; and indeed in some cases the changes are more marked. For brevity I will take for purposes of illustration three substances, and deal with one increase of temperature only, a considerable one and obtainable by rendering a substance incandescent, first by a direct current of electricity, as happens in the so-called "arc lamps" employed in electric lighting, and next by the employment of a powerful induction coil and battery of leyden jars. In laboratory parlance we pass thus from the arc to the jar-spark. In the case of magnesium, iron and calcium, the changes observed on passing from the temperature of the arc to that of the spark have been minutely observed. In each, new lines are added or old ones are intensified at the higher temperature. Such lines have been termed *enhanced lines*.

These enhanced lines are not seen alone: outside the region of high temperature in which they are produced, the cooling vapours give us the cool lines. Still we can conceive the enhanced lines to be seen alone at the highest temperature in a space sufficiently shielded from the action of all lower temperatures, but such a shielding is beyond our laboratory expedients.

In watching the appearance of these special enhanced lines in stellar spectra we have a third series of phenomena available, and we find that the results are absolutely in harmony with what has gone before. Thus

Gaseous stars ...	Highest temperature ...	Strong helium and faint enhanced lines.
Metallic stars ...	Medium temperature	Feeble helium and strong enhanced lines. No helium and strong arc lines.
Carbon stars ..	Lowest temperature ...	Faint arc lines.

It is clear now, not only that the spectral changes in stars are associated with, or produced by, changes of temperature, but that the study of the enhanced spark and the arc lines lands us in the possibility of a rigorous stellar thermometry, such lines being more easy to observe than the relative lengths of spectrum.

Accepting this, we can take a long stride forward and, by carefully studying the chemical revelations of the spectrum, classify the stars along a line of temperature. But which line? Were all the stars, in popular phraseology, created hot? If so, we should simply deal with the running down of temperature, and because all the hottest stars are chemically alike, all cooler stars would be alike. But there are two very distinct groups of coolest stars; and since there are two different kinds of coolest stars, and only one kind of hottest star, it can not be merely a question either of a running up or a running down of temperature.

Many years of very detailed inquiry have convinced me that all stars save the hottest must be sorted out into two series—those getting hotter and those, like our sun, getting cooler, and that the hottest stage in the history of a star is reached near the middle of its life.

The method of inquiry adopted has been to compare large-scale photographs of the spectra of the differ stars, taken by my assistants at South Kensington; the complete harmony of the results obtained along various lines of other work carries conviction with it.

We find ourselves here in the presence of minute details exhibiting the workings of a chemical law, associated distinctly with temperature; and more than this, we are also in the presence of high temperature furnaces, entirely shielded by their vastness from the presence of those distracting phenomena which we are never free from in the most perfect conditions of experiment we can get here.

What, then, is the chemical law? It is this. In the very hottest stars we deal with the gases hydrogen, helium, and doubtless others still unknown, almost exclusively. At the next lowest temperatures we find these gases being replaced by metals in the state in which they are observed in our laboratories when the most powerful jar-spark is employed. At a lower temperature still the gases almost disappear entirely, and the metals exist in the state produced by the electric arc. Certain typical stars showing these chemical changes may be arranged as follows:

Stars getting hotter.	Hottest stars.	Stars cooling.
	Bellatrix	
ζ Tauri		β Persei
Rigel		γ Lyra
α Cygni		Castor
γ Cygni		Procyon
α Orionis		Arcturus and Sun

This, then, is the result of our first inquiry into the existence of the various chemical elements in the atmospheres of stars generally. We get a great diversity, and we know that this diversity accompanies changes of temperature. We have also found that the sun, which we independently know to be a cooling star, and Arcturus, are identical chemically.

We have now dealt with the presence of the various chemical elements, generally, in the atmospheres of stars. The next point we have to consider is whether the absorption which the spectrum indicates for us takes place from top to bottom of the atmosphere, or only in certain levels.

In many of these stars the atmosphere may be millions of miles high. In each the chemical substances in the hottest and coldest portions *may* be vastly different; the region, therefore, in which this absorption takes place, which spectroscopically enables us to discriminate star from star, must be accurately known before we can obtain the greatest amount of information from our inquiries.

Our next duty then clearly is to study the sun—a star so near us that we can examine the *different parts* of its atmosphere, which we cannot do in the case of the more distant stars. By doing this we may secure facts which will enable us to ascertain in what parts of the atmosphere the absorption takes place which produces the various phenomena on which the chemical classification has been based.

It is obvious that the general spectrum of the sun, like that of stars generally, is built up of all the absorptions *which can make themselves felt* in every layer of its atmosphere from bottom to top, that is from the photosphere to the outermost part of the corona. Let me remind you that this spectrum is *changeless* from year to year.

Now sun-spots are disturbances produced in the photosphere; and the chromosphere, with its disturbances, called prominences, lies directly above it. Here, then, we are dealing with the lowest part of the sun's atmosphere. We find first of all that in opposition to the changeless general spectrum, great changes occur with the sun-spot period, both in the spots and chromosphere.

The spot spectrum is indicated, as was found in 1866, by the widening of certain lines; the chromospheric spectrum, as was found in 1868, by the appearance at the sun's limb of certain bright lines. In both cases the lines affected seen at any one time are relatively few in number.

In the spot spectrum, at a sun-spot minimum, we find iron lines chiefly affected; at a maximum they are chiefly of unknown or unfamiliar origin. At the present moment the affected lines are those recorded in the spectra of vanadium and scandium, with others never seen in a laboratory. That we are here far away from terrestrial chemical conditions is evidenced by the fact that there is not a gramme of scandium available for laboratory use in the world at the present time.

Then we have the spectrum of the prominences and the chromosphere. That spectrum we are enabled to observe every day when the sun shines, as conveniently as we can observe that of sun-spots. The chromosphere is full of marvels. At first, when our knowledge of spectra was very much more restricted than now, almost all the lines observed were unknown. In 1868 I saw a line in the yellow, which I found behaved very much like hydrogen, though I could prove that it was not due to hydrogen; for laboratory use the substance which gave rise to it I called helium. Next year I saw a line in the green at 1474 of Kirchhoff's scale. That was an unknown line, but in some subsequent researches I traced it to iron. From that day to this we have observed a large number of lines. They have gradually been dragged out from the region of the unknown, and many are now recognised as enhanced lines, to which I have already called attention as appearing in the spectra of metals at a very high temperature.

But useful as the method of observing the chromosphere without an eclipse, which enables us

"... to feel from world to world,"

as Tennyson has put it, has proved, we want an eclipse to see it face to face.

A tremendous flood of light has been thrown upon it by the use of large instruments constructed on a plan devised by Respighi and myself in 1871. These give us an image of the chromosphere painted in each one of its radiations, so that the exact locus of each chemical layer is revealed. One of the instruments employed during the Indian eclipse of this year is that used in photographing the spectra of stars, so that it is now easy to place photographs of the spectra of the chromosphere obtained during a total eclipse and of the various stars side by side.

I have already pointed out that the chemical classification indicated that the stars next above the sun in temperature are represented by γ Cygni and Procyon, one on the ascending, the other on the descending branch of the temperature curve.

Studying the spectra photographed during the eclipse of this year we see that practically the lower part of the sun's atmosphere, if present by itself, would give us the lines which specialise the spectra of γ Cygni or Procyon.

I recognise in this result a veritable Rosetta stone which will enable us to read the celestial hieroglyphics presented to us in stellar spectra, and help us to study the spectra and to get at results much more distinctly and certainly than ever before.

One of the most important conclusions we draw from the Indian eclipse is that, *for some reason or other*, the lowest hottest part of the sun's atmosphere does not write its record among the lines which build up the general spectrum so effectively as does a higher one.

There was another point especially important on which we hoped for information, and that was this. Up to the employment of the prismatic camera insufficient attention had been directed to the fact that in observations made by an ordinary spectroscope, no true measure of the height to which the vapours or gases extended above the sun could be obtained; early observations, in fact, showed the existence of glare between the observer and the dark moon; hence it must exist between us and the sun's surroundings.

The prismatic camera gets rid of the effects of this glare, and its results indicate that the effective absorbing layer—that, namely, which gives rise to the Fraunhofer lines—is much more restricted in thickness than was to be gathered from the early observations.

We are justified in extending these general conclusions to all the stars that shine in the heavens.

So much then, in brief, for solar teachings in relation to the record of the absorption of the lower parts of stellar atmospheres.

Let us next turn to the higher portions of the solar surroundings to see if we can get any effective help from them.

In this matter we are dependent absolutely upon eclipses, and I shall fulfil my task very badly if I do not show you that the phenomena then observable when the so-called corona is visible, full of awe and grandeur to all, are also full of precious teaching to the student of science. This also varies like the spots and prominences with the sun-spot period.

It happened that I was the only person that saw both the eclipse of 1871 at the maximum of the sun-spot period and that of 1878 at minimum; the corona of 1871 was as distinct from the corona of 1878 as anything could be. In 1871 we got nothing but bright lines indicating the presence of gases; namely hydrogen and another, since provisionally called coronium. In 1878 we got no bright lines at all, so I stated that probably the changes in the chemistry and appearance of the corona would be found to be dependent upon the sun-spot period, and recent work has borne out that suggestion.

I have now specially to refer to the corona as observed and photographed this year in India by means of the prismatic camera, remarking that an important point in the use of the prismatic camera is that it enables us to separate the spectrum of the corona from that of the prominences.

One of the chief results obtained is the determination of the position of several lines of probably more than one new gas, which, so far, have not been recognised as existing on the earth.

Like the lowest hottest layer, *for some reason or other*, this upper layer does not write its record among the lines which build up the general spectrum.

General results regarding the locus of absorption in stellar atmospheres.

We learn from the sun, then, that the absorption which defines the spectrum of a star is the absorption of a middle region, one shielded both from the highest temperature of the lowest reaches of the atmosphere where most tremendous changes are continually going on, and the external region where the temperature must be low, and where the metallic vapours must condense.

If this is true for the sun it must be equally true for Arcturus, which exactly resembles it. I go further than this, and say that in the presence of such definite results as those I have brought before you, it is not philosophical to assume that the absorption may take place at the bottom of the atmosphere of one star, or at the top of the atmosphere of another. The *onus probandi* rests upon those who hold such views.

So far I have only dealt in detail with the hotter stars, but I have pointed out that we have two distinct kinds of coolest ones, the evidence of their much lower temperature being the shortness of their spectra. In one of these groups we deal with absorption alone, as in those already considered; we find an important break in the phenomena observed; helium, hydrogen and metals have practically disappeared, and we deal with carbon absorption alone.

But the other group of coolest stars presents us with quite new phenomena. We no longer deal with absorption alone, but accompanying it we have radiation, so that the spectra contain both dark lines and bright ones. Now since such spectra are visible in the case of new stars, the ephemera of the skies, which may be said to exist only for an instant relatively, and when the disturbance which gives rise to their sudden appearance has ceased, we find their places occupied by nebulae, we cannot be dealing here with stars like the sun, which has already taken some millions of years to slowly cool, and requires more millions to complete the process into invisibility.

The bright lines seen in the large number of permanent stars which resemble these fleeting ones—*new stars*, as they are called—are those discerned in the once mysterious nebulae which, so far from being stars, were supposed not many years ago to represent a special order of created things.

Now the nebulae differ from stars generally in the fact that in their spectra we have practically to deal with radiation alone, we study them by their bright lines, the conditions which produce the absorption by which we study the chemistry of the hottest stars are absent.

A new view of stars.

Here then we are driven to the perfectly new idea that some of the cooler bodies in the heavens the temperature of which is increasing and which appear to us as stars, are really disturbed nebulae.

What then is the chemistry of the nebulae? It is mainly gaseous; the lines of helium and hydrogen and the flutings of carbon, already studied by their absorption in the groups of stars to which I have already referred, are present as bright ones.

The presence of the lines of the metals iron, calcium, and probably magnesium, shows us that we are not dealing with gases merely.

Of the enhanced metallic lines there are none, only the low temperature lines are present, so far as we yet know. The temperature then is low, and lowest of all in those nebulae where carbon flutings are seen almost alone.

A new view of nebulae.

Passing over the old views, among them one that the nebulae were holes in something dark which enabled us to see something bright beyond, and another that they were composed of a fiery fluid, I may say that not long ago they were supposed to be masses of gases only, existing at a very high temperature.

Now, since gases may glow at a low temperature as well as at a high one, the temperature evidence must depend upon the presence of cool metallic lines and the absence of the enhanced ones.

The nebulae, then, are relatively cool collections of some of the permanent gases and of some cool metallic vapours, and both gases and metals are precisely those I have referred to as writing their records most visibly in stellar atmospheres.

Now can we get more information concerning this association of certain gases and metals? In laboratory work it is abundantly recognised that all meteorites (and many minerals) when slightly heated give out permanent gases, and under certain conditions the spectrum of the nebulae may in this way be closely approximated to. I have not time to labour this point, but I may say that a discussion of all the available observations to my mind demonstrates the truth of the suggestion, made many years ago by Prof. Tait before any spectroscopic facts were available, that the nebulae are masses of meteorites rendered hot by collisions.

Surely human knowledge is all the richer for this indication of the connection between the nebulae, hitherto the most mysterious bodies in the skies, and the "stones that fall from heaven."

Celestial evolution.

But this is, after all, only a stepping-stone, important though it be. It leads us to a vast generalisation. If the nebulae are thus composed, they are bound to condense to centres however vast their initial proportions, however irregular the first distribution of the cosmic clouds which compose them; each pair of meteorites in collision puts us in mental possession of what the final stage must be. We begin with a feeble absorption of metallic vapours round each meteorite in collision; the space between the meteorites is filled with the permanent gases driven out further afield and having no power to condense. Hence dark metallic and bright gas lines. As time goes on, the former must predominate, for the whole swarm of meteorites will then form a gaseous sphere with a strongly heated centre, the light of which will be absorbed by the exterior vapour.

The temperature-order of the group of stars with bright lines as well as dark ones in their spectra, has been traced, and typical stars indicating the chemical changes have been as carefully studied as those in which absorption phenomena are visible alone, so that now there are no breaks in the line connecting the nebulae with the stars on the verge of extinction.

Here we are brought to another tremendous outcome, that of the evolution of all cosmical bodies from meteorites, the various stages recorded by the spectra being brought about by the various conditions which follow from the conditions.

These are shortly that at first collisions produce luminosity among the colliding particles of the swarm, and the permanent gases are given off and fill the interspaces. As condensation goes on, the temperature at the centre of condensation always increasing, all the meteorites in time are driven into a state of gas. The meteoritic bombardment practically now ceases for lack of material, and the future history of the mass of gas is that of a cooling body, the violent motions in the atmosphere while condensation was going on now being replaced by a relative calm.

The absorption phenomena in stellar spectra are not identical at the same mean temperature on the ascending and descending sides of the curve, on account of the tremendous difference in the physical conditions.

In a condensing swarm, the centre of which is undergoing meteoritic bombardment from all sides, there cannot be the equivalent of the solar chromosphere; the whole mass is made up of heterogeneous vapour at different temperatures, and moving with different velocities in different regions.

In a condensed swarm, of which we can take the sun as a type, all action produced from without has practically ceased; we get relatively a quiet atmosphere and an orderly assortment of the vapours from top to bottom, disturbed only by the fall of condensed metallic vapours. But still, on the view that the differences in the spectra of the heavenly bodies chiefly represent differences in degree of condensation and temperature, there can be, *au fond*, no great chemical difference between bodies of increasing and bodies of decreasing temperature. Hence, we find at equal mean temperatures on opposite sides of the temperature curve, this chemical similarity of the absorbing vapours proved by many points of resemblance in the spectra, especially the identical behaviour of the enhanced metallic and cleveite lines.

Celestial dissociation.

The time you were good enough to put at my disposal is now exhausted, but I cannot conclude without stating that I have not yet exhausted all the conceptions of a high order to which Fraunhofer's apparently useless observation has led us.

The work which to my mind has demonstrated the evolution of the cosmos as we know it from swarms of meteorites, has also suggested a chemical evolution equally majestic in its simplicity.

A quarter of a century ago I pointed out that all the facts then available suggested the hypothesis that in the atmospheres of the sun and stars various degrees of "celestial dissociation" were at work, a "dissociation" which prevented the coming together of the finest particles of matter which at the temperature of the earth and at all artificial temperatures yet attained here compose the metals, the metalloids and compounds.

On this hypothesis the so-called atoms of the chemist represent not the origins of things, but only early stages of the evolutionary process.

At the present time we have tens of thousands of facts which were not available twenty-five years ago. All these go to the support of the hypothesis, and among them I must indicate the results obtained at the last eclipse, dealing with the atmosphere of the sun in relation to that of the various stars of higher temperature to which I called your attention. In this way we can easily explain the enhanced lines of iron existing practically alone in Alpha Cygni. I have yet to learn any other explanation.

I have nothing to take back either from what I then said or what I have said since on this subject, and although the view is not yet accepted, I am glad to know that many other lines of work which are now being prosecuted tend to favour it.

I have no hesitation in expressing my conviction that in a not distant future the inorganic evolution to which we have been finally led by following up Fraunhofer's useless experiment, will take its natural place side by side with that organic evolution the demonstration of which has been one of the glories of the nineteenth century.

And finally now comes the moral of my address. If I have helped to show that observations having no immediate practical bearing may yet help on the thought of mankind, and that this is a thing worth the doing, let me express a hope that such work shall find no small place in the future University of Birmingham.

DIFFUSION IN RELATION TO WORK.

IN this month's *Philosophical Magazine* Mr. A. Griffiths has an interesting paper on diffusion convection, in which he suggests an indirect method of measuring rates of diffusion of liquids, and concludes with the following deduction from the fact that diffusion sometimes produces convection currents and sometimes does not:—"Does not this indicate that the heat produced on mixing a solution with water depends on how the mixing takes place? Is the matter connected with a sort of surface-tension existing in the spaces between a strong and a weak solution?"

Mr. Griffiths does not seem to have observed that his investigation applies quite well to gases as to liquids, and that his indirect method of measuring rates of diffusion is applicable to gases. In the case of gases there can be sensible surface-tension, and, as the theory of diffusion in gases is quite simple, there is no serious difficulty in seeing how there is a difference between different ways of mixing them.

It is generally known that two different gases may be mixed by irreversible, or by, at least, partially reversible, processes. They may be allowed to diffuse freely into one another, or may be separated by a porous partition. In the latter case a considerable difference of pressure may be produced between different parts of the space containing them, and this difference of pressure can be used to do work. The final condition in this case is, of course, cooler than if the gases did no external work. In the same way a solution diffusing into water may do so without doing external work, or it may do so by a reversible process, through a semi-permeable diaphragm, producing considerable differences of pressure, which may be used to do work. The final condition in this latter case would, of course, be cooler than in the former case of inter-diffusion without doing external work. Now whenever convection currents are produced, these are to some extent reversible. We might put vanes into the liquid to be moved by the currents and to do work outside the liquid, and by reversing this we would reverse the convection currents. Hence any method of mixing in which convection currents are produced, which do work or produce heat outside the liquid, will necessarily produce less heat in the liquid than a method of mixing in which there are either no convection currents, or these produce heat by viscous flow inside the liquid.

That we can, at pleasure, either use the diffusion of two gases into one another to do external work or not, is really not different from the case of a single gas expanding into a larger volume. We may do work by this expansion and cool the gas, or we may allow the gas, as in Joule's experiments, to expand into a larger volume without doing external work, and in this case there is only a very small change of temperature.

In these cases it is a question of change of entropy in the system, which can either be effected by an irreversible process in which no work is done, or by a variety of other processes, more or less reversible, in which the more reversible they are the more work can be done. In the case of producing convection currents, or, in general, of diffusion of a heavy fluid upwards into a lighter one, the amount of heat produced would not be exactly the same as if gravity were not acting: the centre of gravity of the system is raised by diffusion. Now in Mr. Griffiths's case, and in the case of diffusion currents generally, this raising of the centre of gravity takes place throughout part of the space considered by diffusion, and the centre of gravity is continually falling down again in the convection currents. Hence the work that can be done by the convection currents is part of the work that was done by diffusion against gravity. In the case of diffusion without convection currents, we might use the whole of this work done against gravity, by which the centre of gravity of the system has been raised, to do external work. If, for example, the containing vessel were supported at its centre of gravity, in the unmixed condition, the centre of gravity would, after diffusion, be above the point of support, and the vessel and its contents might be arranged to turn round the support doing work during the fall of the centre of gravity to its original level. Another way of utilising the rise is to allow the fluid to flow into another broader vessel until its centre of gravity has returned to the original level. The thing to be specially observed is, that the amount by which the centre of gravity is raised depends entirely upon the shape of the vessel. If it be tall, the centre of gravity will be raised a great deal; while if it be low, the centre of gravity will be only slightly raised. By causing diffusion to take place in a tall thin vessel, the final temperature will be lower than in a broad low one, not on account of any superficial tensions, but on account of the work done against gravity. In Mr. Griffiths's methods diffusion is continually taking place along tall thin vessels, and convection currents lowering the centre of gravity again by flow into broad ones. GEO. FRAS. FITZGERALD.

THE EXPECTED METEORIC SHOWER.

THE imminent return of the Leonids once more attracts us to prepare for their observation and discuss their phenomena. The circumstances this year will be much more favourable, all round, than they were in 1897, but our prospects of witnessing a really brilliant return appear to be somewhat slender. No doubt, on the morning of November 15, meteors will appear in sufficient abundance to gratify moderate expectation, but the conditions scarcely warrant the influence that we are to have a grand display. We must wait until 1899 or 1900 to see the shower at its best. In 1832 it is true Dawes saw many astonishingly fine meteors; and well he might, for the parent comet of the Leonids was very near that section of the orbit which the earth intersected in the year named. In 1865 we passed through a region of the stream some way in advance of the comet, for the latter arrived at its descending node about two months after the earth had crossed the point. There was nothing deserving the title of a great meteoric shower on that occasion. But there was certainly an unusual number of fine shooting-stars, the majority of the objects observed being as bright as, or brighter than, stars of the first magnitude. At Greenwich it was estimated that more than 1000 meteors must have been visible on the morning of November 13. Mr. Knott, observing at Cuckfield in Sussex, estimated the number as more than one per minute for two observers. According to some other accounts the richness of the display far exceeded this, for a captain of a British ship, near the West Indies, wrote to say that the heavens were in a blaze with shooting-stars from 8 p.m. on November 12 to 5 next morning. But accounts of the latter description are often exaggerated, and it is always unsafe to draw any definite conclusions from them.

At the approaching return the earth crosses the meteoric orbit still further in front of the comet than it did in 1865. In fact the comet will have five or six months' journey to run at its highest rate of speed before it reaches its descending node. This is not allowing for any perturbations which the comet has experienced since 1866, and there is no doubt that some serious disturbances have been introduced, particularly, by Saturn and Jupiter.

It seems that in July 1895, the comet approached to within 45 millions of miles of Saturn, and though the former has not passed so near as this to Jupiter, both planets have exercised a very appreciable influence both on the comet and its associated meteoric stream. Dr. Berberich gives these conclusions in an important paper published in *Ast. Nach.*, 3526, and states as a result of his investigation that the meteor shower will appear 21 hours late in 1898 and 26 hours behind time in 1899. The comet of Tempel (1866 I.) is not, according to Dr. Berberich, likely to be observed at the ensuing return to perihelion, as it will present itself under unfavourable conditions. Dr. Berberich's results are interesting as showing the necessity for expecting the meteors on the mornings of the 15th and 16th, rather than on earlier dates. His conclusions seem strengthened by the fact that last year a pretty strong shower of Leonids was witnessed just before sunrise on the morning of the 15th, whereas very few were seen on the previous morning.

Under all the circumstances a very rich shower can hardly be expected. Our historical records do not warrant the assumption that the section of the orbit in the van of the comet is thickly strewn with meteoric particles. In the comet's wake, for an enormous distance, the material appears to be densely distributed. This was sufficiently attested by the succession of three brilliant displays of 1866, 1867 and 1868.

Meteoric and cometary phenomena are, however, somewhat unstable in character, and certainly variable in their manifestations. They are quite capable of giving surprises. More meteors may now precede the cometary nucleus than the number there a generation ago, though the period is a comparatively short one, and comprises only one revolution of the swarm. There is one highly favouring circumstance this year, and that is the absence of moonlight. If the atmosphere is also free from cloud, the nights following the 14th and 15th will afford a splendid opportunity both for the visual observer and the photographic manipulator. I believe the night of the 14th will turn out the most productive, and especially the latter part of it forming the few hours before sunrise on the 15th.

Ordinary observers, while watching the meteors, will be usefully employed in determining, as accurately as possible, the time when the maximum in point of numbers is reached. The meteors should be counted at short intervals, and the horary rates of apparition during the night ascertained. The position of the radiant point is already well known; a mean of seventy values places it at R.A. 149° 28′, Dec. 22° 52′+, so that it is centrally within the curve of the "Sickle" of Leo, and close to the star *x* Leonis (Mag. 5·7) of Bode or Piazzi IX. 230.

It is especially to be hoped that attempts to obtain determinations of the radiant point by photography will be successful. The want of success in previous efforts has been very disappointing. Thus Mr. W. H. Pickering writes in *Popular Astronomy*, that on November 13, 1897, though he exposed eighty-one plates, only two meteor trails were secured. No doubt there are difficulties to be overcome; but as soon as the photographic method can be successfully utilised on a great meteoric shower, and a sufficient number of trails obtained to indicate a really good radiant, the visual method will have to be abandoned in its favour. It will be a long time hence, if ever, that the photographic plate will supersede the eye in ordinary meteoric observation; but in the case of a display such as the Leonids can furnish, the new method seems to promise well as regards the great accuracy of its records, though hitherto the latter have been exceedingly meagre.

W. F. DENNING.

MR. LATIMER CLARK, F.R.S.

ON Sunday, October 30, Mr. Latimer Clark, F.R.S., died very suddenly at his residence at Kensington, in his seventy-sixth year. His loss will be keenly felt by the various learned societies of which he was a member; especially by the Institution of Electrical Engineers, who claimed him as a founder and past-president. The name of Latimer Clark is familiar to all who during the past half-century have watched the various phases of progress in the science and practice of electrical engineering. Submarine cable engineers associate it with inventions that relate to every branch of their profession, from the process of sheathing the "core," to the last refinements of testing; and the constructors of land-lines still recognise the "Latimer Clark" double-bell insulator as a type universally accepted. His book, written in conjunction with the late Robert Sabine, on "Electrical Tables and Formulae," is to be found in every electrician's library, and in every cable-factory and telegraph testing-station in the world; his "approximate method" of fault-testing on submarine cables, by applying two successive potential differences, was an important step in the development of the modern empirical but nevertheless remarkably exact system of testing by two applications of different battery power; and his test of the electrical condition of "joints" in cable core is, under the name of "the accumulation method," still in daily use at cable works and on board ship. Another of his valuable contributions to telegraph progress is his study of the errors due to the inductive action of a galvanometer-needle upon its own coil when using shunts of different values, in a series of comparative "discharges." To this must be added his important modification of Poggendorff's method of comparing electro-motive forces, and the introduction, with this test, of the well-known potentiometer that bears his name. This instrument is perhaps associated in our minds rather with the laboratory than with the cable-testing room; and, moreover, it is here in the physical laboratory that we discover what is undoubtedly the best-known of Mr. Latimer Clark's inventions: the zinc-mercury standard cell. The vast amount of work that has been done, the modifications suggested, and the pages written in regard to this small apparatus, might well lead the uninitiated to suppose that it contains some potent *talia azman* to which electricians are for ever looking for revelation and mysteries. It happens to be merely the electricians' practical standard of potential-difference; but to those who care to study such things, it is still full of the mystery of the origin and meaning of contact electro-motive force.

The written and legendary history of the early days of electric telegraphs, over land and under sea, shows how closely Mr. Latimer Clark was associated with this work, both at home and abroad. Success did not always reward the efforts of the telegraph engineer, even in those times; for although commercial competition did not then exist to its present extent, there were all the difficulties of inexperience to be fought against. Success as regards the technical details of construction and working, came sooner than financial success. Estimating the cost of land-lines was beset with the almost insurmountable difficulties of transport and commissariat in countries savage and unexplored. Mr. Latimer Clark, in those pioneer days, was one upon whom the brunt of these reverses at first fell somewhat heavily. All honour to him and to his comrades; they fought for the greatest achievement in the world's history.

R. A.

THE TREASURERSHIP OF THE ROYAL SOCIETY.

IN the list of the proposed Council of the Royal Society for the ensuing year will be noticed a change in the Treasurership. Sir John Evans, K.C.B., retires, and the Council proposes to replace him by Mr. Kempe. Concerning this proposal the following letter has appeared in the *Times*:—

Sir,—The list of officers of the Royal Society proposed for election at the general meeting at the end of this month, published in the *Times* of Friday last, will not surprise any Fellow who is acquainted with the inner history of the society during the past few years, but in the change of *personnel* of the treasurership suggested it will astonish the great body of Fellows and may well arouse misgiving, if not anxiety, in the mind of the public—misgiving not to be lessened by the veiled *communiqué*, intended, apparently, to allay apprehension, which appeared in a certain section of the London press on Saturday.

The treasurer of the society is, like the two secretaries, a permanent officer, and these three officers have, therefore, a dominant influence in the affairs of the society, the treasurer having place by custom, at any rate next to the president.

Outside the society, too, in those responsible relationships with the public which the position of the society, as representative of science, engenders these permanent officials have a voice, consultative or executive, for the society. The choice, then, of treasurer is a matter of immediate moment to a wider circle than the Fellows of the society, and the nomination to the office by the present officers and council may therefore be fairly submitted for criticism in the *Times*. It is an open secret that an influential protest failed to arrest it.

Assuredly the roll of the society furnishes in abundance names of Fellows well tried in its work and veterans in the cause of science from which, as heretofore, a selection of treasurer could be made which would not only safeguard the interests of the society but also be a guarantee to the public that the best blood of the society was being devoted to the services it justly claims. Why, then, should choice fall, as it has fallen, upon a comparatively junior Fellow who, whatever his scientific merit, is unknown as a leader in science? Is there no room at present for another planet in the official firmament? Whatever be the cause, a large number of Fellows view with dismay this departure from the wise tradition which required pre-eminence amongst the eminent in science as the passport to the position of officer in the Royal Society, and to many the nomination, if it be confirmed, will appear a damaging blow to the society's prestige.

It may be that notwithstanding the protest referred to those responsible for the nomination do not realise its full significance and the feeling it has stirred. If this be as strong as it appears there is provided by the constitution of the society at the general meeting on the 30th an opportunity for its expression.

I am, &c., F.R.S.

It may be remarked that on looking back into the history of the Society, we find the last four Treasurers to have been—

General Sabine	1850
Prof. W. A. Miller	1861
Dr. Spottiswoode	1870
Sir John Evans	1878

NOTES.

THE Royal Society's medals have this year been adjudicated as follows:—Copley Medal, Sir William Huggins, F.R.S.; Royal Medals, Rev. John Kerr, F.R.S., Mr. Walter Gardiner, F.R.S.; Rumford Medal, Prof. Oliver Lodge, F.R.S.; Davy Medal, Prof. Johannes Wislicenus, For. Mem. R.S.; Darwin Medal, Prof. Karl Pearson, F.R.S.

AT the anniversary meeting of the Royal Society on November 30, the following names will be recommended for election into the Council of the Society for the year 1899:—President: Lord Lister. Treasurer: Alfred Bray Kempe. Secretaries: Prof. Michael Foster, Prof. Arthur William Rücker. Foreign Secretary: Sir Edward Frankland, K.C.B. Other members of the Council: Prof. Thomas George Bonney, Captain Ettrick William Creak, R.N., Prof. Daniel John Cunningham, Prof. James Dewar, Prof. William Dobinson Halliburton, Prof. William Abbott Herdman, Victor A. H. Horsley, Joseph Larmor, Prof. Nevil Story Maskelyne, Sir Andrew Noble, K.C.B., Prof. Edward Bagnall Poulton, Dr. William James Russell, Prof. Arthur Schuster, Dr. Dukinfield Henry Scott, Dr. George Johnstone Stoney, Prof. Joseph John Thomson.

PROF. OSTWALD will give an address at University College, Gower Street, on Monday next, November 14, at 5 p.m., in the Chemical Theatre. Visitors are invited.

THE appointment of a Commission, consisting mainly of scientific experts, to report upon the plague in India, has already been referred to in these columns (vol. lviii. p. 626). We now learn that Dr. Thomas R. Fraser, F.R.S., Professor of Materia Medica and Clinical Medicine at Edinburgh University, has accepted the duty of president, and with him will be associated two other scientific experts, Dr. Wright, Professor of Pathology at the Army Medical School, Netley, and Dr. Rüffer, who has been for some time head of the Egyptian Sanitary Department at Cairo. Two officers of the Indian Civil Service, Mr. J. P. Hewett, and Mr. A. Cumine, both of whom have had much to do with recent plague affairs in India, have also been appointed to the Commission by the Government of India. The scope of the Commissioners' inquiries will include (1) the origin of the different outbreaks of plague; (2) the manner in which the disease is communicated; (3) the effects of certain prophylactic and curvative serums that have been tried or recommended for the disease. The members of the Commission will reach Bombay towards the end of the present month.

MR. CECIL B. CRAMPTON, of the University of Edinburgh, has been appointed to the position of assistant-keeper in the geological department of the Manchester Museum, Owens College, in succession to Mr. Herbert Bolton.

AT the anniversary meeting of the Mineralogical Society, to be held on Tuesday next, November 15, the election of officers and Council will take place. Prof. A. H. Church, F.R.S., has been nominated president, and Prof. G. D. Liveing, F.R.S., and Dr. Hugo Müller, F.R.S., vice-presidents.

WITH reference to Dr. Calmette's gift of 10,000*l*. to the Pasteur Institute at Lille, mentioned last week, the *British Medical Journal* states that, according to the terms of the deed of gift, the money is to be applied provisionally to the defraying of building expenses till the Municipal Council is in a position to vote the sums required for that purpose. The money is then to be employed in the purchase of material for new researches, or for the maintenance of young men of science who wish to make original researches in the laboratory. Dr. Calmette states that the money which he has thus generously bestowed, represents the profits accruing to him from the application of one of his discoveries in a large distillery at Seclin.

THE new session of the Royal Geographical Society will commence on Monday next, November 14, when addresses upon the subject of a British Antarctic expedition will be given by the President and others. At a meeting on November 28, Mr. C. W. Andrews will give an account of a year's work on Christmas Island. Other papers which are announced are the following:—"Exploration in the Caroline Islands," by F. W. Christian; "Lake Rukwa and Central Africa," by L. A. Wallace; "In Search of Mount Hooker and Mount Brown in the Canadian Rockies," by Dr. Norman Collie, F.R.S.; "Oceans and Continents," by Dr. J. W. Gregory; "Atlantic Highlands of the United States," by Prof. W. M. Davis; "Exploration in Sokotra," by Dr. H. O. Forbes.

DR. H. C. SORBY, F.R.S., who last year completed fifty years' connection with the Sheffield Literary and Philosophical Society, during which period he on several occasions filled the presidential chair, has just received a gratifying testimony of the esteem in which he is held locally as well as in the broad world of science. His admirers have had his portrait painted, and presented it to him with an illuminated address on Tuesday in last week. The portrait represents Dr. Sorby seated, and in his scarlet academic gown. The inscription at the foot of the frame is as follows:—"H. Clifton Sorby, LL.D., F.R.S. (1847–1897). This portrait was painted to celebrate Dr. Sorby's fifty years' connection with the Sheffield Literary and Philosophical Society, and to commemorate his world-wide scientific reputation. Funds for the purpose were provided by subscription amongst the proprietors and members of the Society. The artist was Mrs. M. L. Waller, and the presentation was made on behalf of the subscribers by the Lord Mayor of Sheffield on November 1, 1898."

THE first meeting of the new session of the Society of Arts will be held on Wednesday next, November 16, when an address will be delivered by Sir John Wolfe Barry, K.C.B., F.R.S., Chairman of the Council. Among the subjects of papers to be read before Christmas are: "Long Distance Transmission of Electric Power," by Prof. George Forbes, F.R.S.; "Photographic Developers and Development," by Mr. C. H. Bothamley. The papers for meetings after Christmas include: "Tuberculosis in Animals," by Mr. W. Hunting; "Canals and Inland Navigation in the United Kingdom," by Mr. L. F. Vernon-Harcourt; "Preservation of Timber," by Mr. S. B. Boulton; "Electric Traction and its Application to

Railway Work," by Mr. Philip Dawson; "Coal Supplies," by Mr. T. Forster Brown; "Wireless Telegraphy," by Mr. W. H. Preece, C.B., F.R.S.; "Leadless Glazes," by Mr. Wilton P. Rix. The following courses of Cantor lectures will be delivered: "Acetylene," by Prof. Vivian B. Lewes; "Bacterial Purification of Sewage," by Dr. Samuel Rideal; "Cycle Construction and Design," by Mr. Archibald Sharp; "Leather Manufacture," by Prof. Henry R. Procter.

WRITING in the *Chemical News* "On the supposed new gas, Etherion," described by Mr. Charles F. Brush at the recent Boston meeting of the American Association, Sir William Crookes concludes as follows:—"On the evidence at present available, I consider it more probable that etherion is water vapour than that it is a new elementary gas, and this is corroborated by the observations made by Mr. Brush, that etherion is absorbed by phosphoric acid and soda-lime, as well as by the powdered glass from which it has previously been driven off by heat."

MR. JOHN S. BUDGETT, who accompanied Mr. Graham Kerr in his recent successful expedition to Paraguay, has left England, under instructions of the Zoological Society, for a winter visit to the Gambia, in order to obtain information concerning the Antelopes and other larger mammals of that Colony. Mr. Budgett will also make a collection of the fishes of the River Gambia, concerning which little is at present known, and of the other zoological products of the district.

THE expedition of Mr. Harrington and Dr. Hunt, of Columbia University, New York, to Egypt, referred to last week, resulted in bringing back an admirable collection of Nile fishes, and other zoological materials, but was not successful in its chief object, which was to obtain a set of the embryonic stages of *Polypterus*. Although these naturalists remained in the Delta until August 30, and adult specimens of this fish were obtained as late as that date, the eggs were still immature; so that the important question of the nature of development of *Polypterus* still awaits investigation.

MR. STANLEY S. FLOWER, lately curator of the Royal Museum, Bangkok, has been appointed director of the Zoological Gardens at Gizeh, Cairo, and has arrived there from Siam to take up his appointment. Mr. Flower, on his voyage westward, brought with him, as a present to the Zoological Society of London, a young Siamang (*Hylobates syndactylus*), which is believed to be the first specimen of this rare ape that has ever reached Europe alive. In 1830 the late Dr. George Bennett started from Singapore, with a living Siamang, which he intended to bring to the Society, but it unfortunately died on its way home.

A NEW Natural History Museum was opened at King Williams Town, Cape Colony, on October 5. At the conversazione, subsequently held, an address was given by Mr. W. L. Sclater, director of the South African Museum, Capetown. Mr. Sclater, after speaking of museums in general and their origin, gave an account of their introduction into South Africa in 1856 by the foundation, under the governorship of the late Sir George Grey, of the South African Museum at Capetown. Not long afterwards the Albany Museum at Grahamstown was instituted with the object of illustrating the natural products of the eastern provinces of the Colony. There are also museums in South Africa at Port Elizabeth, Bloemfontein, Pretoria, Maritzburg and Durban.

MANY students of science will regret to see the announcement that *Science Progress* comes to an end with the number just published. The valuable character of the contributions which have appeared in that magazine since the first number was published in March 1894, are well known in the scientific world; and it is a little disappointing to the publishers to have to confess that there is not sufficient demand for such literature to justify them in continuing to issue it. It is to be regretted that a periodical of this kind, containing articles which assist the advance of scientific knowledge, should have to cease for want of financial support.

CAPTAIN J. W. MAXWELL CARROLL has sent to the *Geographical Journal* (November) a few interesting particulars with reference to ancient stone circles discovered by him in the neighbourhood of Lamin Koto, on the right bank of the Upper Gambia. The stones are in very good preservation, and are regarded with respect by the natives. Prayers are offered in their vicinity on feast days during Ramadan by the Almame, or high priest. The diameter of the circle of stones is eighteen feet, and the stone at which the priest stands is a few feet to the east of the circle. Stone circles were also found by Captain Carroll at Chamen and Palellan. At the latter place a large rectangular stone, twelve feet by four, was discovered. Its height was six feet at one end and four at the other, and its shape suggested that it had been used as a sacrificial altar.

IN the *Zeitschrift der Gesellschaft für Erdkunde* we notice, besides minor articles, an account by Dr. C. Lauterbach of the geographical results of the expedition to Kaiser Wilhelm's Land, and a paper, by Dr. Meinardus, on the relation between the winter climates of central and north-western Europe and the waters of the North Atlantic. The latter is an extension of the author's recent paper in the *Meteorologische Zeitschrift*, discussing the observations of Pettersson and Dickson as a possible basis for long-period weather forecasting.

IN our issue of September 29 last, we very briefly referred to Dr. Köppen's chart of yearly isotherms and isabnormals of the sea surface. This chart, together with a discussion of its chief features, is reproduced in *Globus* of the 15th ult. The chart shows, in addition to the isotherms, those districts where a temperature anomaly of more than 2° C. exists; the areas where the water is too cold are shaded blue, and those which are too warm are shaded red, while the districts which are thermically neutral are left unshaded. It is seen that between latitude 0° and 40° S., cold currents extend like long tongues from the west coast of South Africa and South America towards the west, while to the north of the equator analogous currents are developed to a much less extent; on the coast of the Sahara the sea-temperature is only slightly below the normal value of the latitude. On the western sides of the oceans, in similar latitudes, there exist warm currents trending northwards. In the South Atlantic the warm and cold currents are nearly equalised. In the South Pacific, the cold current, and in the South Indian Ocean, the warm current, preponderates. This latter feature especially occurs in the northern hemisphere, and more particularly so in the North Atlantic. It is also seen that an area of cold water occurs on the western edge of the warm currents, and between them and the continents, where the latter stretch northwards as far as the zone of westerly winds, viz. on the east coasts of Asia, North and South America. There are many other points of interest, to which we are unable to allude at present.

THE Deutsche Seewarte has recently published its twentieth annual report, for the year 1897. The death of Captain Seemann, on September 24 of that year, has been a great loss to the department, as he had for a long time devoted himself to the study and practice of weather telegraphy. A conference of the heads of German meteorological institutions was held at the Seewarte in October 1897, at which special attention was given to the organisation of the meteorological service; a report of the proceedings has been published. During the year, 283 merchant ships were supplied with registers, and 794 logs were received; the majority of the observations were made in the North Atlantic, but the other oceans are also fairly represented. The observations for the North Atlantic are chiefly utilised in the preparation and publication of results for one-degree squares and of daily synoptic weather charts, both of which works we have already noticed. The Seewarte undertakes the verification of a large number of instruments; it also publishes the results of scientific investigations in the work entitled *Aus dem Archiv der Deutschen Seewarte*. This valuable publication has also already been referred to in our columns. The collection of observations from distant stations is a useful addition to the various other labours of the institution, but the publication of the results has been temporarily retarded by pressure of other work.

PROBLEMS on the deformation of an elastic ellipsoid are known to require for their complete solution functions in working with which a fairly good mathematician may easily go out of his depth. MM. Eugène and François Cosserat, however, send us a note, reprinted from the *Comptes rendus*, in which they show that the particular solutions corresponding to harmonics of the second and third orders, assume comparatively simple forms.

A HIGHLY interesting note by Prof. B. Grassi, on the connection between mosquitoes and malaria, appears in the *Atti dei Lincei*, vii. 7. The theory that these insects disseminate the germs of malaria by their punctures, seems to have been first brought into notice by Laveran; but Dr. Grassi for a long time had doubts on the subject, owing to the absence of malaria from certain districts where mosquitoes abound; Schwetzingen, in Germany, being a notable instance. A careful classification of the various species of gnat found in different districts has now led him to the conclusion that, while certain kinds are not confined to malarious regions, the distribution of others coincides very closely with the distribution of the disease. The common *Culex pipiens* is to be regarded as perfectly innocuous; being most abundant in places from which malaria is absent. On the other hand, a large species (*Anopheles claviger*, Fabr.), known in Italy as "zanzarone," or "moschino," is constantly found associated with malaria, and is most abundant where the disease is most prevalent. In illustration of this fact Dr. Grassi enumerates a number of striking coincidences in which both gnats and the disease are confined to the same limited and well-defined regions. Another disseminator of malaria is *Culex penicillaris*, and the author gives authentic instances in which recorded punctures of this gnat have been followed by febrile symptoms. Certain other species of *Anopheles* are confined to the marshy regions where malaria rages, and two or three additional species of *Culex* are suspected, but on less conclusive evidence. The fact is mentioned that *Anopheles claviger* confines its attacks chiefly to the evening after sunset, and in this circumstance the old superstition that it is dangerous to fall asleep in malarious regions just after sunset, finds a ready explanation. These facts open up new hopes that it may be possible to stamp out malaria by taking proper steps for the destruction of mosquito larvae in districts where dangerous species abound.

THE annual report for 1896-97 on British New Guinea (*c*-9046-5) contains only a few notes of interest to science. The reports of visits of inspection are not so full as in previous years, and there are the ominous footnotes "not printed" relating to several documents of interest. The natives of the lower villages of the Mambare River are very untrustworthy. It was during the visit to this district that the inspectors "for the first time learned how the natives make the hole for the reception of the wooden handle in stone clubs. It is chipped out by means of a small stone about the size and nearly of the shape of a rifle bullet." On the crossing of the Chirima they were visited by about one hundred natives from the village of Neneba. They are the only tribe that actually live on a spur of Mount Scratchley. They are somewhat darker in tint than the coast people, but distinctly lighter than the average Fly River man. They are of fair size and wiry in build. No wavy-haired native was seen in that part of the country, and young men wear the eyebrows, while the elders have whiskers. The features are good and not irregular. The men wear the T-bandage, and the women, in addition to this, wear a petticoat and a mantle. The chief ornaments are earrings made of lizards' tails, and cigarette-holders carried in the lobe of the ear. They had the bow and arrow, and stone clubs, but, like many other bow and arrow tribes, they have no pottery. The floors of their houses are six or eight feet above the ground. At the village of Gosisi, on the Vanapa, the natives did not appear to know of any place or people on the other side of the Owen Stanley range. The men of these tribes have remarkable physical proportions and strength.

AN interesting pamphlet upon the temperance question, from the pen of Dr. Archdall Reid, has just reached us. It is entitled "The Temperance Question from a Biological Standpoint." The author bases his theories and conclusions upon Weissmanism, viz. upon the assumption that inborn or congenital characters alone are transmitted to the offspring, acquired characters not being transmitted. Man is still undergoing evolution at the present day, and this, according to the author, mostly consists in the acquisition by him of immunity against disease or the effect of powerful drugs, including harmful narcotics. Alcohol is a harmful narcotic; from this it follows that one of the directions which the evolution of man is taking at the present day is the acquisition of immunity against alcohol, and this takes the special form of a diminution of the "normal" craving for alcohol. According to Dr. Reid the longer a race has had alcohol, and the easier and more abundant its supply, the more sober it is. For instance, the grape-growing southern Europeans are at the present time more sober than the races of northern Europe, where alcohol is more difficult to obtain, although formerly they were quite as drunken. They have become now immune to alcohol. The method by which this immunity has come about is naturally, from the point of view of the temperance reformer, of the utmost importance. Since, if it could only be imitated successfully, the temperance question would be solved. According to Dr. Reid this diminution of the craving for alcohol has been produced by the action of natural selection working in the presence of an abundant supply of the harmful substance in question. Any cause which reduces the supply of alcohol, or in any way increases the difficulty of obtaining it, in that it hampers the action of natural selection, tends to perpetuate drunkenness rather than to produce temperance. This truly dreadful picture of the world, or rather all races not yet immune, becoming "thoroughly drunken before they can hope to become thoroughly sober," can, to some extent, be mitigated by artificial selection. The innate drunkard, when found out by letting everybody have free access to alcohol, must be treated as a lunatic, and above all not be allowed to procreate. By this means the alcohol tainted "germ plasm" will finally be eliminated, and the race will become immune to alcohol.

THE older entomologists used to complain that the *Lepidoptera* were a peculiarly difficult order to classify, owing to the want of any salient characters; but now that the details of their structure are more minutely studied, the difficulty is rather to decide on the importance to be attached to the structure of particular organs. Even the eggs are now taken into account in classification, and also the larvae in their various stages, for the earlier stages often possess characters of importance, throwing much light on the real affinities of the insects, which characters disappear in the half-grown or full-grown larva. The organs of the perfect insects are also receiving much attention from various entomologists who interest themselves in morphology; and two years ago Dr. Enzio Reuter, of Helsingfors, published an elaborate account of the structure of the palpi in butterflies; while in the last part of *Novitates Zoologicae*, the organ of the Tring Museum, Dr. K. Jordan has published a long and interesting article on the antennae of butterflies, dealing especially with the structure of the scales, sense-hairs, setiferous punctures and sense-bristles in the various families of butterflies, and, incidentally, in some moths. As is generally the case in such inquiries, "we learn that an antennal organ or structure is variable in one family, while it is relatively constant in other groups." We have not space to notice Dr. Jordan's remarks on the bearings of his inquiries on the phylogeny and classification of butterflies, for which we must refer our readers to the paper itself.

IN the same part of the *Novitates Zoologicae*, Dr. Jordan replies to some severe criticisms made by the late Prof. Eimer on the views put forward by the Hon. Walter Rothschild and Dr. Jordan on the classification of the *Papilionidae*. We cannot enter into the controversy; but may say that Dr. Jordan holds that Prof. Eimer was himself in error, owing to want of sufficient materials on which to base trustworthy conclusions.

MESSRS. OLIVER AND BOYD, Edinburgh, will, early in 1899, publish a book containing a biographical sketch of the late Mr. James Shaw, Tynron, and selections from his prolific writings on scientific, antiquarian, rural and literary subjects. Two hundred and fifty copies have already been subscribed for, and the material is now being prepared for press by Prof. Robert Wallace, University, Edinburgh, to whom all communications on the subject should be addressed.

A CONSIDERABLE space in the *Journal of Horticulture* for October is occupied by several papers on perfumes, by Mr. F. W. Burbidge. He gives a long list of perfumes and essential oils, and of the plants from which they are obtained, and a copious bibliography of the subject. A description and drawing is also given of the late Mr. A. Smee's apparatus contrived for condensing the perfume from fresh flowers; and reference is made to the antiseptic properties of perfumes, and to their remarkable power, as described by Prof. Tyndall, of absorbing heat from the atmosphere. The burning of perfumes or incense in churches, hospitals, &c., had undoubtedly originally a hygienic purpose. The Rev. G. Henslow gives a paper on the advantages to gardeners of a knowledge of vegetable physiology; and Mr. F. Enock one of his entertaining papers, very well illustrated, on insect blights and blessings. Mr. F. M. Bailey adds three new species of *Nepenthes* to the flora of Queensland, the pitchers of which are figured.

A VOLUME containing reports of experiments on the manuring of oats, hay, turnips, and potatoes, conducted in 1897 on farms in the south-west and centre of Scotland, under the direction of the agricultural department of the Glasgow and West of Scotland Technical College, has just been published.

THE following announcement is made in the *British Journal of Photography*:—"M. Berthiot, the well-known optician of Paris, has constructed a new 'satz' or casket of wide-angle lenses. It contains four single lenses; composed of three elements that have 24, 24, 31 and 39 cm. foci respectively, and can be used as single lenses, or combined they give 12, 16, 16 and 17·5 cm. foci lenses. On the authority of Dr. C. Fabre, the author of the well known *Traité Enclyclopédique de Photographie*, the doubtlets will include an angle of more than 100° without spherical aberration."

THE fourth volume of "Bibliotheca Geographica," edited by the Berlin Gesellschaft für Erdkunde, and prepared by Dr. Otto Baschin, has just appeared. It is a classified catalogue of geographical works published during 1895, the works being arranged alphabetically according to authors. The classification adopted is as follows:—A. General geography: (1) bibliography; (2) methods and instruction; (3) general publications; (4) historical geography; (5) mathematical and astronomical geography, cartography; (6) physical geography; (7) biological geography; (8) anthropo-geography; (9) hints for travellers and observers. B. Special geography: (1) voyages and travels in several continents; (2) Europe; (3) Asia; (4) Africa; (5) Australia and New Zealand; (6) Oceania; (7) America; (8) polar regions; (9) oceans and seas. The publisher of the bibliography is W. H. Kuhl, Berlin.

A USEFUL series of graduated arithmetical examples, worked in full by approved methods, makes up a little volume entitled "How to Work Arithmetic," by Mr. Leonard Norman, published at the Rugby Press. The models appear to have been carefully chosen, and should be of assistance in cultivating neatness of style and uniformity of method in large schools.—The use of sketches in teaching the first rules of arithmetic is shown in the "Picturesque Series" of arithmetical problems published by the National Publishing and Supply Association, Ltd., Reading, for Standards I. to III. of elementary schools. The same publishers issue a "Deductive Series of Arithmetical Problems," by Mr. T. Bowen, based on questions asked by inspectors of elementary schools, and with solutions of leading questions worked in full. We have also received from the National Publishing and Supply Association the second edition of "Quantitative Exercises for Beginners in Chemistry," Parts I. and II., by Mr. A. H. Mitchell. The books are adapted to the requirements of students under the Department of Science and Art in quantitative and qualitative analysis.—The third edition of a "Key to Algebraical Factors, and their application to various Processes in Algebra," by Mr. Dorabji H. Vachha, has been published by Messrs. Longmans, Green, and Co.

A SERIES of experiments on the connection between taste and chemical composition has been carried out by Dr. Kahlenberg, and described by him in the *Bulletin* of the University of Wisconsin. Thirteen persons between twenty and thirty years of age—three being women—a lady of sixty, and a gentleman of sixty-three, served as subjects. The subjects were abstainers from alcohol and tobacco, and were kept in ignorance of the composition of the liquids tasted. The results show that for a substance to affect the taste, it must be soluble in water readily diffusible and capable of reacting chemically with the protoplasm of the terminals of the nerves of taste. The taste of solutions is said to correspond to the modern theory of electrolytic dissociation. Thus a sour taste is attributed to hydrogen ions, which may be detected in a 1/800 normal solution, whilst alkaline taste is due to hydroxyl ions. Chlorine ions have a salty taste, and so in a less degree have bromine and iodine ions. The variation of intensity of taste with atomic weight, here indicated, is said to be observed with positive ions.

THE current number of the *Berichte* contains an account of the re-determination of the density of ozone by Prof. Ladenburg. The ozone was prepared as pure as possible by cooling ozonised oxygen in a tube surrounded by liquid air. Of the 22 cc. of liquid thus obtained, nine-tenths were allowed to evaporate in order to remove the liquid oxygen. In this way 2 to 3 cc. of a blue-black opaque liquid were obtained, and with the gas produced by its evaporation two experiments were made, one to determine the density, the other to determine the percentage of ozone. The density was determined by measuring the velocity of effusion, water being used instead of mercury as the trapping liquid. The amount of ozone in the gas was determined by means of potassium iodide and sodium thiosulphate. The results gave for ozone a density of 1·456 as compared with 1 for oxygen; the theoretical number being, of course, 1·5. The agreement, considering the difficulty of the experiments, is quite satisfactory. In the course of the observations Prof. Ladenburg found that water at ordinary temperatures and pressures does not dissolve more than one-hundredth of its volume of ozone. In attempting to determine the boiling point of liquid ozone it appeared that this point lay at $-125°$ C., but as soon as the boiling commenced the liquid exploded with great violence and reduced the whole apparatus to powder.

The additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval*) from Africa, a Black-footed Penguin (*Spheniscus demersus*) from South Africa, presented by Mr. H. S. H. Cavendish; two Black-backed Jackals (*Canis mesomelas*) from South Africa, presented by Lady De Trafford; a South Albemarle Tortoise (*Testudo vicina*) from South Albemarle Island, Galapagos Group, presented by Captain E. S. Tindall; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, a Garnett's Galago (*Galago garnetti*) from East Africa, a —— Kangaroo (*Dorcopsis*, sp. inc.) from New Guinea, an Orange-winged Amazon (*Chrysotis amazonica*) from South America, deposited; two Spur-winged Geese (*Plectropterus gambensis*), two —— Fruit Pigeons (*Phalacrotreron abyssinica*) from West Africa, two Bar-tailed Godwits (*Limosa lapponica*), European, purchased; a Bennett's Wallaby (*Macropus bennetti*), two Squirrel-like Phalangers (*Petaurus sciureus*), born in the Gardens; six Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

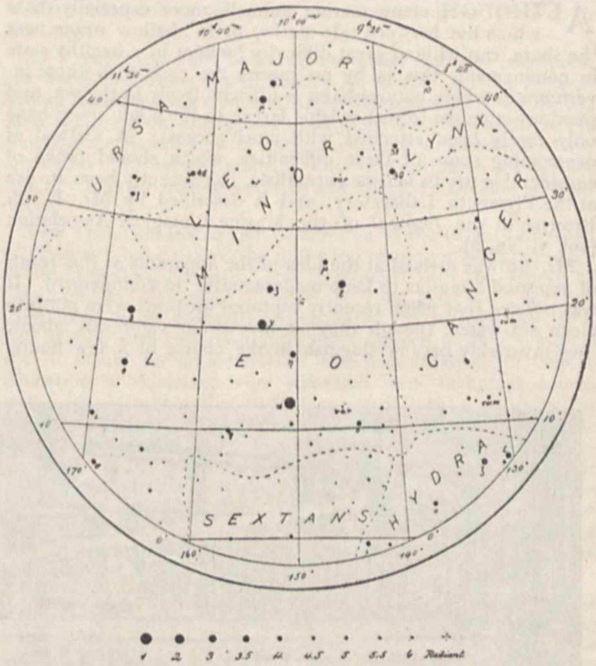
The Leonids.—During the present week, if we are favoured with fine weather, the Leonid swarm or swarms of meteorites should be very conspicuous, assuming they have not decreased very considerably in number since the year 1865. That a great number of observers will be on the watch for them, there is little doubt, and photography will most probably be extensively used for obtaining records in addition to the naked eye. It may be well here to sum up some of the important features which must be noted when observing these moving strangers, and we cannot do better than enumerate those given by Mr. Denning in his interesting article (*Observatory*, 1897) on this great meteor swarm. Thus, the observer should record the exact time of maximum abundance, the number of meteors per minute, the position of the centre of radiation, the area of this radiant if diffuse, and the duration of the shower's chief activity. Further, their relative magnitudes, duration of their visible flights, colours, and the apparent paths of the brighter meteors should be noted. Many other peculiarities which the observer may remark, such as shape of nuclei and apparent diameters of bolides (if there be any), description of curved paths, broken streaks, and duration of streaks with direction of their drift, should be accurately recorded. A convenient form of table for entering such data could be made with the following headlines:—Date, Greenwich Mean Time, Magnitude, Observed path (from R.A., Dec. to R.A., Dec.), Length of trail, and Notes.

It will be of interest to inquire whether the shower is divided into three parts, as Mr. Marsh has suggested. The following is the predicted times for these groups when they will be centrally passed by the earth:—

	Preceding.	h.	Central.	h.	Following.	h.
1897 ...	Nov. 13	9·25	Nov. 14	0	Nov. 14	15
1898 ...	,,	15·75	,,	6·5	,,	21·5
1899 ..	,,	22·25	,,	13	,,	4

As there will be practically no moon to interfere with the observations this year, every opportunity ought to be taken to obtain a good record. Next year at the same period the moon will be nearly full and visible the whole night, and this will undoubtedly interfere with observations, in spite of the fact that the number of meteors reaches its maximum.

The accompanying chart, which is a reproduction of that published by Prof. W. H. Pickering in his account of the last year's observations at Harvard, shows the position of the radiant point in Leo and the neighbouring constellations.



Further information concerning the probable appearance of this swarm of meteors will be found in the interesting article contributed by our well-known authority on this subject, Mr. Denning, in the present issue.

Comet Brooks.—This comet is rapidly decreasing its declination and becoming fainter. The following ephemeris is based on the elements of Ristenpart and Muller.

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Br.
Nov. 11	17 53 1	+ 7 39·6	0·6
13	17 57 14	4 50·4	
15	18 0 56	+ 2 16·3	0·5

The comet is still in the constellation of Ophiuchus, and on the 15th will lie in the prolongation of a line joining κ and β Ophiuchi at a distance from β of about one-third of that between these stars.

Stars with Great Velocities in the Line of Sight.—Prof. W. W. Campbell, who is making spectrographic determinations of stellar motions, has found evidences of large velocities in several of the stars he has examined. η Cephei is one of the stars he mentions (*Astrophysical Journal*, vol. viii. No. 3), and the mean velocity deduced on five different occasions from a discussion of 136 lines in the spectra amounts to $-86·8$ kilometres per second; this when corrected for solar motion reduces to $-74·1$ kilometres per second. The results of Belopolsky for the brighter component of ζ Herculis (*Astr. Nachr.*, vol. 133, p 257–262) have also been corroborated, the corrected velocity amounting to $-53·9$ kilometres per second. It may be remembered that Prof. Keeler found for the planetary nebula G.C. 4373 as a result from six nights of measurement, a velocity of $-64·7$ kilometres per second.

η Pegasi seems to have a very variable velocity, the extreme range observed amounting to 23 kilometres per second. The velocities that Prof. Campbell has obtained up to the present time are:—

	km.		km.
1896 Aug. 27	+ 7·1	1898 Aug. 29	+ 16·5
Sept. 23	+ 5·1	Aug. 30	+ 15·6
1897 July 8	− 6·4	Sept. 4	+ 16·5
Sept. 28	− 2·2		

We are evidently here dealing with a period somewhere about two years in length. Prof. Campbell hopes that if other observers have secured measurements of this star, they will communicate their results to assist him in determining the period.

ON KEEPING MEDUSAE AND OTHER FREE-SWIMMING MARINE ANIMALS ALIVE IN SMALL AQUARIA.

ALTHOUGH many marine animals, more especially those which live between tide-marks, or in shallow water near the shore, can without great difficulty be kept in a healthy state in confinement, this is by no means the case with those invertebrates whose natural habit is to swim freely in the sea, and previous attempts to rear pelagic larvae to the adult stage have only rarely been attended with much success. A method of overcoming some of these difficulties, which should prove of considerable use to marine naturalists, has recently been in use at the Plymouth Laboratory, and is described by Mr. E. T. Browne in the *Journal* of the Marine Biological Association (vol. v. No. 2).

Mr. Browne arrived at the idea of the apparatus as the result of repeated attempts to keep medusae alive in confinement. It was noticed that when recently captured medusae were put into clean sea-water, though they at first swam vigorously about, hey invariably became sluggish in the course of a few hours, even if the water were constantly changed, settled to the bottom and finally died. When watching medusae in the sea it was observed that they simply float along with the tide without often pulsating the umbrella. It was therefore thought that if a movement in the water of an aquarium could be obtained, which would keep the medusae constantly floating about independently of their own pulsation, better results might be obtained; and this has proved to be the case. A suitable movement of the water can be conveniently brought about by means of a glass plate made to rise and fall slowly through the water.

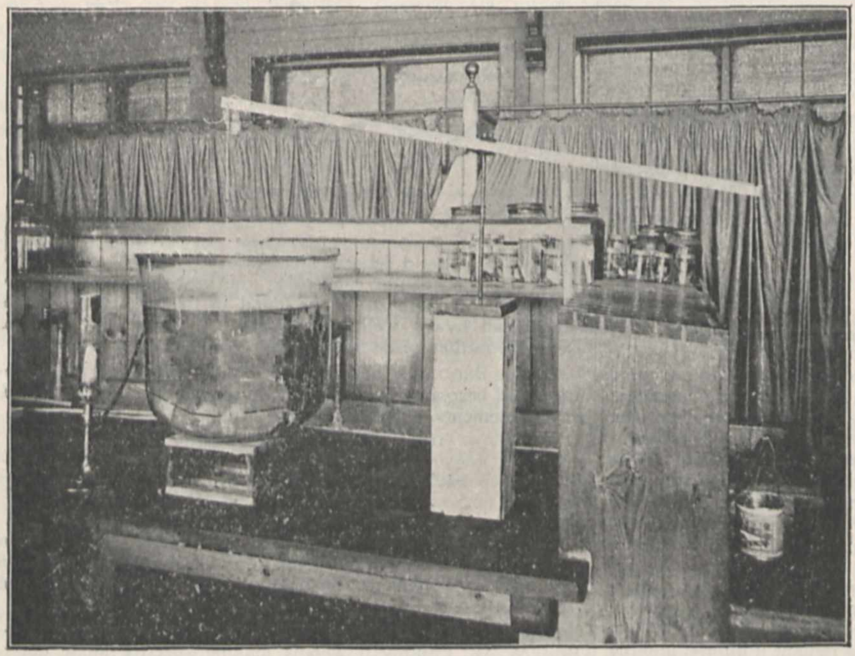


FIG. 1.—Bell-jar with glass plunger.

A motion of this kind can be arranged in many different ways, the apparatus, illustrated in Fig. 1, being the form originally designed by Mr. Browne in conjunction with the Director of the Plymouth Laboratory, which has now been continuously working for a year. The sea-water, obtained from the open sea at some distance from shore, is contained in a glass bell-jar of about 10 gallons capacity, provided with a wooden cover made in two halves. A glass plate is suspended in the water by means of a glass rod passing through a hole in its centre, the other end of the rod being attached to one end of a light wooden beam. This beam works on a hinge at the centre, and from its other end a small tin bucket is hung. The bucket is fitted with a self-emptying siphon, and is supplied with a slight stream of water by means of a rubber tube attached to the fresh-water supply. The weights of the bucket and glass plate are so adjusted that the plate moves up and down in the sea-water as the bucket alternately fills and empties. Extra weight is added when required by placing shot in a small bottle hung at one end of the beam. In this way a delicate adjustment can be made, and the plate caused to travel as slowly as is desired. The length of the stroke is regulated by two stops, and a slit in the cover of the bell-jar, through which the glass rod passes, prevents the plate from striking the sides of the jar.

Arrangements have since been made in the laboratory, by which a large number of glass plates, or "plungers" as they have been named, can be worked in a similar way. A modified form of the apparatus, in which the glass plate is replaced by a glass funnel with a small hole in its top, has also been used with advantage. The funnel is fixed so that it is brought out of the wa er by the upward stroke of the plunger. At each downward stroke it carries with it a funnel-full of air, which escapes by way of the hole, and bubbles through the water.

Amongst the medusae which were successfully kept in the bell-jar were *Phialidium buskianum*, which grew and developed fresh tentacles, *Phialidium cymbaloideum*, which in twenty-five days added five new tentacles and five marginal bulbs, and a species of *Margelis*, which in seventeen days added two new tentacles in each of the four marginal groups, and the oral tentacles twice dichotomously divided. Two medusae of *Cladonema radiatum* were placed in the same bell-jar in the summer of 1897, and in the following spring several colonies of the hydroid of this species appeared. During the present summer (1898) these colonies have freely budded off medusae, several hundreds being seen in the bell-jar at one time.

Crustacean, annelid and molluscan larvae were put into the bell-jar from time to time (together with Copepods), as food for the medusae. Many of the larvae, which escaped capture by the medusae, continued to develop and attained the adult form. Amongst these were *Chaetopterus variopedatus* (the tube of an adult worm from an 1897 larva being about four inches long in June 1898), *Capitella capitata*, *Polynoe* sp., *Nika edulis*, *Portunus* sp., as well as small Gasteropods, Hermit-crabs, and Barnacles. Colonies o. hydroids were also found to flourish well when kept in similar aquaria and plentifully supplied with Copepods, which they capture and devour in large numbers. E. J. A.

PHYSICS AT THE AMERICAN ASSOCIATION.

THE Physics Section (Section B) of the American Association was organised with Vice-President Prof. F. P. Whitman in the chair. His vice-presidential address, on colour vision, printed in the issue of *Science* for September 9, was well received, and constitutes a valuable *résumé* of the subject.

The programme of the Section included titles of fifty papers, of which forty were read. Many of these papers were of a very high order, and almost every one of them was creditable and interesting. Brief abstracts of some of them are subjoined.

"A redetermination of the ampere," undertaken, under a grant from the Association, by Prof. G. W. Patterson and Mr. Karl E. Guthe, of Ann Arbor. This work, for which an accuracy of about one part in 8000 is claimed, gives 0·0011192 grammes for the electro-chemical equivalent of silver, and reconciles almost exactly the mechanical equivalent of heat as obtained by electrical methods with Prof. Rowland's corrected value. An electro-dynamometer of the Weber type was used for measuring current, and the torque due to the current was balanced by the torsion of a phosphor-bronze wire. This wire was standardised by studying its torsional vibrations in a vacuum when carrying a mass of known moment of inertia, and precautions were taken to eliminate the effects of elastic lag.

Experiments bearing upon the "velocity of light in a magnetic field," which were undertaken under a grant from the Association, were reported by Profs. E. V. Morby, H. T. Eddy and D. C. Miller. Their conclusion is that the velocity of light in carbon bisulphide is not altered by one part in a hundred million by a magnetic field of such an intensity as to turn the plane of polarisation through 180° in a path of 65 cm.

"A new gas" was described by Mr. Charles F. Brush. While searching for evidence of the absorption of hydrogen by glass, Mr. Brush discovered that pulverised glass gives off, when heated at a low pressure, a gas whose thermal conductivity at a pressure of a few millionths of an atmosphere is about a hundred times that of hydrogen. This gas was obtained from many other substances, and also by diffusing air through a porous porcelain plug. The kinetic theory indicates that the heat conductivity of a gas is proportional to the reciprocal of the square root of its density. Assuming this relation to hold, this new gas must have a molecular weight of only 0·0002, and a molecular velocity 100 times that of hydrogen.

"On the relative brightness of pigments by oblique vision," by Prof. F. P. Whitman. Prof. Whitman used the flicker photometer, and found that the brightness at the red end of the spectrum decreases as the vision becomes more oblique, while the opposite is true (but to a less extent) at the violet end. The brightness of yellow-green is nearly independent of the angle.

"A geometrical method for investigating diffraction by a circular aperture," by Prof. A. G. Webster. Prof. Webster plots the definite integral involved in this case, and obtains a curve similar to Cornu's spiral, but having cusps like a ratchet.

N. ERNEST DORSEY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The one hundred and ninety-second meeting of the Oxford University Junior Scientific Club was held on Wednesday, October 26. After private business, Prof. Sollas read a paper on "Funafuti; a study of a Coral Reef." Mr. E. Gurney (New College) then read a paper on "The Birds of the Westman Islands"; in this he also touched upon the characteristic beliefs of the Icelanders, who make their living by catching the birds.

The one hundred and ninety-third meeting of the Club was held on Friday, November 4. After private business, which included the election of twenty-three new members, Dr. Gustav Mann read his paper on "The Origin of Life." Mr. E. S. Goodrich (Merton) briefly explained a model, devised by an American painter, to illustrate the theory of protective coloration in birds, after which the meeting ended. The officers for this term are:—President, Mr. F. P. Nunneley (B.N.C.); Biological Secretary, Mr. E. Gurney (New College); Chemical Secretary, Mr. H. B. Hartley (Balliol); Treasurer, Mr. W. E. Blackall; Editor, Mr. H. E. Stapleton (St. John's); Committee, Mr. F. Soddy (Merton), Mr. A. Angel (Christ Church), Rev. G. D. Allen.

CAMBRIDGE.—At St. John's College, on November 7, the following graduates of the College were elected to fellowships: R. C. Maclaurin, twelfth wrangler 1895, first division of first class Mathematical Tripos, Part II. 1896, bracketed second Smith's Prizeman 1897, Macmahon Law Student 1898; V. H. Blackman, first class Natural Sciences Tripos 1894–95, Hutchinson Research Student 1897, botanical assistant in the British Museum.

At the biennial election of eight members of the Council of the Senate held on November 7, the following were the successful candidates: The Master of Christ's and the Master of Emmanuel, as heads of Colleges; Prof. Ewing, F.R.S., and Prof. Forsyth, F.R.S., as professors; and Dr. Donald MacAlister, Mr. R. T. Wright, Mr. F. Whitting, and Mr. A. W. W. Dale as members of the Senate.

MR. THOMAS REID, of Dundee, has been appointed to the post of Head Teacher of the Engineering Department of the Birmingham Municipal Technical School.

MR. SWALE VINCENT has been elected to the Sharpey Physiological Scholarship (150*l.* per annum) at University College, London. This scholarship carries with it the post of chief assistant in the Physiological Laboratory.—Mr. D. J. Armour has been appointed to the vacant demonstratorship in Anatomy.

AT a meeting of the Council of University College, Liverpool, last week, donations to the amount of 13,000*l.* for the Medical School Building fund from the Right Hon. the Earl of Derby, Mrs. George Holt and Miss Emma Holt, Mr. R. Brocklebank, and Mr. J. Rankine were announced, and a Committee was appointed to prepare plans. The Council hope for further contributions to enable them to put the work in hand without delay.

THE Technical Instruction Committee of the County Borough of Plymouth have passed the following resolution with reference to the Secondary Education Bill introduced into the House of Commons by Colonel Lockwood in June last:—"That this Committee, while generally approving of the introduction of a Bill dealing with this most important subject, is of opinion (1) that it would be prejudicial to the best interests of higher education if secondary were separated from technical education. (2) Also that the multiplication of local authorities for educational purposes is undesirable. (3) That the funds at the disposal of Technical Education Committees are already inadequate for the purposes to which they are assigned, and that it would be impossible to devote any part of the present income to aid secondary education. (4) That the funds which Parliament at present votes for the special encouragement of science and art ought not to be diverted to cover the whole field of secondary education.

THE Calendar for the eighteenth session (1898-9) of the University College, Nottingham, has been received. The College appears to offer every inducement to students to follow systematic courses of study. Day courses of instruction are specially arranged for boys who have just left school and intend to follow the engineering profession in one of its branches. The course of instruction in architecture has been arranged in conjunction with the Nottingham Architectural Society and the School of Art; and the commercial course has been arranged in conjunction with the Nottingham Chamber of Commerce. The associate course in chemistry requires work in the College practically the whole time for three sessions. All chemistry students are strongly advised to continue their studies during a fourth year, so that they may undertake some original investigation and work at the higher branches of the subject. The courses in technical and practical physics, engineering, natural sciences, and agriculture provide for thorough work in these subjects.

IN general (says the *New York Nation*) the Prussian Government, in deciding the salary of a teacher, makes the sum depend to a great extent on the personality and reputation of the individual. A special law regulates the inequality resulting from the difference in the lecture fees received by the various professors—these lecture fees in all the German universities being an income in addition to the regular salary—by decreeing that in Berlin the full professor can receive annually only one-half of these in case they exceed the sum of 4500 marks, and in the provinces 3000; the other half being taken by the State for the benefit of other teachers not blessed with large salaries or fees. In the Würtemberg University of Tübingen, a three-class system of normal salaries is in vogue for the full professors, based on the years of service. The minimum salary is 4030 marks. The assistant professor begins with 2020. A special fund of nearly 150,000 marks is at the disposal of the Government for special salaries in special cases. In the two universities of Baden, Heidelberg and Freiburg, the average salary of the ordinarius is 6955 marks, with additional sums in special cases. The assistant professors draw salaries varying from 1820 to 5220 marks. The Imperial University at Strassburg and the Saxon at Leipzig pay good salaries, but the sums are not mentioned; while the Hessian Institution at Giessen pays its full professors 4300, and its assistants or associates 3250, with an increase until after twenty-five years of service the maximum sums of 6300 and 5250 are reached. In Rostock, the smallest of the German universities, the salaries of the full professors run from 4500 to 5850 marks; the assistant professor begins with 2400. In Jena the lowest sums are paid, the full professors receiving 300 less than is paid even at Rostock.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, October.—The number opens with an account of the fifth summer meeting of the Society, which was held at the Massachusetts Institute of Technology, Boston. As on former occasions, the Society was affiliated with Section A of the American Association for the Advancement of Science. There was a large attendance of members, and at the three sessions which were held twenty-five papers were communicated. Short abstracts of papers by Messrs. Blake, Chessin, Lovett, Baker, Hall, Moore, Conant, Boyd, Stecker, Dickson, Stabler and Martin are given. The journals in which these papers will appear are indicated. Note on the generalisation of Poincaré and Goursat's proof of a theorem of Weierstrass's, by Prof. Osgood, gives an interesting sketch of the theorem, accompanied by full references to original memoirs.—The same author supplies a supplementary note on a single-valued function with a natural boundary, whose inverse is also single-valued. This is supplementary to a paper in the June *Bulletin*, and states the writer's indebtedness for a simple proof of his principal theorem to Prof. Hurwitz.—Prof. Chessin contributes a note on the periodic developments of the equation of the centre and of the logarithms of the radius vector.—The theorems of oscillation of Sturm and Klein is a third paper on the subject, by Prof. Bôcher. Its object is to extend the results previously established to some cases in which the coefficients of the differential equation (discussed in the preceding papers) are no longer continuous throughout the intervals considered in the investigation. The article occupies pp. 22–43. There are numerous vacation notes, and a long list of new publications. It is worth noticing that the Society has appointed a Committee to consider the question of securing improved facilities for the publication of original mathematical papers (in the States). On p. 48 it should be Prof. Price has resigned the Sadleian Professorship (not Sadlerian, which is a Cambridge professorship).

Symons's Monthly Meteorological Magazine, October.—Heat and drought in September 1898. Reference to the regular table of rainfall and temperature at fifty stations shows that the month was remarkably dry over the whole of England and Wales. At twenty-one of the stations the rainfall was less than half the average, and nine of them show a deficiency of 75 per cent. The deficiency is most marked in the east and north-east of England, where the falls were generally about a quarter of an inch. September 1895 was very dry; September 1898 yielded a larger number of both absolute and partial droughts, but a smaller number of stations with less than half the average fall. To illustrate the distribution of temperature during the month, a table of shade maxima at twenty-five stations is given, for September 3–9 and 14–17. On all these days there are numerous entries above 80°, while on the 8th there are eleven records of 90° and upwards. Although the absolute maximum at Camden Square in 1898 (91° 2) is unprecedented, and no other September during the last forty years has had so many days above 85°, yet in 1865 there were two more days above 80°.—Results of meteorological observations for September at Camden Square for forty years, 1858–97. The average rainfall is 2·39 inches; the year 1898 had only ·33 inch, being the smallest September fall since 1858. The mean temperature in September for the forty years is 57°·7. The mean for 1898 was 61°·6, being an excess of 3°·9 from the normal; there is only one instance of a higher mean, viz. 63°·6, in the year 1865.

Wiedemann's Annalen der Physik und Chemie, No. 9.—Electric currents produced by Röntgen rays, by A. Winkelmann. Like Perrin, the author succeeded in obtaining differences of potential between two different metals under the influence of x-rays, and also a steady current of about 6×10^{-9} amperes in a circuit containing two such metals. He calculates an inferior limit for the ratio of the number of ionised molecules of air traversed by x-rays to the total number of molecules, and finds it to be $4{\cdot}6 \times 10^{-13}$.—Magnetic hysteresis, by F. Niethammer. The loss of energy in alternate-current hysteresis is greater than in magnetostatic hysteresis. It is nearly the same for sinusoïdal and for flat curves, but less for pointed curves, for the same maximum induction.—Reflection of kathode rays, by H. Starke. The rays enter a spherical vessel from a side tube, and are reflected by a metallic mirror mounted in the centre and movable by a handle outside. After reflection, the rays are caught in another side tube containing an electrode leading to a galvanometer. The galvanometer shows the same deflection within wide limits of the orientation of the mirror. Hence the deflection is diffuse, the particles being so small that even a highly polished surface is rough to them. The current is greatly increased by insulating the mirror instead of connecting it to earth. The denser metals have the greater reflective power.—Disintegration of incandescent platinum and palladium wires, by W. Stewart. The disintegration of wires rendered incandescent by an electric current gradually decreases as time goes on, but is unaffected by the presence or absence of moisture in the air. When the air is exhausted, the disintegration of platinum diminishes, while that of palladium increases. Platinum is not disintegrated in hydrogen.—Causes of the changes of resistance discovered by Branly, by D. van Gulik. Branly's view that the conductivity of powders acquired under the influence of electric radiation is due to a modification of the dielectric surrounding them is untenable, as experiments with minute terminals under the microscope prove the correctness of Lodge's view that the conductivity is due to mechanical contact.—Observations concerning coherers, by E. Dorn. To be effective, metallic powders should be somewhat easily oxidised, and should be exposed to the air so as to acquire a coating of oxide. Good results are obtained with iron and copper, but not with the noble metals.—A supposed unknown constituent of the atmosphere, by O. Neovius. The author finds a number of lines which are identical in the nitrogen spectrum and the blue argon spectrum, and may be due to an unknown gas occurring as an impurity in both. These lines show only a single coincidence with those of crypton, at 4736.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 28.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—A paper was read by Mr. W. R. Pidgeon on an influence machine. The machine, which was exhibited, consists of a pair of glass discs, rotating in opposite directions upon a spindle. They are partially covered on one face with narrow radial sectors of tin-foil, each provided with a small brass knob. This face of the disc, including its sectors, is then coated with insulating wax, leaving only the knobs projecting through the wax. Two earthing-brushes pass through two insulated fixed inductors, and support them. The inductors are kept charged by exploring-points connected to each, and placed so as to collect electricity from the revolving discs. By means of brushes, the sectors on each of the discs are successively earthed at the moment they pass the fixed inductors, *i.e.* at the moment that their capacity is a maximum; and they are made to deliver up their charge to the main collecting brushes at the moment when they are electrically farthest from the inductors, *i.e.* when their capacity is a minimum. Hence, if there is no loss of electricity in the process, the potential at the collecting brushes is proportionately high. Each sector of a particular disc, as it moves away from its inductor with rising potential, induces a corresponding potential on the sectors opposed to it on the second disc; this action is cumulative. The thick coating of wax restricts leakage to the small area of the contact knobs, so that surface effects of dirt and moisture are minimised. Captain J. H. Thomson, R.A., said that, apart from its electrical merits, the machine possessed advantages in mechanical construction. He thought there was still room for improvement in this respect. The counter-shaft should be done away with, and ball-bearings should be introduced. The inductor was a distinct improvement; he thought the efficiency might be increased by adding other inductors. Platinum-iridium was the best material for brushes of such machines. Prof. Ayrton asked what efficiency was obtained with modern influence machines, in general. Captain Thomson had found that when running a machine by a motor, about 80 per cent. of the power was wasted in mechanical friction; of the remaining 20 per cent. a great deal was lost as electrical leakage. Prof. S. P. Thompson thought it had been pointed out by Mr. Wimshurst that influence machines did not work well unless there were at least two thicknesses of glass between the inducing and induced conductors. That was why Mr. Wimshurst put his sectors on the outer faces of the glass discs. Mr. Pidgeon had departed from this. The advantage of the narrow spacing of the sectors was not very apparent. Mr. Wimshurst (abstract of communication): Waxing the discs reduces leakage, and increases the output; the wax-coating virtually doubles the number of plates. Inductors contribute a further increase to the output. In 1883 Mr. Wimshurst tried thick coatings of shellac, and also, duplicating the glass, with in some cases sectors upon the second glass to increase the capacity. The output was increased, but the construction lost simplicity. The indifference of Mr. Pidgeon's machine to dirt and dust was a most valuable result. Mr. Pidgeon, in reply, showed a set of secondary inductors such as Captain Thomson had just proposed. They improved the output by about 15 per cent., but they were troublesome to keep in order, for they increased the tendency to "reverse."—Dr. S. P. Thompson then repeated an experiment discovered by Prof. Righi, on a magneto-optic phenomenon. It was originally described in *Roma, R. Accad. Lincei, Atti* 7, *ser.* 5, 1898. A substance absorptive of light is submitted to a powerful magnetic field between the pole-pieces of an electro-magnet. The pole-pieces are drilled so that a beam of light from an arc-lamp can traverse the gap *along* the magnetic lines. A polarising prism is placed between the arc-lamp and the electro-magnet. After having passed through the magnetising apparatus, the beam thus polarised is examined by an analyser. The analyser must be turned to "extinction" before the magnetising current is turned on. If this is done, brightness is restored at the analyser as soon as the magnetic field is established. The substance absorbing the light in the gap may be nitric oxide fumes, or an ordinary spirit-lamp sodium flame. The second effect to be noticed is that when the emergent beam is examined, there is a splitting of the lines. Righi explains this by supposing that when light of frequency n is brought into a magnetic field and passed *along* the lines of the field, it is split up into two sets of circular waves, a right-handed and a left-handed set, one of which sets is accelerated and the other retarded. There are now two frequencies n_1, n_2, one a little higher and the other a little lower than n. But since the analyser is adjusted to extinguish n, there is brightness for n_1, n_2. Normally, nitric oxide absorbs green, and red is observed; but when the magnetic field is set up, blue-green light is seen at the analyser; for there are now two different kinds of light being absorbed, one of higher and one of lower frequency than the normal, and what is observed is the complementary spectrum. Again, if a tube of sodium is warmed to a point far short of that which would cause it to emit visible rays, and the vapour is passed into the magnet gap, at the moment when the magnetic field is set up the D line becomes visible in the observing spectroscope, *i.e.* the emission spectrum is obtained of a substance which is not actually emitting light. Mr. Blakesley said that no doubt the analyser was used at the position of extinction for convenience merely. In other positions the eye would be overwhelmed with light.—Mr. Albert Campbell then read a paper on the magnetic fluxes in meters and other electrical instruments. He has recently undertaken the measurement of the magnetic fluxes and fields in certain instruments, to determine the order of magnitude of the flux density. In other cases the *total* flux is measured; and in the tests on meters, the power lost in the various parts of the instruments is determined. For the measurement of B, the ordinary ballistic-galvanometer method is employed, with an exploring-coil. But, for alternating fluxes, two special methods are adopted, in the first of which the exploring-coil is in series with a heating-coil associated with a thermopile; in the second, a telephone is connected in series with the search-coil and a potentiometer resistance strip. A constant current is sent through the strip from the main alternate-current circuit supplying the meter or other apparatus; the telephone and search-coil therefore forms a shunt to that circuit at the strip. The search-coil is put into position in the field to be tested, and the strip is then adjusted to give silence in the telephone. All these methods are described in detail in the paper, and very important deductions are made, especially as regards the influence of the earth's field on instruments generally assumed to be independent of the earth's H. In a few cases, diagrams are given of the fluxes in magnets, showing exactly what proportion of the total flux is effective at the gap. Dr. S. P. Thompson suggested that as the paper was of great significance to all who were interested in the design of electric meters and other measuring instruments involving a knowledge of magnetic fluxes and their variation, an opportunity should be given for a full discussion.—The President proposed votes of thanks, and adjourned the discussion of Mr. Campbell's paper to the next meeting on November 11.

PARIS.

Academy of Sciences, October 31.—M. Wolf in the chair.—Remarks on rotatory magnetic polarisation, and anomalous dispersion, by M. Henri Becquerel. Remarks concerning the experiments of MM. Macaluso and Corbino. A bundle of polarised white light traverses the pierced armature of a strong electro-magnet, and is analysed by a spectroscope after passing through a sodium flame placed in the field. The absorption bands under these conditions are seen when the current is passing to be bordered by a series of bright dark bands, which are displaced on rotating the analysing nicol.—Peculiarities relating to the innervation and general physiological properties of the nerves of the *sphincter ani*, by MM. S. Arloing and Edouard Chantre.—On divergent series and functions defined by a Taylor's series, by M. Le Roy.—A property of a first integral of the equations of dynamics of two variables with homogeneous potential, by MM. W. Ebert and J. Perchot.—On the ratio of the two specific heats of gases, and its variation with temperature, by M. A. Leduc. From the formulae developed in previous papers the author concludes that γ, the value for the ratio of the two specific heats of air, varies slightly with the temperature, the ratio γ_0/γ_{100} being about 1·0006. The variation is much more rapid with carbon dioxide, for which γ_0/γ_{100} is 1·028. From the experiments of Wüllner, the values of γ_0 are calculated for several gases.—New apparatus for the measurement of luminosity, by M. Onimus. The apparatus described permits of the comparison of the light intensities of two days, or of one country with another. The method adopted is a photographic one, the tint taken up by a standard sensitised paper under fixed conditions being compared with a tintometer prepared by superposing pellicles of slightly tinted collodion; the deepest tint, No. 24, being composed of 24 pellicles of collodion. The apparatus is extremely simple, and can be used without any special knowledge of photography, the ferro-prussiate paper used requiring only washing with water after exposure.—Action of phenylhydrazine upon chloranilic acid, by M. A. Descomps. The result of the reaction is a well-crystallised substance of the composition $C_6Cl_2O_2$,

$$(OH.C_6H_5.NH.NH_2)_2,$$

analogous to the body obtained by MM. Baeyer and Kochendoerfer by the interaction of phenylhydrazine and phloroglucinol.—On the presence of a soluble proteo-hydrolytic ferment in mushrooms, by MM. Em. Bourquelot and H. Hérissey. A solution of the ferment was obtained by triturating the fungi *Amanita muscaria* and *Clitocybe nebularis* with sand and chloroform water, and this was allowed to act upon milk, specially freed from fat. The action of the ferment is analogous to, if not identical with, trypsine.—On the influence of temperature on the determination of sex, by M. Marin Molliard. Experiments carried out on the development of *Mercurialis annua* at varying temperatures showed that heat favours, in this case, the production of female individuals.—Characters of the latent life of bulbs and tubers, by M. Leclerc du Sablon.—The limurites in contact with the granitic rocks of the Hautes-Pyrenees, by M. A. Lacroix. These rocks are characterised by the existence of a violet axinite, which sometimes forms nearly the whole rock mass, but is more often accompanied by pyroxene, quartz, albite, and other minerals.—Experimental study of subterranean sedimentation, by M. Stanislas Meunier.—On the secondary formations of the south of the Montagne-Noire, by M. René Nicklès.—The absorption of mercury by leucocytes, by M. Henri Stassano. The leucocytes of the blood of dogs, into whose veins minute quantities of mercury perchloride had been injected, showed, after careful separation, the presence of a perceptible amount of mercury. The experiments show clearly that the leucocytes are the exclusive agents of transportation and absorption of mercurial compounds in the circulation.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1898, contains the following memoirs communicated to the Society:—

May 14.—G. Kümmell: The climatological data of Göttingen for the years 1887–1896.

March 19.—E. Wiechert: Experimental researches on the velocity and magnetic deviability of the kathode-rays.

July 9.—W. Voigt: On the light which penetrates the second medium in so-called "total" reflexion.—A Hurwitz: On the composition of quadratic forms of any number of variables.—E. Timerding: The Reyeian geometry of the *continua* of projective ground-forms.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 10.

MATHEMATICAL SOCIETY, at 8.—Some Secondary Needs and Opportunities of English Mathematicians: Presidential Address.—The Structure of certain Linear Groups with Quadratic Invariants: Dr. L. E. Dickson.—Multiform Solutions of certain Differential Equations of Physical Mathematics and their Applications: H. S. Carslaro.—A Discovery in the Theory of Compound Partitions: Major Macmahon, R.A., F.R.S.—On Groups of Order $p^a q^\beta$: Prof. Burnside, F.R.S.—On the Null Spaces of a One System and its Associated Complexes: W. H. Young.—On the Functions Y and Z which satisfy the Identity

$$4(x^p - 1)/(x - 1) = Y^2 \pm pZ^2:$$

Prof. L. J. Rogers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rotatory Converters: Prof. Silvanus P. Thompson, F.R.S.

FRIDAY, NOVEMBER 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.—The Development of $\left[\frac{r}{a}\right]^n$ sin cos mw: R. T. A. Innes.—Remarks on Dr. Gill's Paper in the *Monthly Notices* for June 1898: A. A. Rambaut.—Note on Mr. Pogson's Manuscripts relating to his proposed Atlas of Variable Stars: Rev. J. G. Hagen.—(1) On the South Temperate Current of Jupiter; (2) Nomenclature of the Chief Surface Currents of Jupiter: A. Stanley Williams.—(1) On a New Instrument for Measuring Astrophotographic Plates; (2) On a Method of obtaining Perfectly Circular Dots unaffected by Phase, and their Employment for Determining the Pivot Errors of the Cape Transit Circle: David Gill.—On some Photographs of the Moon, Comets, Meteors, and the Milky Way, and on the Exterior Nebulosities of the Pleiades: E. E. Barnard.—(1) Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1897, deduced from Photographs taken at Greenwich, at Dehra Dûn (India), and in Mauritius; (2) Observations of Planet 433 (1898 DQ) with the 30-inch Reflector of the Thompson Equatorial: Royal Observatory, Greenwich.——*Papers promised*: Brief Account of the New Photographic Telescope at Cambridge Observatory: Sir R. S. Ball.—(1) Approximate Ephemeris of the Leonids; (2) Forecast of the Time of the Leonid Shower of 1898; (3) On the Presence of Helium in the Earth's Atmosphere: G. Johnstone Stoney.

PHYSICAL SOCIETY, at 5.—Discussion on Mr. A. Campbell's Paper on the Magnetic Fluxes in Meters and other Electrical Instruments, to be opened by Prof. W. E. Ayrton, F.R.S.—On the Propagation of Damped Electrical Oscillations along Parallel Wires: Prof. W. B. Morton.—On the Properties of Liquid Mixtures: R. A. Lehfeldt.

MALACOLOGICAL SOCIETY, at 8.—A Revision of the Pliocene Non-Marine Mollusca of England: A. S. Kennard and B. B. Woodward.—Description of Two New Species of *Trochidae* from the Commander Islands: Edgar A. Smith.—Description of a New Species of *Tridacna*: G. B. Sowerby.—On some Supposed New Species of Land Mollusca from the Moluccas: H. Fulton.

MONDAY, NOVEMBER 14.

IMPERIAL INSTITUTE, at 8.30.—Trinidad, with Special Reference to the Recent Hurricane: H. Caracciolo.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A British Antarctic Expedition: Addresses by the President and others.

TUESDAY, NOVEMBER 15.

ZOOLOGICAL SOCIETY, at 8.30.—A Revision of the Moths of the Subfamily *Pyraustinae* and Family *Pyralidae*, Part I.: Sir George Hampson, Bart.—List of Mammals obtained by Mr. R. McD. Hawker during a Recent Expedition to Somaliland: W. E. de Winton.—On Mammals collected by Mr. J. D. La Touche at Kuatun, N.W. Fokien: Oldfield Thomas.—Revision of the Genera and Species of Fishes of the Family *Mormyridae*: Mr. Boulenger.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—Election of Officers and Council.—Plagionite, Heteromorphite, and Semseyite as Members of a Natural Group of Minerals: L. J. Spencer; with Chemical Analyses by G. T. Prior.—Petrographical Notes on Rock Specimens collected during the Ross Antarctic Expedition of 1839–43: G. T. Prior.—Mineralogical Notes from the Oxford University Laboratory (Communicated): Prof. Miers, F.R.S.—Note on the Occurrence of Riebeckite in Trachytic Rocks from Abyssinia: G. T. Prior.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Electrical Transmission of Power in Mining: William Beedie Esson.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—On Rapid Dry Plates for Process Work: Combined Screen and Colour Negatives for Three-Colour Printing: A. A. K. Tallent.—On the Melting and Setting Points of Gelatine Solutions, and their Modification: R. Child Bayley.

WEDNESDAY, NOVEMBER 16.

SOCIETY OF ARTS, at 8.—Opening Address by Sir J. Wolfe Barry, K.C.B., F.R.S., on the Internal Traffic of London.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on Experiments upon the Exposure of Anemometers at Different Elevations: The Wind Force Committee.—Comparison of Estimated Wind Force with that given by Anemometers: Captain D. Wilson-Barker.—The Tornado at Camberwell, October 29, 1898: William Marriott.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Thum's Slides of Diatoms in High Refractive Media.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 17.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On some Spiders from Chili and Peru: F. O. Pickard Cambridge.—The Botanical Results of a Journey into the Interior of Western Australia: Spencer Moore.

CHEMICAL SOCIETY, at 8.—Preparation of Hyponitrite from Nitrite through Oxyamidosulphonate: Dr. E. Divers, F.R.S., and T. Haga.—(1) Absorption of Nitric Oxide in Gas Analysis; (2) Interaction of Nitric Oxide with Silver Nitrate; (3) Preparation of Pure Alkali Nitrites; (4) The Reduction of an Alkali Nitrite by an Alkali Metal; (5) Hyponitrites: their Preparation by Sodium or Potassium and Properties: Dr. E. Divers, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Story of the Cotton Plant: F. Wilkinson (Newnes).—Primer of Geometry: J. Sutherland (Longmans).—Chemistry in Daily Life: Dr. Lassar-Cohn, translated by M. M. P. Muir, 2nd edition (Grevel).—Das Leitvermögen der Elektrolyte: Dr. F. Kohlrausch and Dr. L. Holborn (Leipzig, Teubner).—Comparative Photographic Spectra of Stars to the 3½ Magnitude: F. McClean (Dulau).—Spectra of Southern Stars: F. McClean (Stanford).—Monographia Roccelleorum: O. V. Darbishire (Stuttgart, Nägele).—Observations and Researches made at the Hongkong Observatory in the Year 1897: W. Doberck (Hongkong).—Railway "Block" Signalling: J. Pigg (Biggs).—Chemistry for Schools: C. H. Gill, 10th edition, revised and enlarged by Dr. D. H. Jackson (Stanford).—First Lessons in Modern Geology: A. H. Green (Oxford, Clarendon Press).—A Middle Algebra: W. Briggs and Prof. Bryan (Clive).—Elemente der Mineralogie: Naumann and Zirkel, ii. Hälfte, Specieller Theil (Leipzig, Engelmann).—Electrical Engineering: W. Slingo and A. Brooker, new edition (Longmans).—Conspectul Florei Romaniei: Dr. D. Grecescu (Berlin, Friedländer).—Four-footed Americans and their Kin: M. O. Wright (Macmillan).—An Introductory Logic: Prof. J. E. Creighton (Macmillan).—Differential and Integral Calculus: P. A. Lambert (Macmillan).—Der Ursprung der Kultur: L. Frobenius. Erster Band: Der Ursprung der Afrikanischen Kulturen (Berlin, Borntraeger).

PAMPHLETS.—A Plan and Plea for National Medicine; E. L. Garbett (Reeves).—The Transition of North Carolina from Colony to Commonwealth: Prof. E. W. Sikes (Baltimore).—Petrographical and Geological Investigations of certain Transvaal Norites, Gabbros, and Pyroxenites, and other South African Rocks: J. A. L. Henderson (Dulau).—Mines and Quarries: Reports of Le Neve Foster for the North Wales, &c., District (No. 9) for the Year 1897 (Darling).

SERIALS.—Fortnightly Review, November (Chapman).—National Review, November (Arnold).—Madras Government Museum, Bulletin, Vol. 2, No. 2, Anthropology (Madras).—Natural Science, November (Dent).—Middlesex Hospital Journal, October (London).—Zeitschrift für Physikalische Chemie, xxvii. Band, 2 Heft (Leipzig, Engelmann).—Geographical Journal, November (Stanford).—Knowledge, November (Witherby).—Journal of the Sanitary Institute, October (Stanford).—Science Progress, October (Scientific Press).—Terrestrial Magnetism, September (Cincinnati).—Journal of Botany, November (West).—Botanische Jahrbücher, Sechsundzwanzigster Band, 2 Heft (Leipzig).—Zeitschrift für Wissenschaftliche Zoologie, lxiv. Band, 4 Heft (Leipzig).

CONTENTS.