THURSDAY, NOVEMBER 8, 1900.

SCIENCE AND PSEUDO-SCIENCE.

Genèse de la Matière et de l'Energie—Formation et Fin d'un Monde. Par A. Despaux, Ingénieur des Arts et Manufactures. Pp. 232. (Paris: Félix Alcan, 1900.)

THERE are two classes of writers whose works on scientific subjects possess little or no intrinsic scientific value. The first consists of those who, carrying their distrust of rational authority even beyond the bounds of sanity, run headlong against established modes of thought, and lose themselves in a maze of paradox. To the second class belong authors who, while they show no outward disrespect for the accepted elements of orthodox philosophy, have neither the patience nor the ability to pursue the arduous paths which lead to truth, but with a courage born of want of knowledge of the real difficulties take their own way under the treacherous guidance of blind intuition.

The rapidity of their progress is astonishing, but whether it has an end worth reaching may in general be questioned. The cautious critic finds these excursions difficult to follow, and he therefore has a natural tendency perhaps to do them less than justice. But it may be proper to insist here on the fact that it is of little use even to blunder on a truth unless care be taken to free it from all that is doubtful, and to place it in a convincing light. Failure in this respect constitutes a serious objection to the intuitive method as exemplified by the book under review.

To the representatives of intuitive as opposed to more scientific methods the borderland of the known in science offers great opportunities. In particular, the problems of cosmogony and molecular physics seem to possess a singular fascination for this type of mind. It seems to matter little that these problems present the very greatest difficulties, of which the mere exact formulation is not to be undertaken lightly, and which seem to demand for their solution a mastery over so wide a range of experimental fact and so great a power in the use of mathematical analysis as to have baffled hitherto the most gifted investigators. Indeed, it is being realised more and more how inadequate is the store of facts and how great the need, probably, of an entirely new machinery of analysis. And yet how petty are our discussions, for instance, of the propriety of employing the principle of Action, how futile our doubts about the appropriateness of certain mechanical models to represent ethereal operations! Our intuitive philosophers, as we have said, are ready at one bound to surmount such pedantic obstacles, and why should we not follow them?

The mere title of this book seems to give some justification for suspecting that M. Despaux is not quite innocent of those heretical methods to which we have alluded. Within the modest compass of 232 octavo pages he attempts to explain the origin and nature of matter and energy, the constitution of the molecule, gravitation, many fundamental questions in physics, such as radiant energy and electricity, and, in addition to all this, the formation of the solar system. The scheme is so ambitious that the conclusion seems inevitable that the author has failed to realise the stupendous difficulties to be overcome. And this impression, which is fully confirmed on reading his book, makes it impossible to consider it very seriously. The phenomena to which the author refers are only such as must be well known even to the most elementary student of physics, and if M. Despaux has any claims to be considered a mathematician, his modesty has led him to conceal the fact most scrupulously.

The reader of the book quickly finds that in order to follow the author closely he must gain some idea of M. Despaux' views on the nature of the ether and of the atom. The former he considers as the vehicle necessary for the transference of energy in an undulatory form. Up to a certain point his notions of wave motion are clear and well expressed. Unfortunately, they are as restricted as those of a century ago, and are in effect confined to waves of the condensational-rarefractional type. The result is that the author describes the ether as a discontinuous medium, possessing in some measure the qualities of a gas, thus ignoring all the difficulties which arise from the phenomena of polarisation. On the other hand, his general views on the meaning of action at a distance, and on the ether as the true energy medium, are much more satisfactory and consistent with modern ideas. It is more difficult to follow M. Despaux' suggestions as to the nature of the atom. We gather that there is an essential unity between all kinds of matter, and that all atoms are intrinsically alike. They are the seat of kinetic energy, and appear to be differentiated only by their particular modes of motion. The energy gives rise to vibrations of two types of which one becomes apparent in the form of radiant energy, while the other causes the effect of mutual gravitation and chemical affinity. But lest we should misrepresent his thoughts, we may quote M. Despaux' own words—

"La gravitation est due à la rotation hélicoïdale des atomes ou molécules qui produit une translation dans l'éther; sans rotation, pas de gravité, les corps seraient sans poids, sans chaleur, sans couleur, . . . Ce qui caractérise la matière, c'est en effet le mouvement des atomes bien plus que les atomes eux-mêmes centres de ces mouvements. . . . En résumé, contrairement aux idées reçues, nous estimons que la masse d'un corps dépend moins du nombre des molécules que de leur vitesse de rotation.—Toutes les energies mettant en jeu les attractions et les répulsions sont de même nature que la gravitation" (pp. 94, 95).

Now the implied connection between gravitation and heat is as repugnant to our ideas as the caloric theory of heat itself; for the former involves an identification o mass with energy which is as objectionable as the confusion of a form of energy with matter in the latter. The grounds of objection are, in fact, precisely the same in both cases. The origin of the heresy is to be found in M. Despaux' incapacity to realise the meaning of mass as a distinct entity. He professes carefully to eschew all arguments which appear to him of a metaphysical nature, and yet fails to see that the discussion of fundamental physical conceptions really belongs to the domain of metaphysics. It is distinctly a pity that he has virtually exceeded the limits of his purpose, for his qualifications as a philosopher seem to be inferior even to his equipment as a physicist.

It seems idle to pursue the author further in his speculations. Not content with formulating a theory of the operation of nature on the molecular scale, he devotes the last part of his essay to the exposition of his views on the subject of cosmogony. In this he adopts the nebular theory of Laplace as a general scheme, and applies to it the ideas which he has previously developed. He has an explanation to offer of the cases of retrograde motion in the solar system and of other phenomena which have been thought to present difficulties. On these points he apparently satisfies himself, though others, in the absence of rigorous proof, may remain sceptical. It is in reference to a subject of some debate, the ultimate fate of the solar system, in fact, that he offers a novel suggestion, based on his peculiar conception of the atom. As others have supposed, the end must come with the slow dissipation of energy; but, in the system of M. Despaux, this implies the loss, not only of heat, but also of gravitational power in the atom, or, in other words, of weight. The energy passes to the ether, and matter deprived of its chief property becomes immaterial. The world, then, no longer remains as an inert mass, but reaches its dissolution and leaves "not a rack behind." It is true that M. Despaux contemplates a return of the energy to the atom, and the whole process from the birth to the death of the system repeated in an endless cycle. But even he does not venture to describe in any detail how this is to come about.

Enough has been said as to the scope of this book, and some reason has been assigned for considering it unphilosophical in design and unenlightened in execution. But it is not to be thought that the author is an unfavourable example of the class to which he belongs. He expresses clearly and concisely what he has to say; he is respectful to the great workers who have adhered to the recognised laborious paths; and it should not be thought that there are no ideas to be found in his work which are true, though such as are true may generally appear not to be original. Yet, when all that is said, it is difficult to conceive the utility of such a work.

A NEW TEXT-BOOK ON SOUND.

A Text-Book of Physics. Sound. By J. H. Poynting, Sc.D., F.R.S., and J. J. Thomson, M.A., F.R.S., Hon. Sc.D. (Dublin), Hon. D.L. (Princeton). Pp. x + 163. (London: Chas. Griffin and Co., Ltd., 1899.)

THIS volume will be welcomed by those interested in the teaching of physical science, not only on account of its individual merits, but also as the first instalment of a complete treatise on physics now in preparation by the authors. It is intended for the use of students who lay most stress on the study of the experimental part of physics, and who have not yet reached the stage at which the reading of advanced treatises on special subjects is desirable. For this class of students it is important that the mathematics used should be of the simplest. So far as concerns those who are unacquainted with the calculus, this is self-evident; it is, further, none the less true with regard to those possessing some knowledge of the higher mathematics. Unless great care is exercised, the use of the calculus is apt to become so far mechanical that the student may possibly miss many tacit assumptions which it would be advantageous for him to clearly recognise. To all students it is alike of importance that each stage in the reasoning employed should be brought into view as clearly as possible, and subjected to the most searching scrutiny. This can be done, sometimes by the use of comparatively simple analytical and geometrical devices, often by the application of the principles of the calculus developed *ab initio*. The volume under consideration comprises many most successful attempts to apply simple mathematical methods to the solution of important, and sometimes fairly intricate, problems. The investigation of the modes of vibration of a stretched string, on pp. 86–88, is perhaps the least successful effort in this direction; few students would, it may be feared, be able to keep the essential features of the problem clearly distinguished from the number of geometrical and analytical assumptions and approximations involved. The investigation of the same problem from another standpoint, as given on p. 93, is much to be preferred in this respect.

In the first chapter a good account is given of the general nature and characteristics of sound. A simple experiment, due to Prof. Boys, in which the vibratory character of sound in air is made manifest, might perhaps have been mentioned with advantage. A Bunsen flame is burnt near the end of an open organ pipe, and when the latter is sounded the sinusoidal paths of dust particles traversing the flame are readily seen. From a mathematical point of view, it is to be regretted that a solution is not here given of the problem of the motion of a heavy particle, attracted toward a point with a force proportional to its displacement therefrom. If we suppose the particle to revolve in a circular orbit about the point, then it is easily seen that the centrifugal force must be equal to the central attraction exerted. Resolving the instantaneous displacement, velocity and central force parallel and perpendicularly to any given axis, then we have two harmonic motions executed under the actions of forces proportional to the displacement from the centre. Considering only one of these harmonic motions, the value of the kinetic and potential energies at any point may easily be written down, when it becomes evident that their sum is constant. Equating the potential energy at the extremity of an excursion to the kinetic energy at the point of equilibrium, the well-known expression for the time of vibration is readily obtained. It is interesting to note that this graphical solution corresponds to assigning the real part of $A\epsilon^{iat}$ as the value of x which satisfies the differential equation

$$\frac{d^2x}{dt^2} + a^2t = 0.$$

The second chapter commences with a simple theoretical investigation of the velocity of sound in a fluid, and is followed by an interesting and valuable account of the experimental aspect of the same question. In connection with the reflection of sound, the curious musical ring, often heard to follow each footfall when one is walking near palisading, is simply explained, and Lord Rayleigh's theory of whispering galleries is described. The introduction in ensuing editions of a few reproductions of Prof. Wood's photographs of sound waves would enhance the interest of this section. Refraction of sounds by winds and air-layers of different densities is also described and explained. The third chapter is occupied with the frequency and pitch of notes, methods of determining the period of a tuning fork, Döppler's principle and musical scales. Whilst comprising little that is new, the account given should prove very useful to students. A short account of resonance and forced vibrations is given in the fourth chapter, whilst the succeeding chapter is occupied with the analysis of vibrations. The mathematical investigation on p. 66, concerning the superposition of harmonic curves, might advantageously have been given rather more in detail considering the class of students for whom the book is written; but there are few other instances where this objection can be raised.

Chapter vi. is concerned with the vibrations of strings, and a very useful and systematic account of this part of the subject is given. This should prove very acceptable to students as leaving unexplained no point on which difficulties are likely to hang. The vibrations of air in pipes, and of rods, plates and membranes, are treated of in an equally satisfactory manner in Chapters vii. and viii.

One of the most interesting chapters in this volume is the ninth, devoted to singing flames, sensitive flames and jets, and musical sand. Lord Rayleigh's investigation of the conditions necessary for the production of a singing flame is clearly and simply explained, and many other phenomena dependent on similar principles are described. The description and explanation of the musical note, produced when certain sands are struck or otherwise disturbed, will doubtless be read with great interest.

Finally, it may be confidently predicted that this volume will meet with an appreciative reception from all serious students of physics. It is characterised throughout by the absence of obscure and inconclusive reasoning such as is sometimes found in treatises dealing with intricate problems in an elementary manner, by the employment of sound yet simple mathematical methods, and by the inclusion of accounts of recent work not to be found in other books of the same class. Many students might wish that examination questions had been added at the end of each chapter, and some may consider that sixty-six pages of advertisements at the end of the book somewhat exceed what might have been expected in this direction. Otherwise it would be difficult to find grounds for any sentiment but gratification that a gap in our scientific literature has been so worthily filled.

E. E.

GEOLOGY AND PRACTICE.

Steinbruchindustrie und Steinbruchgeologie: technische Geologie nebst praktischen Winken für die Verwertung von Gesteinen, unter eingehender Berücksichtigung der Steinindustrie des Königreiches Sachsen. By Dr. O. Herrmann. Pp. xvi + 428. (Berlin: Borntraeger, 1899.)

IN its elaborate title, of which we have omitted the concluding lines, this work explains its own existence. While it gives a useful account of methods of quarrying, and of the practical applications of various kinds of stone, it specially describes the rocks of Saxony and their economic relations at the present day. The two divisions, general and special, occupy almost equal space, and it will be seen that the book is thus a valuable addition to our libraries. What some of the American States have done for their own areas, what Mr. G. H. Kinahan did for Ireland, in his papers on "Economic Geology," is here repeated for a country of great geological interest. It appears that in Saxony, as in London itself, the use of stone for buildings of a permanent character is becoming more and more extensive, while increasing demands are made upon the quarries for ordinary engineering works.

Dr. Herrmann prefaces his book by an account of the more common rock-forming minerals, and of the rocks ordinarily quarried. This is said to be "zur Orientierung für Nicht-Geologen"; but naturally the elements of mineralogical knowledge are presupposed. A quarry-owner would not be expected to identify his minerals from the descriptions given here, but would doubtless have received, in his preliminary scientific training, a good foundation of chemistry and some practical acquaintance with the materials of the earth's crust. Dr. Herrmann therefore does well to emphasise, in his descriptions, the characters that give each mineral or rock its importance from a technical point of view. The lists of localities, reminding one of those in Roth's "Allgemeine Geologie," and references to the buildings where certain rocks have been employed, might, it seems, have been omitted from this section, in view of the forty-three pages devoted to this subject in a later portion of the work.

The author, writing as recently as 1899 (p. 53), places all the ordinary lavas, rhyolite, basalt, and so forth, as "Eruptivgesteine tertiären und nachtertiären Alters," a classification which is merely playing with words, and which has only a superficial justification in the field. His excuse must lie in the powerful continental combination in favour of an arrangement which, to Western minds, savoured too strongly of the Wernerian school; its abandonment of late years may, indeed, mark the breaking down of the "mineral cabinet" system of geology, which the spread of microscopic research tended at one time to maintain.

The valuable section of the work (pp. 123-181) on the characters required in rocks selected for various industrial purposes, and on methods of extraction, is illustrated by photographs of actual quarries, taken by the author. We then pass to the special consideration of the application (Verwertung) of the rocks of Saxony to the technical requirements of the country. Many of these rocks are so well known to every student of geology that an account of their mode of occurrence, from a new point of view, is of scientific as well as industrial importance. We notice the tendency to introduce foreign stones side by side with those of some well-worked local quarry, the materials being cut and polished on the same spot. The natural demand for variety in the colour-scheme of our great city-buildings will often limit the demand for a local stone, however excellent, and "foreign competition" may be favoured by good taste as much as by a war of prices.

The account of the Serpentine of Zöblitz, which "has arisen from the alteration of a Lherzolite," is a good example of the interest attaching to the author's mode of treatment. His historical review extends back to the cutting of the stone by a herd-boy, as he watched his cattle, in the middle of the fifteenth century (p. 255).

As an illustration of the many details of geological value that are probably to be found only in these pages, we may mention the statement (p. 235) that the pitchstones of Meissen are melted up, in increasing quantities, for producing bottle-glass, but that difficulties arise from the very ready formation of bubbles in the mass. This at once reminds us of the experiments of Berger, by which obsidians were converted into pumice before the blowpipe, and of Judd's far-reaching deductions in connection with the lavas of Krakatoa.

An appendix gives, in somewhat unnecessary detail, an account of the road-metal used on the Government roads of Saxony in 1896. The conclusion, however (p. 351), is worth quoting: "Thus, from the group of sandstones, limestones, dolomites, mica-schists, phyllites, slates, loams and clays, which together form 40 per cent. of the surface of Saxony, no material at all was selected for the construction of the roads, while only 1·94 per cent. of the total road-length was made of sands and gravels, which none the less cover great areas." This surprising fact may be commended to our county surveyors, especially in the limestone districts of Ireland. It is true that in France, with a magnificent system of steam-rolling and workmen's caravans, a good road can be made of limestone, if frequently examined and renewed; but the failure in such regions as the Côte d'Or plateaux, where the difficulties of our own Cotteswolds are encountered, shows how much lies in the choice of materials at the outset. Perhaps the eye for minerals, and the natural aptitude for their extraction, which have made Saxon miners the pioneers of Europe, have found expression also in the accurate choice of road-metal.

While Dr. Herrmann's work does not presume to rank as a general text-book, it should be added to our scientific and technical libraries, if only as a record of progress in a State where science is rightly regarded as the inspiring muse of industry. GRENVILLE A. J. COLE.

OUR BOOK SHELF.

Die Mathematik an den Deutschen technischen Hochschulen. Dr. Erwin Papperitz. (Leipzig: Veit, 1899.)
Ueber den Plan eines physikalisch-technischen Instituts an der Universität Göttingen. Felix Klein. (1895.)
Die Anforderungen der Ingenieure und die Ausbildung der mathematischen Lehramtskandidaten. Felix Klein. (1896.)

THESE pamphlets are interesting as showing that the revolutionary ideas brought forward by Prof. Perry on the teaching of mathematics have already begun to agitate the German academic mind; and that his ideas concerning the proper method of presenting the principles of the subject, having regard to the requirements of the student, will receive powerful support in Germany.

The cleavage now going on in mathematical thought was very evident in the recent Physical and Mathematical Congresses, held simultaneously in Paris. The followers of Maxwell and Kelvin found the interest they required in the Physical Congress; the Mathematical Congress was almost entirely engrossed in the development of the analytical ideas of Weirstrass. A lover of music nowadays must become a Wagnerian, or run the risk of hearing no music at all; so, too, the mathematician, who is not absorbed in developments of the convergency of series, must turn to the physical section for the interest he requires.

The Cambridge student of old-fashioned mathematical physics, of the school which the foreigner considered worth imitation, is now driven elsewhere, into the National Science Tripos; and so we find the serious shrinkage in the Mathematical Tripos now in rapid progress. G.

A Glossary of Botanic Terms with their Derivation and Accent. By Benjamin Daydon Jackson. Pp. xi + 327. (London: Duckworth and Co., 1900.)

MR. DAYDON JACKSON has laid those who have to consult botanical literature under a great obligation by the publication of this excellent and compendious glossary. Such a work was badly needed, and no one possesses greater qualifications for the undertaking of it than Mr. Jackson himself, who has done such good work in other departments of an analogous character.

The definitions are usually good and concise, and the errors, so far as we have been able to discover them, are surprisingly few. We cannot help, however, expressing our regret that in the definition of the words "axial" and "axile" the author did not emphasise the difference between them which has been insisted on by some of the best writers. *Axial* should be reserved for structures appertaining to the morphological axis (as distinct from its appendages), *axile* merely denoting position without reference to the morphological nature of the structure concerned. But it would be unfair to tax Mr. Jackson with a confusion only too apparent in literature in which the two terms are frequently used synonymously.

It is often of interest to know by whom a term was introduced, as it is thus possible to ascertain exactly the meaning it was originally intended to convey, and it is to be hoped that Mr. Jackson may see his way to give this information in a future edition. Some of the more recently introduced terms are already dealt with in this way in the volume before us, and we cannot but think that an extension in the direction indicated would still further improve what is already an exceedingly valuable work of reference.

Antropometria. By Dr. R. Livi. Pp. 237. (Milan: Hoepli, 1900.)

THE "Antropometria" of Dr. Livi treats of the subject under three main headings. In Part i. measurements are enumerated and described and their modifying factors reviewed. Instruction is then given in the treatment of data, with especial reference to the statistical method. Part ii. will be found to contain generalisations based on the foregoing sources of evidence, and expressed in the form of laws regulating the rate of growth in various parts of the body; some useful notes on the relation of stature and weight are appended to this part. Part iii. is devoted to an exposition of the principles and method of anthropometric identification, and a stenographic system of recording observations, similar to that used by Dr. Garson in this country, is suggested. Finally, a long table of indices will be found at the end of the volume. Like Dr. Livi's other work, the present contribution to anthropometric literature is thorough and clear; the manual will be extremely useful to students and teachers of physical anthropology.

Elementary Questions in Electricity and Magnetism. Compiled by Magnus Maclean, D.Sc., and E. W. Marchant, D.Sc. Pp. viii + 59. (London: Longmans, Green and Co.)

IT is sometimes a convenience to teachers and students to possess a collection of questions apart from those often given in text-books. There are 311 questions in this volume, arranged under 24 different headings, referring to various sections of frictional electricity, magnetism and current electricity. In addition, the book contains 14 tables of electrical constants, and answers to the numerical questions. The student who works through the exercises in the book will establish his knowledge of electrical principles upon a sound footing.

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.*]

Secondary Sexual Characters.

IN his article on "Antelopes and their Recognition Marks" in the number of NATURE dated October 11, Mr. R. I. Pocock suggests that the darker colour of the males in certain species is the outcome or accompaniment of "male katabolism." As generally used, this term seems to denote some peculiarity universally associated with the male sex and giving rise to male peculiarities, so that a character which is the outcome of male katabolism does not require to be explained by the theory of sexual or that of natural selection. This is the sense in which Geddes and Thomson use the term in their "Evolution of Sex": "So brilliancy of colour, exuberance of hair and feathers, activity of scent glands, and even the development of weapons, are not and cannot be explained by sexual selection, but in origin and continued development are outcrops of a male as opposed to a female constitution." But if male katabolism is always associated with the male sex, how is it that there are so many species in which there are no secondary differences between male and female, no outcrops of male katabolism? Either male katabolism, as something different from female katabolism, does *not* exist in the males of all species, or it sometimes exists without producing any visible effect.

It is therefore evident that male katabolism in the kinetic, and not merely the potential, state occurs only in the males of those species which exhibit sexual dimorphism. After all, katabolism is only a name for certain phases of physiological activity, and we thus arrive at the hypothesis that male sexual peculiarities are the result of the peculiar katabolism of the males that possess them. Now we have a reason for such peculiar katabolism, or metabolism, in the special nervous and muscular activity which is observed in the sexual habits of those males which possess secondary sexual characters. This excitement and muscular exertion involves an increase of the metabolism, which goes far to explain, among other things, an increased production of pigment, and the consequent darker or more intense colouring of the males in many instances. The special metabolism is thus due to the habits of life, to external conditions, not to any quality necessarily associated with male sexuality.

It seems to me that, regarding the subject from the point of view I have indicated, we may arrive at the explanation of the darker colour of certain male antelopes, and also of the presence of horns in the males only. If the peculiarities of the male, in particular its colour, are thus the necessary results of physiological processes, they are sufficiently explained, without the additional suggestion that the hornless female has been compelled to adhere to the normal protective colouring of the group, while the males, by reason of their horns and superior strength, have been able to dispense with that advantage. Moreover, Mr. Pocock maintains, in other cases in which horns are developed in the male only, that the markings of the male are protective, for instance, in the kudu. J. T. CUNNINGHAM.

Penzance, October 27.

The Value of the Cylinder Function of the Second Kind for Small Arguments.

IN investigating the propagation of electrical oscillations along cylindrical conductors, the "K_0" function, which satisfies the Bessel's equation and vanishes at infinity, is used to express the vectors outside the wire. Under the conditions of the problem the approximate value of this function for very small arguments is needed. I wish to point out an error in this value, which occurs in all three important memoirs in which the subject has been discussed—viz. those of Prof. J. J. Thomson ("Recent Researches," p. 263), Sommerfeld (*Wied. Ann.*, lxvii. p. 245, 1899) and Mie (*Ann. d. Physik*, ii. p. 211, 1900), an error which can, I think, be traced to a misprint in Heine's "Kugelfunctionen."

The formula given by Heine (vol. i. p. 245) yields as the approximate value $K_0(x) = \log \frac{2}{x} - C + \frac{1}{2}\pi i$.

C is Euler's constant 0·5772 . . . but in the statement of its value which follows − C is printed for C. This mistake, which is not corrected in the errata, is pointed out in the "Treatise" of Gray and Mathews (p. 88, footnote).

If we put $e^{\gamma} = {}$·5772, we have $K_0(x) = \log \frac{2i}{\gamma x}$. In the papers referred to, the γ appears in the numerator, which would correspond to the alteration in the sign of C. In Prof. Thomson's work the i in the numerator is omitted.

The error has no effect on the theoretical conclusions reached in the papers. The numerical results given by Sommerfeld and Mie are subject to corrections, which will not, however, affect the order of magnitude. For example, the attenuation constants worked out by Sommerfeld are something like 10 per cent. too small. W. B. MORTON.

Queen's College, Belfast, October 25.

Mosquitoes and Diseases.

AT p. 627 of your issue of October 25, while noticing Profs. Grassi and Noè's observations on *Filaria immitis*, you say "Malaria is not the only disease which is propagated by mosquitoes." May I remind your readers of Dr. Patrick Manson's important observations on *Filaria sanguinis-hominis*, originally communicated to the Linnean Society by Dr. Cobbold, on March 7, 1878 ("On the Development of *Filaria sanguinis-hominis*, and on the Mosquito considered as a Nurse": *Journ. Linn. Soc. Zool.*, xiv., pp. 304–311), and amplified later in a paper communicated on March 6, 1884 ("The Metamorphosis of *Filaria sanguinis-hominis* in the Mosquito": *Trans. Linn. Soc. Zool.*, ser. 2, vol. ii., pp. 367–388, pl. xxxix.)? W. F. KIRBY.

British Museum (Natural History), London, S.W., October 30.

OUR STELLAR SYSTEM.

IN a recently published volume[1] I endeavoured to bring together the facts relating not only to the distribution of stars generally, but to those which the spectroscope has more recently brought before us touching the distribution of the various chemical groups of stars. One of the interesting results of the inquiry was that the Milky Way, which dominates the general distribution, is also the region of the heavens in which undoubted nebulæ giving us bright-line spectra most do congregate. Nor is this all. Those so-called "stars," in the spectra of which bright lines are seen, "bright-line stars" and "new stars," which I have elsewhere shown are nebulæ or stars associated with nebulæ, are also almost entirely confined to the Milky Way. The new spectroscopic knowledge, although so priceless to the student of the chemistry of space, tells us, however, nothing as to the distances of the bodies from us; it only tells us that they lie in the galactic plane. If, however, we combine with the chemical facts the results obtained by Monck, Kapteyn and others touching the proper motions of the various kinds of stars as defined by their spectra, the results we obtain are most definite.

Dealing with the stars generally, it may be stated that the latest inquiries have suggested the following very general classification of stars depending upon temperature:—

Highest Temperature.

Gaseous stars { Proto-hydrogen stars.
Cleveite-gas stars.

Proto-metallic stars.
Metallic stars.
Stars with fluted spectra.

Lowest Temperature.

Now to make the most general statement, we find that the gaseous stars are not only confined to the Milky Way, but they are the most remote in every direction, in every galactic longitude; all of them have the smallest proper motion. The metallic stars are nearest to us, but they are *not* confined to the Milky Way. The proto-metallic stars are intermediate between these two great groups,

[1] "Inorganic Evolution," pp. 124–143.

both in regard to their proper motion and their distribution.

Now the spectroscopic similarity between the gaseous stars and the "bright-line" and "new" stars, and the planetary nebulæ, justifies our assuming provisionally that they exist under some similar conditions, and, as they are all confined to the Milky Way, we are further justified in assuming that they lie at the same distance from us.

The smaller proper motion of the hottest stars, in which I include the bright-line stars, proves that the region which gives rise to them as well as the new stars, and the planetary nebulæ, is far away *on all sides*. If it were not so we should get a very small proper motion in one direction and a very large proper motion in another.

But the stars in question in the Milky Way, which is a great circle, are all equally remote; and the only place whence such a state of things can be observed must be a point equally distant from all, that is, in the centre of the system under observation.

It is worth while to repeat that it is because we are in the centre, because the solar system is in the centre, that the observed effect arises, and if we imagine the solar system very far from the centre we should get very different proper motion conditions on this side and on that; but seeing that we have found that we get the smallest proper motion with regard to all the hottest phenomena that we know of in space, we have to consider that the still truly nebulous region is far away from us in every direction, and that it practically is limited to the plane of the Milky Way.

Photographs of some drawings made by Herschel, when he was first brought into the presence of the wonderful nebulæ with which the heavens are peopled, will give an idea of what possibly may be the condition of things touching our own system. We have amongst them drawings of "globular" nebulæ, possibly not globes, but systems looked down upon from their poles, and the possibility of that arises from the fact that many nebulæ are looked at edge-ways, and are very thin. Hence we do not know that the apparently globular clusters are not really those things looked at from the poles of their movement. We have not only those globular and elliptic nebulæ, but we have double elliptic nebulæ, which might be considered as explaining how the Milky Way happens somehow or another to be doubled. In addition to these we have well-defined ring nebulæ, the best example of which is in the constellation Lyra. It has been often imagined, up to now, by those who have considered this subject, that the Milky Way owes its appearance to the fact that there is really a spiral nebula in question, and that the stars which form the stellar system and form the companions of the sun exist at the centre of a spiral nebula. One of these spiral nebulæ, which we observe looking down on the whole system from the pole is the spiral nebula in Canes Venatici. The wonderful nebula in Andromeda, also a spiral nebula, we look at side-ways, and so it appears elliptical, and in this we notice that the greatest condensation is in the centre. But we know, from what I have stated, that our greatest condensation is not in the centre; in our case the greatest vacuity is in the centre. We are in the quiet, in the centre; so that certainly if we take our choice of these different forms, we must say that our system is much more like that of the ring nebula in Lyra than it is to such systems as those in Canes Venatici and Andromeda. We, according to Gould's work, have in the centre of our system, represented by the Milky Way, a small number of cooling stars all congregating together; outside that at an infinite distance from these relatively cool bodies, we have the Milky Way stretching with all its concomitants of gaseous stars, planetary nebulæ, bright-line stars, new stars, and so on. We must therefore consider that in our present knowledge such a condition of things as is represented by the ring nebula in Lyra fits our facts very much better than the condition which is represented by such a spiral structure as Andromeda, in which the greatest heat—I say that because there is obviously the greatest luminosity—is located at the centre. I have already referred to the proper motion evidence. It is obvious that in the case of the nebula of Andromeda, if we imagine an observer at the centre, large, medium, and small proper motions would be observed in every direction in the plane of the system, for the reason that the spirals lie in some cases near to, and in others far from, the centre, and that there are many spirals. We practically know that in our system the centre is the region of least disturbance, and therefore cooler conditions.

I now come to another point which must be considered in the next place.

Let us assume for the moment that the average brightness of stars depends upon their distance; then the

FIG. 1.—Spiral nebula of Canes Venatici, from a photograph by Dr. Roberts.

number of stars of a given magnitude indicates the stellar density at a corresponding distance. Gould from actual enumeration has given a formula which shows us that if the stars were uniformly scattered in space, and the light from them suffered no extinction in coming to us—if it did not meet anything that it could not get through—then the number of stars visible to us through a telescope, such as we have at Kensington or at Mount Hamilton, should be about 12,000,000,000. But the number actually visible, so far as counts are concerned, is certainly very much less, and, in fact, it has been estimated that the countable number, instead of being 12,000,000,000, is only about 100,000,000. This estimate seems to me very low, but I am bound to give it. When we come to consider the stars of different magnitudes in different parts of space, we find a very great difference in relation to the plane of the Milky Way; but irrespective of this it may be said that omitting some 500 of the brighter stars, which have to be classed separately, up to the 9th magnitude, the actual and theoretical numbers are fairly accordant, but there is a distinct indication of a thinning out of stars after the 9th magnitude is passed. An example of this has been furnished by Prof. Pickering, who has given us a very useful diagram of the brightness of the stars seen within 1° from the celestial pole: that is to say, a region about 28° from the Milky Way. There is a very considerable number of stars of the 9th and 10th magnitudes, but very few of the 14th and 15th. In

FIG. 2.—The great nebula in Andromeda, from a photograph by Dr. Roberts.

that way it is possible to investigate the conditioning of stars with regard to their brilliancy in the Milky Way itself; the value of the diagram now given is that it shows what happens in a position away from the plane.

There is one other point which arises which is well worth our attention. It is a subject that we have to approach with caution, because it is such a large one, and because so little is known about it. When we look away from the plane of the Milky Way to the poles, we find, as the late Mr. Waters very conclusively proved to us by his tabulations, the greatest number of so-called nebulæ; it is very difficult to discuss this matter, because the nature of these nebulæ is undefined, we are without any information as to whether they are gaseous nebulæ or non-gaseous, and we may burn our fingers by talking about them. If, however, we consider the matter from the point of view at which we have now arrived from the complete discussion which is open to us, the question arises whether this enormous increase of nebulæ towards the poles of the Milky Way

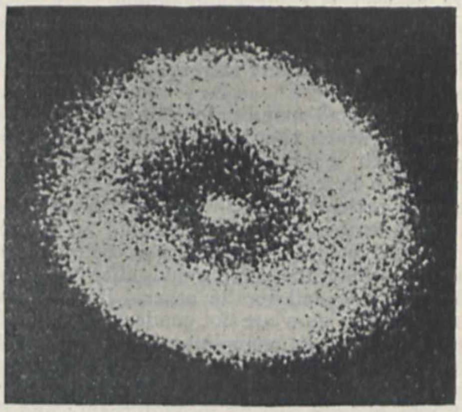


FIG. 3.—The ring nebulæ in Lyra.

does not show us that these things are probably other universes, other systems, like our own. We must consider most of the stars which we see with our most powerful telescopes as belonging to our own system. The number, as we know, increases tremendously as the plane of the Milky Way is approached, and it is possible that as that central plane of the system contains not only stars but nebulæ, it must also contain any number of dark bodies down to the smallest meteorite, and that we may possibly have there a *vera causa* for an extinction of light near the plane of the Milky Way, which is not possible in other parts of the heavens, especially towards the galactic poles. If that be so, the increase of "nebulæ" towards the poles of the Milky Way may simply mean that we see other universes than our own in greater plenty where the conditions for seeing them become more favourable, and that is the reason why towards the poles of the Milky Way we have this overpowering number of apparently nebulous bodies. Of course if that be so, what will turn out will be that most, if not all, of them are not nebulæ at all; they are systems like our own, are clusters of stars with which our own system has absolutely no concern or connection.

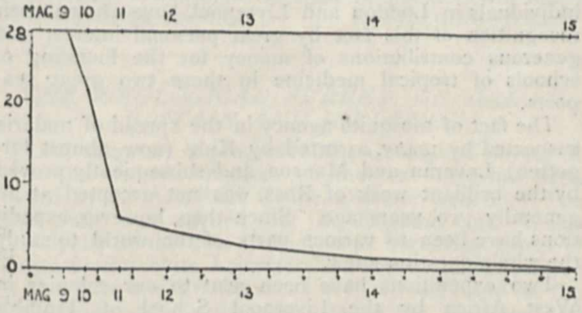


FIG. 4.—Pickering's diagram.

It follows also that the overwhelming number of very faint stars in the Milky Way are stars which would appear brighter if they happened to lie near the galactic poles.

The above suggestion is only an extension of an idea first put forward I believe by Schiaparelli. In spite of the considerable literature on the subject of the extinction of light in space, it was not till 1889, so far as I can make out, that the possibility of such an extinction being brought about by fine particles of matter was suggested,[1] and he referred to the constitution of comets, falling stars and meteorites in support of this idea.

Now that the nebulæ and stars giving us bright-line spectra, as well as comets and falling stars, have been associated with meteorites, we must expect that the extinction of light, if produced as suggested by Schiaparelli, must very rapidly increase as the Milky Way is approached.

Hence the small magnitude stars in the Milky Way are stars of which the light has been dimmed, and the gap which separates system from system may be gathered from Pickering's diagram (Fig. 4).

We may perhaps, after the recent surveys of space, go a little further than Schiaparelli. A stoppage of light by solid bodies, whether small meteorites or condensed stars like the sun, would affect the spectrum equally from one end to the other. But we now know that many of the stars are not condensed bodies like the sun, and that in the surroundings of these, as well as in the so-called gaseous nebulæ, are gases and vapours which would undoubtedly stop the short more than the long waves of light passing through them; and there is ample evidence, as we have seen, that such stars and nebulæ are more numerous in the plane of the Milky Way than elsewhere. If we take stars of the same chemical species in and away from the Milky Way, and find differences in the lengths of their spectra in the ultra-violet, the inquiry would be carried one stage further.

It is a sure sign of the interest taken in such subjects as these, that, since the above was written, two important contributions to our knowledge have appeared. I hope it may be possible for me to refer to them on a future occasion.

NORMAN LOCKYER.

[1] "Sulla distribuzione apparente delle Stelle viribili ad occhio nudo."

THE MALARIA CAMPAIGN.

DURING the last two years, no subject has been more discussed in the medical world than paludism, and in the discussion the general public has taken an interest which purely medical matters seldom enjoy. But this is not a matter of only scientific interest, as is readily seen when one hears that five million human lives are the toll India alone pays annually to the grim spectre of malaria.

The prevention of malaria is a problem of great human, political and economic importance, and the Secretary of State for the Colonies, and many wealthy individuals in London and Liverpool, have shown their recognition of this fact by great personal interest and generous contributions of money for the founding of schools of tropical medicine in these two great seaports.

The fact of mosquito agency in the spread of malaria suspected by many, asserted by King (now almost forgotten), Laveran and Manson, and subsequently proved by the brilliant work of Ross, was not accepted at all generally two years ago. Since then, however, expeditions have been to various parts of the world to study the whole question anew.

Two expeditions have been sent to our colonies in West Africa by the Liverpool School of Tropical Medicine, another by the Royal Society to British Central Africa, some members of which subsequently followed the Liverpool men to West Africa, and lastly, in May of this year, at the instance of Dr. Patrick Manson, the London School of Tropical Medicine despatched an expedition, of which more anon, to the Roman Campagna.

In addition to these special expeditions sent out from home, Bignami, Celli, Grassi and other well-known Italian observers have been hard at work in their own country, while many medical men of our Colonial service have in their own districts been on the trail of the malaria parasites.

Germany, too, as is her wont, has been equally energetic. The great Koch, at the head of several expeditions, has visited many parts of the world and contributed largely to the sum of our present knowledge. Furthermore, Hamburg, the principal German seaport, has rightly been chosen the seat of a school of tropical medicine, whose objects are identical with those of our own schools and whose head is Prof. Nocht. It is interesting to note that the foundation of this school is due to the initiative of the Imperial Government and the enterprise of the municipal authorities of Hamburg. Save sympathy, our English schools owe nothing to the Government of an empire whose interests are more vitally affected by the problems of tropical medicine than any other in the world.

In the aggregate, the addition to our knowledge from these various sources has been immense. The whole life-history of the Hæmamœbidæ responsible for malaria has been accurately worked out, and a particular genus of mosquito (Anopheles) has been, after due trial, definitely convicted of carrying these parasites from man to man and of acting as definitive host to the parasite during its sexual phase of development. On the other hand, man, the intermediate host in this cycle of alternation of generations, has been proved equally necessary for the propagation of the species. A constant association therefore of man with mosquito seems the rule in a vicious circle, which keeps up the supply of parasites and precludes the possibility of their destruction and extinction.

One day, however, it may be shown that the human Hæmamœbidæ can complete their asexual cycle in some mammal other than man. But as yet there is no evidence of this, and Koch has stated his disbelief in the existence of any second alternative host.

As soon as there was a fair presumption (if not positive proof) that the parasites of malaria multiplied by a process of alternation of generation, in which man and a mosquito played the leading parts as intermediate and definitive hosts respectively, all workers in the subject turned their attention to the identity of the species of mosquito concerned, their habits and bionomics, and to the best method of applying practically their newly-found knowledge with a view to reducing the ravages of the fever.

New species of Anopheles were met with, and statistics of health and meteorological observations collected, with the result that our knowledge of mosquito life generally, and especially its relation to malaria, has greatly increased. Major Giles, in his recent monograph on "Mosquitoes," has collected and arranged many of the new facts, but even now we do not know how many varieties of Anopheles there are nor are we certain if all species of this genus are hospitable to the malaria parasites.

In a report recently issued by the trustees of the British Museum, Mr. F. V. Theobald gives us much further information about the Culicidæ, their distribution in nature and some points to help in the identification of species. From this report we learn that twenty-two species of Anopheles are now known, and of these ten are entirely new to science, while of Culex some ninety new species have been described.

It would appear that as a genus Anopheles is worldwide in its distribution, but is more limited in regard to species. This pamphlet is a valuable contribution to knowledge, and is evidence of the magnitude of the work now being done to increase our meagre knowledge of the Culicidæ and gives a good idea of the special difficulties of the subject.

Necessarily there has been some differences of opinion, and what has been found true in one place has been denied elsewhere. This is not remarkable if one considers how much mosquito life and habits are influenced by meteorological factors, and these obviously differ greatly in different latitudes and at different altitudes. On certain essential points, however, all observers are agreed: malaria is caused by three (possibly four) species of the Hæmamœbidæ, and these are indisputably conveyed from man to man by mosquitoes of genus Anopheles.

Another important point has been noted in West Africa by Stephens and Christophers and by Koch in Java and elsewhere. Native children of one to three years old are peculiarly the victims of malaria parasites, and as they grow older the invasion by parasites becomes less and less. These facts have been taken to prove what has long been asserted, viz., that prolonged residence in a malarial country produces a relative amount of immunity.

Koch used the presence or absence of parasites in the blood of young children as a criterion of the question as to whether malaria was endemic or merely imported. It further shows how great a danger to white men is living in close proximity to native habitations. This has been insisted on in West Africa, much to the indignation of the educated blacks.

Incidentally, additions to our knowledge of the fauna of West Africa have been made by these expeditions. Mr. Ernest Austen, of the Zoological Department, British Museum, accompanied the first expedition to Sierra Leone, and a report on his work there has been recently published by the authorities of the museum.

Fifteen hundred specimens of insects were obtained, chiefly of the Lepidoptera, Diptera and Neuroptera, though four other orders were represented in the collection. In his report Mr. Austen describes a variety of Tsetse fly (*Glossina longipalpis*), and a Muscid (probably new) known locally as the "Tumba" fly. The latter deposits its egg under the skin of man and other animals, and when the larva is hatched a boil of a peculiarly painful character is produced. The departure of Mr. Austen, immediately on his return from Sierra Leone, to South Africa with the City Imperial Volunteers has prevented us as yet of obtaining the full fruits of his work, which, now that he has safely returned, we shall eagerly look for.

The best methods of malaria prophylaxis have been much discussed. The original views of Major Ross and the first Liverpool expedition, in the light of wider and more recent knowledge, seem somewhat too sanguine. The destruction and extermination of mosquitoes by drainage and the use of culicicides, as suggested in their report, is now regarded as impracticable in some districts, although in many places these methods, in conjunction with the intelligent use of mosquito-curtains and quinine, could not fail to bring about a marked improvement.

On the whole, however, we must rely, as Dr. Manson has insisted, on the prolonged treatment of patients with quinine and during the time they have parasites in their blood on their rigorous isolation and protection from mosquitoes.

Paradoxical as it may seem, we must first aim at preserving mosquitoes from infection and so limit the chances of the dissemination of the parasites as far as possible.

It cannot be too strongly emphasised that in a malarious country where Anopheles are present a case of fever is infectious.

The value of the proper use of mosquito netting is strikingly shown by the following experiments. In March last Dr. Manson, speaking at the Colonial Institute, announced that the Colonial Office, in conjunction with the London School of Tropical Medicine, had authorised him to make an experiment to show the practicability of preventing malaria by easily applied means. A hut was to be erected in the most malarious part of the Roman Campagna with wire gauze doors and windows so as to render it mosquito proof. This hut two skilled observers were to occupy from May to October, that is, during the whole malarial season. By day they would be able to go out, but at sunset, before the mosquitoes rose, they were to enter their hut and remain closed in until daybreak. By this means it was contended they would be free from all possibility of infection by mosquitoes. In accordance with this plan Drs. Low and Sambon, of London, took up their residence in June, and the latest information is that they have passed through a trying ordeal unscathed and without any appearance of fever. This experiment is of great value, though open to criticism on the grounds that the conditions are somewhat artificial.

A similar experiment, under more natural conditions, and therefore, perhaps, of a more searching character, has been tried by the members of the second Liverpool expedition to West Africa. For four months, in the most malarious districts on the Niger, Drs. Annett, Dutton and Elliott have lived, relying, not on quinine, but only on their proper use of mosquito curtains. A recent communication shows that they have retained their health throughout their stay.

Another important experiment has recently been tried, an experiment which may be considered the complement of those just mentioned.

A consignment of Anopheles, fed on the blood of a patient in Rome known to contain parasites, was received in London from Prof. Bastianelli in July last. A son of Dr. Manson, who had not been in a malarious country since childhood, submitted himself to the bites of these infected mosquitoes. Within a fortnight Mr. Manson had a typical attack of fever, and in his blood were found parasites similar to those causing the fever of the Roman patient on whom the mosquitoes had originally been fed.

This is a crucial experiment, and proves to the hilt, if further proof were needed, that malaria is conveyed by mosquitoes from man to man. Similar "feeding" experiments had been done before, but never has such a striking and satisfactory demonstration been obtained. We have now to deal no longer with theories, but with facts, and it remains to put into practice the valuable information we have obtained as to the possibility of limiting malaria, and so improve the sanitary condition, and thereby increase the commercial prosperity of many of our greatest colonies.

R. FIELDING-OULD.

THE GEOLOGICAL SURVEY OF GREAT BRITAIN AND IRELAND.[1]

THE summary of progress of the Geological Survey of the United Kingdom for the year 1899 has been issued by Sir Archibald Geikie, Director-General. The field-work was carried out in England and Wales principally in the coal districts and bordering tracts of North Staffordshire, Leicestershire and Glamorganshire; in the slate and granite areas of Cornwall; and in the Cretaceous and Tertiary regions of the southern and southern-midland counties. In Scotland the survey of the Highland regions was prosecuted as vigorously as the nature of the ground permitted, and progress was also made in the surveys of Arran and Skye. In Ireland the revision of Silurian areas was continued.

The bulk of the summary is taken up with a somewhat detailed record of the observations made in the field; and

1 "Summary of Progress of the Geological Survey of the United Kingdom for 1899." Pp. v + 214. (London: Printed for H.M. Stationery Office, 1900.)

this is supplemented by an account of work done in the petrographical and palæontological departments of the Survey. The field record is arranged stratigraphically, beginning with the pre-Cambrian rocks and ending with the recent deposits. Thus there are notes on nearly all the main geological systems, excepting only the Cambrian, Permian, and some of the Tertiary divisions.

In the accounts of Highland regions we find many references to the complex folds, the faults and thrust planes, which have affected the Lewisian gneiss, the schists of the "Moine series," the Torridonian and other rocks. In some cases highly altered rocks are found to overlie others which are less altered, showing that the metamorphism must have taken place before the rocks occupied their present relative positions. In places the Moine rocks contain intrusions of partially foliated hornblendic rocks, and some of these are foliated parallel to their sides and cut both the banding and the foliation of the rocks in which they occur.

It seems probable that the Moine schists of the north-west pass into and form part of the Dalradian series of the central Highlands. It is also considered probable that the Moine schists acquired their present crystalline characters since Cambrian times. Moreover, from the fact that the phyllites, quartzites, grits, conglomerates and limestones which extend from the shores of Elgin, Banff and Aberdeen to those of Islay and Jura have had a sedimentary origin, it is thought that they may yet find a definite place among pre-Cambrian or even post-Cambrian formations. In connection with this subject it is to be remembered that a belt of rocks, possibly of Arenig age, has been traced at intervals from Kincardineshire to Dumbartonshire. Here the rocks are wedged in along a line of disturbance between the Highland schists and the Old Red Sandstone; and they comprise graphitic shales, schists and cherts with Radiolaria. Rocks of this character have now been discovered in Arran.

Another interesting discovery is chronicled in the account of the work among the Silurian rocks of Ireland. The majority of the igneous rocks of the Waterford coast have been regarded as volcanic sheets intercalated contemporaneously among the Lower Silurian sediments. Evidence is now brought forward to show that these rocks, which were believed to be tuffs and agglomerates, are intrusive, the "agglomerates" having been in reality produced by a process of brecciation during a prolonged period of igneous intrusion.

It has been pointed out in a previous issue of the "Summary of Progress," that the detailed study of the rocks in the North Staffordshire Coal-field has shown that the coal-measures extend over a much wider area at or near the surface than was previously thought. Evidence furnished by a bore-hole at Thurgarton near Nottingham confirms the persistence and importance of the subdivisions that have been recognised and mapped in the North Staffordshire coalfield.

Much new information has also been gathered in the great Coal-field of South Wales, and some remarkable disturbances accompanied by over-thrusting are figured. Interesting also are the observations which have been made on the secondary rocks in this coal-basin. The occurrence of a red and green marl in the upper part of the Rhætic group at Coity, near Bridgend, and onwards to near the famous old Pyle Inn, is significant as showing the local continuation of conditions akin to those of the Keuper Marl in the Rhætic period.

Fossils of Rhætic character have been found in the passage-beds between the Red conglomerates and Lower Lias of Skye. More important still is the discovery of Rhætic fossils in the island of Arran. Here the beds which have yielded the specimens are not actually *in situ*, but are enclosed in a coarse conglomerate that fills a volcanic vent, probably of Tertiary age.

In the accounts of Lower Cretaceous rocks mention is made of fossils obtained from the Sandgate Beds, near Midhurst; and in the records of Tertiary strata there are notices of new fossiliferous localities in the Reading Beds, London Clay, Bagshot Sands, Bracklesham Beds and Barton Clay of Hampshire.

Among the Tertiary igneous rocks of Skye much new information has been obtained. The gabbro is described as consisting of numerous distinct intrusions in the form of wedges, sheets and tongues. In the basalt plateaux west of the Cuillin Hills the salient features of the slopes are due to the numerous hard intrusive sills intercalated among the softer lava flows. These latter are in general amygdaloidal. References are made to other and later sills which differ from those which follow the bedding-planes of the lavas.

Glacial drifts have received much attention in various parts of the country. Perhaps the most interesting result obtained is that having reference to the sequence in the Gower promontory of South Wales. Evidence is given to show that the deposits holding the Pleistocene fauna in the caves are newer than the raised beach, and that these bone-beds are overlain by the glacial drift.

Of special petrographical work the descriptions of the volcanic rocks of the Exeter district are noteworthy. The results of a further examination of olivine-monzonites from Argyllshire are also stated. Analysis is given of a manganese deposit of Culm-measure age at Hockworthy in Devonshire.

Of palæontological work mention should be made of the detection of phosphatic nodules with traces of probable cell-structure in the Torridonian rocks of Ross-shire. A useful catalogue is also appended of the Eocene and Oligocene type fossils which are preserved in the Museum of Practical Geology.

NOTES.

THE following Fellows of the Royal Society have been recommended by the president and council of the Society for election into the council for the year 1900, at the anniversary meeting on November 30. The names of the new members of the council are in italics. President: *Sir William Huggins, K.C.B.* Treasurer: Mr. A. B. Kempe. Secretaries: Sir Michael Foster, K.C.B., Prof. A. W. Rücker. Foreign Secretary: Dr. T. E. Thorpe, C.B. Other members of the council: *Prof. H. E. Armstrong, Mr. C. V. Boys*, Dr. Horace T. Brown, Mr. W. H. M. Christie, C.B., Prof. E. B. Elliott, Dr. Hans F. Gadow, *Prof. W. M. Hicks*, Lord Lister, *Prof. W. C. McIntosh, Dr. Ludwig Mond*, Prof. A. W. Reinold, *Prof. J. Emerson Reynolds, Dr. R. H. Scott, Prof. C. S. Sherrington*, Mr. J. J. H. Teall, *Sir J. Wolfe Barry, K.C.B.*

THE Royal Society's Medals have this year been adjudicated by the president and council as follows:—the Copley Medal to Prof. Marcellin Berthelot, For.Mem.R.S., for his brilliant services to chemical science; the Rumford Medal to Prof. Antoine Henri Becquerel, for his discoveries in radiation proceeding from uranium; a Royal Medal to Major Percy Alexander MacMahon, F.R.S., for the number and range of his contributions to mathematical science; a Royal Medal to Prof. Alfred Newton, F.R.S., for his eminent contributions to the science of ornithology and the geographical distribution of animals; the Davy Medal to Prof. Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Prof. Ernst Haeckel, for his long continued and highly important work in zoology, all of which has been inspired by the spirit of Darwinism. Her Majesty the Queen has been graciously pleased to approve of the award of the Royal Medals. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's Day (November 30). The Society will dine together at the Whitehall Rooms on the evening of the same day.

TO commemorate Huxley's anthropological work, the Council of the Anthropological Institute of Great Britain and Ireland has decided to found a public lecture, which will be called the "Huxley Memorial Lecture," and will be given annually at the opening of the winter session of the institute. The first Huxley lecture will be delivered by the Right Hon. Lord Avebury, F.R.S., and is announced for Tuesday, November 13, at 8.30 p.m., in the lecture theatre of the Museum of Practical Geology, Jermyn Street, S.W., which, as the scene of so much of Huxley's most impressive teaching, was felt to be the most appropriate place for such a ceremony, and has been placed for the occasion at the disposal of the Anthropological Institute. Applications for tickets of admission should be addressed to the Secretary, the Anthropological Institute, 3, Hanover Square, W., as early as possible.

MANY aspects of the subject of water supply were considered by Mr. James Mansergh in his presidential address to the Institution of Civil Engineers on Tuesday. First and foremost is the question of rainfall and its accurate registration, as providing the prime factor in ascertaining the capability of supply of any given drainage area, with the flow off watersheds of varying form and geological structure, the losses by evaporation, and the discharge by floods. From the point of view of the waterworks engineer, this information is of the highest importance, and has been dealt with by previous presidents of the Institution. On the question of purity, which means, according to the now generally accepted opinion, the absence from the water—as delivered to its consumers—of any pathogenic organisms, the responsibilities of the water engineer are daily becoming more exacting. The best methods of examining and purifying waters for drinking purposes are scientific problems which have not yet been completely answered; and Mr. Mansergh showed in his address that water engineers are awaiting the expression of a definite opinion as to what organisms are actually harmful and what means should be used to remove them.

A PRIVATE conference was held at the Board of Trade last week to consider the protection of the delicate instruments in use at Kew and Greenwich Observatories from magnetic disturbance, through the working of tramways and railways in the metropolis by electricity. Sir Courtenay Boyle presided, and among the officials of the Board of Trade present were Mr. F. J. S. Hopwood, Sir Thomas Blomfield and Mr. Trotter. The observatories and kindred public departments were represented by Mr. Christie (the Astronomer-Royal), Prof. Rücker, Mr. Glazebrook (Director of the National Physical Laboratory), Lieut.-Colonel Raban (Director of Works at the Admiralty), Admiral Sir W. J. Wharton (Hydrographer to the Admiralty), and Profs. Ayrton and Perry. Among those who attended as representatives of the railway and tramway interests concerned were Mr. George White (chairman) and Mr. J. Clifton Robinson (engineer) of the London United Tramways Company, Sir Benjamin Baker and Sir W. Preece. The conference is mentioned in Prof. Perry's address, on p. 46 of the present issue.

A METHOD of diminishing the disturbing effects of electric tramways on magnetic observatories forms the subject of a note by M. Th. Moureaux in a recent number of the *Comptes rendus*. The observatory of Parc Saint Maur is at a distance of about 3·2 kilometres from a line of electric trams between Vincennes and Nogent sur Marne, and the disturbances are due chiefly to erratic currents, which exhibit their influence, not in the form of permanent displacements, but in series of vibrations, symmetrical with respect to the axis of the curves. The effect attains a maximum corresponding apparently to the starting of the cars after stoppages. M. Moureaux recommends as a remedy (1) the use of powerfully magnetised bars of rectangular or square section, (2) the addition of masses of copper with the object of increasing the moment of inertia of the oscillating system, (3) the use of a damper. The author has introduced these modifications into a declinometer and a bifilar magnet, and observations have been made with the new instruments, not only at Parc Saint Maur but also at the forts of Vincennes and Nogent, which are situated in much closer proximity to the tram-line. The general result was a decrease of the disturbing effects of the electric currents to about one-tenth of their former value. It was found that the efficiency of the instruments in recording natural disturbances was in no way impaired by the modifications in question, the records of a small disturbance made with two of the new bifilar instruments at Nogent coinciding in every detail with those taken at Parc Saint Maur.

IN recognition of the services rendered to chemical science by Prof. A. W. Hofmann, new premises have been erected in Berlin for the occupation of the German Chemical Society, and the building has been named "Hofmann Haus." We learn from the *Pharmaceutical Journal* that the formal opening of the building took place on October 20, in the presence of a large number of Government officials and many representatives of the universities and other scientific institutions of Germany. The first step towards the establishment of this memorial was taken in 1888 at the celebration of Hofmann's seventieth birthday, when a sum of 300,000 marks was subscribed for the foundation of an Institute that, besides providing a laboratory for chemical investigation, would serve as a home for scientific societies and a place for meetings, lectures or exhibitions, &c. After Hofmann's death in 1892 the scheme was warmly taken up; the Empress Frederick, who had been a pupil of Hofmann's, supported it by accepting the position of patroness, and with the aid of Dr. J. F. Holtz it has now been successfully carried out, so that the Hofmann Haus could be handed over to Prof. Volhard, the president of the German Chemical Society. The same evening the first meeting was held in the new premises, when addresses were delivered by Prof. v. Baeyer of Munich, and Dr. Brunck, the Director of the Badischen Aniline and Soda Factory, describing the synthesis of indigotin and the development of its manufacture at Ludwigshafen.

AT a meeting of the Council and Members of the Victoria Institute held on Monday, November 5, the president, Sir George G. Stokes, F.R.S., in the chair, Prof. Edward Hull, F.R.S., was elected secretary of the Institute in succession to the late Captain Francis Petrie.

THE annual course of Christmas lectures, specially adapted to young people, at the Royal Institution, will be delivered by Sir Robert S. Ball, F.R.S., whose subject is "Great Chapters in the Book of Nature." The first lecture will take place on Thursday, December 27, at three o'oclock.

A REUTER message from Simla states that since the Pasteur Institute was opened at Kasauli under the direction of Major Semple, seventy-five patients have sought admission, sixty-two of whom completed the course. In no case has the treatment ended in failure, though several of the patients had been bitten on the face by dogs and jackals. Seven British officers, twenty-five soldiers, and twelve European civilians have been treated. The rest of the patients were natives. It is evident that the institute continues to supply a pressing need.

OVERHEAD wires conveying electric currents for tramway traction are certainly unsightly, and an accident which a *Times* correspondent reports from Vienna reminds us of their danger.

A telephone wire which had broken fell upon the overhead wire of the new electric tramway line and made connection with the earth. A lady, who got caught by the loose wire, and three men who went to her assistance, were injured by the current. Two of the persons were so seriously injured that they had to be taken to a hospital, and one is not expected to recover. From the report it is not quite clear how the woman got entangled with the telephone wire, and if the wire coiled round her in falling she might, of course, have been seriously injuied, even if no current from the overhead wires of the tramway line had been passing through it. There is danger when a wire breaks, whether the wire comes in contact with one conveying a strong electric current or not. The accident might, however, have been prevented had nets been placed, as is sometimes cautiously employed, over the tramway overhead wires at places where telephone or telegraph wires cross them.

AT the Imperial Institute, on Monday, Mr. James Stirling discoursed upon "Golden Victoria, its Scenery, Geological Features, and Mines," and gave a glowing account of its resources. Victoria, although the smallest State in the Australian Continent, is the most varied with regard to its surface features, natural resources, climate, &c. It has produced, during the last half-century, more gold than any other country in the world, California excepted, viz., 256 millions out of the total 413 millions produced by Australasia. Bendigo, the deepest mine, is now 3434 feet in depth. Boring operations have proved that deep auriferous leads of about 400 miles in extent exist in various parts of the Colony. The coalfields cover, in Gippsland alone, 3000 square miles of territory, and the seams are up to 5 feet in thickness. In several valleys, such as the Latrobe, immense deposits of brown coal 276 feet thick have been found.

THE *Times* states that the practicability of utilising Mr. Marconi's system of wireless telegraphy in connection with the mail packets running between Dover and Ostend has just been tested, with satisfactory results. The vessel selected for the demonstrations was the Belgian mail packet, *Princess Clementine*, commanded by Captain Romyn. The installation was fitted up in one of the private deck cabins on the starboard side. The receiving and sending wires were connected to the foremast, the height of which had been considerably increased. The land installation was set up at La Panne, on the flat coast between Ostend and Dunkirk, the mast being about 130 ft. in height. The distance between La Panne and Dover is 61 miles. The *Princess Clementine* left Ostend soon after 11 o'clock on Saturday night and arrived at Dover at 2.40 on Sunday morning. Captain Romyn described the results so far beyond anything which the Belgian authorities had anticipated. A message was transmitted from Ostend to La Panne when the *Princess Clementine* left the Belgian port, and telegrams continued to be exchanged between the vessel and the shore at frequent intervals during the voyage to Dover. The messages were transmitted at the rate of about twenty words a minute. Messages were exchanged right up to the time the vessel reached Dover.

THE *Indian Meteorological Memoirs* (vol. xi. Part II.) contain a discussion of the observations recorded during the solar eclipse of January 22, 1898, at 154 meteorological stations in India, by Mr. J. Eliot, F.R.S. The weather was very fine over India generally, but at some of the more southerly stations the sky was overcast. The cooling effect of the eclipse was marked over the whole area; the maximum decrease of temperature ranged between 8° in the belt of totality to 4° in the extreme north and south, the maximum decrease occurring about twenty minutes later than the maximum obscuration of the sun. The movement of the air was very light generally, and was practically suspended during the greater part of the eclipse, but a noteworthy feature was the occurrence of a short, sudden gust about twenty minutes after the commencement of the eclipse at the majority of stations in and near the belt of totality. There was a remarkable increase in the amount of aqueous vapour, which commenced about the middle of the eclipse and was followed by an equally rapid decrease. This last feature was the most remarkable and unexpected phenomenon of this eclipse; it was exhibited at all stations, and was most pronounced at stations in the interior, on and near the line of totality. The diurnal variation of pressure was also considerably modified, the decrease of the amplitude averaging about ·035 inch.

AT the request of the Austrian Ministry of Agriculture, various experiments have been made by Drs. Pernter and Trabert with the view of testing the use of Mr. Stiger's apparatus for dispersing hail-clouds by gun-firing. The apparatus consists of a mortar with a long funnel fixed to the orifice; upon firing a sufficient charge of powder, rings or whirls are formed in the air and can be followed either by their hissing sound or by the particles of smoke carried up with them. The force and durability of the whirls vary with the charge, and with the size of the funnel, but it does not appear from the experiments that a greater altitude than about 400 metres was reached, which is much less than had been previously stated. It does not seem probable, therefore, that unless the hail-clouds are very low that any practical result is likely to be attained. The most that can be said in favour of the process is that while in some cases the formation of hail may have been prevented by the disturbance of equilibrium, hail frequently falls, in spite of frequent firing. The particulars of the experiments will be found in a recent number of the *Meteorologische Zeitschrift*.

DR. GOLDSCHMIDT, of Essen, has recently described a new welding process invented by himself (says *Fielden's Magazine* for October). The heat required is obtained by means of a compound called "Thermit." Metallic oxides, with aluminium, are its constituents, and it has the property of allowing a fusible mass at a high temperature to be quickly and simply produced. Its use in welding pipes and rails is its most interesting application, as, with its aid, rails can be welded immediately and economically and at any place, a melting-pot only being required. The details of the process are stated as follows:—"The melting-pot is filled with tar-oil, an inflammable mixture is added, and a match is used to ignite it. Spoonfuls of 'Thermit' are then added, which immediately ignites and produces temperatures as high as 3000° C. The highly incandescent contents of the pot consist of iron, called alumino-thermo-iron, on the top of which floats melted carborundum. An aluminium oxide is then poured on to the part of the rail to be welded, and the work is done so quickly that the melting-pot is cold and can be taken into the hand after being emptied."

SOME interesting observations on dielectric hysteresis have been lately published by M. F. Beaulard in the *Journal de Physique*. With condensers of paraffin and mica, little dissipation of energy by hysteresis was found, but with dielectrine, curves of hysteresis of the well-known forms were obtained. It was found, however, that the area of the curves and therefore the absorption of energy, varied with the period of time in which the cycle was performed, being less for slow than for rapid cycles. All this, the author considers, is explicable on M. Bouty's hypothesis, according to which the electric residue is due to a temporary retardation of the fictive polarisation on the polarising field. It is to be remarked that M. Pellat has rendered Bouty's explanation independent of the notion of fictive polarisation by proving the existence of a real polarisation varying with the time, thus explaining the phenomena observed in the present experiments, without assuming the existence of hysteresic properties in dielectrics analogous to those in magnetised bodies.

IN the *Bulletin* of the Cracow Academy, experiments are described by Constantin Zakrzewski on the electromotive force produced by the motion of a liquid through a silvered glass tube. The tube in question was a capillary tube connecting two large glass vessels half filled with water, and the electrodes terminated in the water at a short distance from the end of the tube. The flow of water was brought about by introducing compressed air into one of the vases. A current of water was always found to be accompanied by an electric current the direction of which depended on the water current, and the electromotive force was found (i) to vary as the difference of pressure at the ends of the tube; (ii) to depend on the distance of the electrodes from the ends of the tube, the effect of increasing this distance in the case of the electrode opposite the entering stream being to decrease the electromotive force. It is suggested that this result confirms the hypothesis of Quincke and Helmholtz, according to which the electromotive force has its origin in a kind of tearing of the layer of contact electricity between the silver and the water. The electromotive force depends on the thickness of the silvering, and decreases when the thickness increases. In the case of a solution of nitrate of silver, the electromotive force vanishes and changes sign when the concentration is equal to 1/3000 of the normal.

ABOUT three years ago, Dr. Folgheraiter published a description of observations of the "distinct" points and zones in the magnetisation of rocks, and showed that these singularities, of which he had observed a number in the Campagna, were due to lightning discharges. In a recent issue (No. 10) of the *Frammenti concernanti la geofisica dei Pressi di Roma*, the same author gives an account of certain measurements made with the object of determining (1) to what distance the magnetism produced by lightning produces any sensible action; (2) the direction of the magnetising lightning-discharge. The results already arrived at show that in certain singular zones (*zone distinte*) the direction of discharge is determinable, and the magnetic properties and distribution of magnetism resemble those of an ordinary magnet; while in the case of other zones it has been impossible, as yet, to ascertain either the direction of the magnetising discharge or the position of one of the two magnetic poles.

IN a recent number of *Terrestrial Magnetism and Atmospheric Electricity* (v., 2), Mr. William Sutherland puts forward a possible cause of the earth's magnetism and a theory of its variations. The cause suggested is the rotation of the electrostatic field within the earth, as Rowland's experiments have proved that a moving charge of electricity produces a magnetic field analogous to that of a current. If the earth carries round an electrostatic field in its rotation, then it will have the axis of its magnetic field identical with the axis of rotation, which is the chief approximate fact of the earth's magnetism. The actual obliquity of the magnetic to the rotational axis is traced to unsymmetrical magnetic permeability of the earth, which also causes the induction of earth currents, the secular variation of whose tracks is the cause of magnetic secular variation. The theory advanced to account for daily variation is that, under the action of the sun's rays, the oxygen and ozone of the atmosphere become the active substance of a large secondary battery or accumulator, whose alternate charge and discharge are the cause of the daily variations.

THE metamorphic rocks in Eastern Tyrone and Southern Donegal have engaged the attention of Prof. Grenville Cole, who has sought to determine the relative ages and relations of the granites and gneisses (*Trans.* Royal Irish Acad., vol. xxxi. Part ii. 1900). The oldest recognisable rocks in the two areas are schists foliated by dynamic metamorphism. In Eastern Tyrone, the occasional gneissic character of this schistose series has probably been induced by the intrusion of a granite magma, while the structures due to dynamic action have usually been lost in the new flow-structures set up. The gneisses, as well as the less altered schists, are traversed by and included in the granite of the Slieve Gallion type, which also cuts an overlying basic igneous series. In Tyrone, the older granitic material has not been exposed, but it appears in Southern Donegal, and there the granitoid gneiss is seen to be intrusive in an amphibolite series. The pure quartz-felspar-muscovite gneiss becomes rich in biotite at the junctions, and receives a foliated structure, which is due to flow and not to pressure-metamorphism. Similar relations have been observed elsewhere among the older metamorphic rocks. The Irish rocks, to which attention is now drawn, may all be of Archæan age, although the schists (termed Dalradian) are probably the oldest now remaining in the district. After referring to Dr. Callaway's researches in Galway, where he showed how gneiss has been formed by the intrusion of granite into a series rich in amphibole, the author remarks that his own observations tend to confirm the opinion that gneisses may be produced by admixture along surfaces of igneous contact, and that in such cases contact-metamorphism occurs upon a regional scale. Too often, however, the contact-phenomena on a broad scale have been removed by denudation from the surface of our granite domes, and we encounter them only in section along the flanks of the igneous mass.

THE official report of the polar expedition of the Duke of the Abruzzi is summarised in the *Times*. The following points are of interest. The *Stella Polare* left Christiania on June 12, and the farthest north point reached by it was 82° 4'. After this thet party had left the ship and established themselves on Rudolf Land. The Duke organised short excursions inland, in preparation for the great sledge expedition it was intended to undertake later. During an excursion at Christmas time the Duke and Cagni fell into a crevasse. The result of this was that two fingers of the Duke's left hand were incurably frostbitten, and the terminal joints had to be amputated. The shock of the fall and of the amputation affected the Duke's health so much that the doctor considered he was totally unfit to undertake the command of the expedition over the ice towards the Pole. Captain Cagni started on March 11, with a party consisting of ten officers and men, with numerous dogs and some sledges and kayaks. After nine days' march, during which 43½ miles were made, Cagni, finding the provisions running short, sent back Lieutenant Querini with two men. These three have not been heard of since. On March 31, when the sledge expedition had passed the 83rd parallel, Dr. Cavalli-Molinelli was sent back with two men. This, with two sledges and sixteen dogs, arrived safely at the main camp on April 24, having taken four days longer to return than to go. Cagni, in the meantime, continued his journey with three of the Italian Alpine guides. They were able to increase their speed to 9½ miles per day, and at last they reached Nansen's furthest north, 86° 14'. After a long and careful observation to make sure of this, they passed beyond, and on April 26, 1900, they touched 86° 33' N. at about 56° E., when they decided to turn back. No land was in sight, nothing but ice in a state of thaw. Petermann's Land, which Payer believed he saw, did not exist where he stated, otherwise Cagni would have seen it early in his journey. The same is said of King Oscar Land, which would otherwise have been seen on the return march.

WE have received the November number of the *Entomologist's Monthly Magazine*, which contains notes on the occurrence in Britain of several rare Lepidoptera during the past summer.

THE *Transactions* of the Hull Scientific and Field Naturalists' Club for 1900 contain a number of papers and notes dealing with local natural history and antiquities, among which may be mentioned one by Mr. T. Sheppard on prehistoric man in Holderness.

THE publishers have sent us the third part of Dr. Otto Fischer's elaborate treatise on the walk of man ("Der Gang des Menschen"). This section of the work, which is illustrated with seven plates, is devoted to a review of the scope of the whole investigation, and a summary of the movements of the lower limbs.

IN addition to a note by Mr. R. Hall on the change of plumage in certain birds, the August issue of the *Proceedings* of the Royal Society of Victoria (vol. xii. (n. s.), part I) contains no less than seven papers dealing with various groups of the invertebrate fauna of the colony. Two of these—on Isopod freshwater crustaceans—are by Prof. O. A. Sayce, each containing the description of a new genus. In a paper on the earthworms of the colony, Prof. Baldwin Spencer has to record two genera and a very large number of species as new to science.

IN the July issue of the *Journal* of the Straits Branch of the Royal Asiatic Society, Dr. R. Hanitsch gives an account of his recent expedition to Mount Kina Balu, British North Borneo, together with a summary of its zoological results. The examination of many of the specimens acquired was undertaken by specialists in England and Calcutta; and among the novelties are a new genus of freshwater fish and one of snakes, as well as two other new species of reptiles and one of batrachians, all these having been described by Mr. G. A. Boulenger. The paper is illustrated by two excellent photogravures of Bornean mountain scenery, as well as with two plates of the new reptiles, batrachian and fish. A second paper by Dr. Hanitsch deals with a flying frog of the genus Rhacophorus; and Mr. H. N. Ridley contributes a note on the use of the slow loris in Malay medicine.

WITH the commencement of the current volume of the *Botanical Gazette*, Prof. J. C. Arthur has vacated the editorial chair, which he has occupied since 1886. The responsible editors are now Prof. John M. Coulter and Prof. Charles R. Barnes.

WE have received a prospectus of the County School of Horticulture, Chelmsford, established by the Essex County Council, under the direction of Mr. David Houston and Mr. Charles Wakely. Instruction is given in the various branches of scientific horticulture, and certificates of proficiency are awarded. The technical instruction committee offer free instruction, travelling allowance, and, at their discretion, board and lodging, to fifteen pupils from the county of Essex, to be selected from candidates who fulfil the necessary conditions. Scholarships are also awarded, tenable for two years at the gardens of the Royal Horticultural Society, Chiswick, or other gardens approved by the committee.

NOW that the new Imperial Agricultural Department is settling down to steady work under Dr. Morris, the issue of the series of publications intended to supply colonial cultivators with the latest information on questions of interest to them is becoming more regular. The fourth number of the *West Indian Bulletin*, which has just reached us, is a double number, of 136 pages, in which Mr. Maxwell-Lefroy, the entomologist to the Department, deals with "Moth Borer in Sugar Cane"; Prof. d'Albuquerque and Mr. Bovell describe "Sugar Cane Experiments at Barbados"; Mr. Scard describes "Some Experiences with Seedling Cane in British Guiana"; the Hon. Francis Watts, "Tree Planting in Antigua" and "Care of Pastures in Antigua"; and Mr. J. H. Hart, "Some Fungi of the Cacao Tree." In addition to these contributions there are others on "Sugar Cane Experiments in Louisiana"; "The Fixation of Atmospheric Nitrogen by Leguminons Plants"; "Cacao Industry in Grenada"; "Agricultural Education in English Rural Schools," also in French rural schools; and "Fumigation of Seeds and Plants." Some of the articles are suitably illustrated. It is to be hoped that the planters and others in the various islands are making a careful study of the valuable facts thus brought to their notice by the Imperial authorities, and that they are recognising the absolute necessity of introducing more modern scientific methods into their systems of cultivation and preparation of goods for market, otherwise they must inevitably suffer in the keen competition with those who adopt all the latest discoveries of science to aid them in their calling.

WE have received from Prof. Francesco Porro, of Turin, a reprint of a note communicated by him to the *Giornale di Matematica* (Naples: B. Pellerano, February), containing a simple exposition of the problem of the motion of a planet about the sun. The paper is based on the methods adopted in Prof. Porro's university lectures.

THE September number of the *Physical Review* contains a photogravure frontispiece of the late Thomas Preston, of whom "E. M." contributes a short biography. It also contains a *résumé* of our knowledge of Becquerel rays, by Mr. Oscar M. Stewart.

MM. J. B. BAILLIÈRE ET FILS, Paris, have just published a "Catalogue général de Livres de Science" comprising the titles of books on all branches of physical and natural science. The catalogue contains more than five thousand titles, and reference to its contents is made easy by a detailed index.

MESSRS. ROBERT BOYLE AND SON, LTD., have issued a catalogue of lantern slides for lectures on ventilation, which they are prepared to lend, free of charge. The slides illustrate chiefly the Boyle system of ventilation applied to buildings of various kinds.

AN acetylene generator designed for use with optical lanterns, is included in Messrs. Newton and Co.'s supplementary list of lantern slides for the session 1900-1901. Among the new slides are sets illustrating the methods and results of eclipse observations made by Sir Norman Lockyer's expeditions of 1896 and 1898, Prof. R. W. Wood's photographs of sound waves, and Dr. J. L. Williams's photo-micrographic studies of the morphology and pathology of enamel of teeth.

A NOTEWORTHY characteristic of recent catalogues of many scientific instrument makers is the cheapness and simplicity of a large number of the instruments mentioned and illustrated. The catalogue of electrical apparatus and accessories just issued by Messrs. W. and J. George, Ltd. (late Messrs. F. E. Becker and Co.) is no exception to this commendable feature. Formerly it took years for a good piece of apparatus to find its way into an instrument maker's catalogue, but now the apparatus often becomes available a few months after it has been shown at a scientific society. We notice in the present catalogue, in addition to the usual instruments for lecture-rooms and laboratories, Davidson and Headley's localisers for Röntgen ray work, apparatus for Tesla's experiments with alternating currents of high frequency, and for Hertz wave experiments and wireless telegraphy.

MR. THOMAS MURBY has recently issued new editions of three text-books of science published by him. Prof. Meldola's book on "Inorganic Chemistry," which originally appeared twenty years ago, has been brought more or less into line with the present position of chemical science by Mr. J. Castell

Evans. The chapter on spectrum analysis might with advantage have been revised by some one familiar with recent work. The statement that "450 of the Fraunhofer lines have been observed to coincide with the lines of the iron spectrum," is, like several others, far behind the times, for more than 2000 coincidences have been photographed. A new edition (the tenth) of Skertchly's "Geology" has been prepared by Dr. James Monckman. A new section on petrology has been added to make the book suitable for the present requirements of the examiners of the Board of Education (South Kensington). A few alterations have been made, but the revision is not entirely satisfactory. For instance, a page is devoted to observations made by Mr. W. J. Henwood in 1871 on the temperatures of mines, although an excellent summary of such observations, containing far more instructive information, was given by Mr. Bennett Brough before the Society of Arts four or five years ago, and might have been used. A table of determinations of the earth's density is given, but it does not contain any of the observations made during the last ten years. Lord Kelvin remains Sir William Thomson; and only his early conclusions, and Helmholtz's, are given concerning the age of the earth. The figures, as well as many of the facts, are old-fashioned, and Dr. Monckman would have done better to have rewritten the book from the point of view of the geologist of to-day instead of attempting to adapt past ideas to present positions. Mr. Frank Rutley's little book on "Mineralogy" has deservedly had a successful career, and the twelfth edition, which Mr. Murby has just published, is a veritable *multum in parvo* as regards information of service to elementary students of mineralogy. Among the changes are the addition of a brief outline of the recently adopted treatment of crystal symmetry, a few figures of crystals, and the revision of the chemical formulæ.

THE additions to the Zoological Society's Gardens during the past week include two Patas Monkeys (*Cercopithecus patas*, ♂ ♀) from West Africa, presented by Mr. E. Jones; a Syrian Bear (*Ursus syriacus*) from Western Asia, presented by Mr. Robert de Rustafjaell; a Peregrine Falcon (*Falco peregrinus*) from Canada, presented by Mr. T. H. Small; an Osprey (*Pandian haliaetus*), captured in the Red Sea, presented by Captain T. Yendell; a Bush Dog (*Icticyon venaticus*, ♀) from Colombia, a Tayra (*Galictis barbara*) from South America, a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, three Wattled Honey-eaters (*Anthochoera carunculata*) from Australia, deposited; a Bosman's Potto (*Perodicticus potto*) from West Africa, a Bouquet's Amazon (*Chrysotis bouqueti*) from Dominica, two Ruddy Sheldrakes (*Tadorna casarca*, ♂ ♀), two Knots (*Tringa canutus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE PLANET EROS.—A good opportunity will be offered for detecting this little object on the early evenings of November 10 and 11 before moonrise. The planet will pass near the 5th magnitude star, 4 Persei, the positions of the objects being as follows:—

	R.A. h. m. s.	Decl. ° ′
4 Persei	1 55 38 ...	+54 0
Eros, November 10 ...	1 56 53 ...	+54 21
November 11 ...	1 54 51 ...	+54 19

The position for 4 Persei is for 1900. The places of Eros are for Berlin mean midnight, corresponding to G.M.T., 11h. 7m.

On November 10 Eros will be about ½° N.E. of the star, and on November 11 about ⅓° N.N.W. of the star. The magnitude of the planet will be 9½. If the small stars in the region indicated are carefully watched, Eros may soon be identified by his motion.

EPHEMERIS OF COMET 1900*b*.—The following is an abridgment from a complete ephemeris communicated by Herr A. Wedemeyer to the *Astronomische Nachrichten* (Bd. 153, No. 3670).

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 8 ...	15 26 1·69 ...	+66 7 1·6
10 ...	29 5·06 ...	66 17 18·7
12 ...	32 10·10 ...	66 29 12·3
14 ...	35 16·92 ...	66 42 41·4
16 ...	38 25·58 ...	66 57 45·0
18 ...	41 36·22 ...	67 14 22·2
20 ...	44 48·90 ...	67 32 31·9
22 ...	48 3·70 ...	67 52 12·5
24 ...	51 20·75 ...	68 13 22·8
26 ...	54 40·11 ...	68 36 1·5
28 ...	15 58 1·85 ...	69 0 6·5
30 ...	16 1 26·23 ...	+69 25 35·9

NEW VARIABLE STARS.—In the *Astronomische Nachrichten* (Bd. 153, No. 3669), Herr Jos. Hisgen, of the Valkenburg Observatory, announces that he has detected variability in a star in Cygnus having the following provisional position:—

R.A. = 19h 43m 19s. }
Decl. = + 48° 49′·3 } (1900·0)

The star reaches the 9th magnitude, and the light changes comprises at least *four* magnitudes: an approximation to the period is given as about 250 days.

IN the *Astronomische Nachrichten* (Bd. 153, No. 3670), Dr. T. D. Anderson announces the variability of a star in Pegasus, the change of which has hitherto escaped notice. The position is as follows:—

R.A. = 22h. 4·6m. }
Decl. = + 13° 38′ } (1855·0).

The variation in magnitude is not completely stated, but at its maximum brightness the star is about 9·9 magnitude, while at minimum it was invisible in a 3-inch telescope.

IN the same issue of the above journal, Mr. A. Stanley Williams calls attention to a new variable star in Lyra with the following co-ordinates:—

R.A. = 18h. 32m. 51s. }
Decl. = +43° 49′·6 } (1855·0).

The variation of magnitude was determined photographically from plates taken with a portrait lens of 4·4 inches aperture. When at its greatest brightness the star is of about 10·5 magnitude, diminishing to a minimum of below 12 magnitude. A table of successive observations indicates maxima to have occurred about December 31, 1899, and September 3, 1900.

ASTRONOMICAL WORK AT DUNSINK OBSERVATORY.—The ninth volume of astronomical observations and researches at Dunsink, the observatory belonging to Trinity College, Dublin, consists chiefly of a catalogue giving the mean places of 321 stars, furnished by observations made with the meridian circle during 1898-9, under the direction of Prof. C. J. Joly, the Astronomer Royal of Ireland. The instrument has been provided with a new reticle having three sets of five vertical wires instead of five sets as formerly. The actual observations and preparation of the catalogue were done by Mr. C. Martin.

THE LEONID METEORIC SHOWER.

WITH the return of the Leonid epoch we are naturally led to inquire as to the prospect immediately before us. The expectation of preceding years having been grievously disappointed, observers cannot help feeling very dubious as to the return of the meteors. This is accentuated by the fact that computations made under Dr. Downing's directions show that since their return in 1866 the denser part of the stream has been subject to considerable perturbation. At the middle of November 1899 the meteors probably passed about 1¼ millions of miles inside the earth's orbit, and therefore escaped a rencontre with the earth. At the ensuing approach the conditions appear even less favourable, for the calculations indicate that the swarm will pass us by at a point about 1¾ millions of miles nearer to the sun than the earth. There would seem therefore to be little chance of a rich display this year.

No one can question that the calculations so far as they go are perfectly trustworthy. But is it possible, in dealing with an enormous assemblage of meteors in respect of which our knowledge is admittedly very inadequate, to define either its position, extent or density with great exactness? There is still much of mystery involved in comets and meteors. It is just possible that some development or variation in the system of Leonids will bring it prominently into view again this year. At any rate, this must be regarded as a quite possible contingency, for it is certain that every feature connected with and influencing the visibility of the meteors cannot have been allowed for. Our historical knowledge of the various attributes of the stream is very rough and incomplete, for the swarm has only made one visible return since meteoric astronomy has been recognised as an interesting and important branch of astronomy.

But, whether or not the mathematical conclusions are justified or falsified by the experiences of next week, every one of us encourages the hope that a plentiful, if not a brilliant, display of meteors will be seen. And astronomers in every part of the world will look for it as a duty. Charts will be got ready for properly recording the paths; cameras will be put into position and every preparation made to suitably record the display should it put in an appearance. The event is not only magnificent as a spectacle, but it is capable of teaching us some valuable lessons.

The moon will offer some interference this year, as she rises on November 13 at 11h. 1m., on November 14 at 12h. 8m., and on November 15 at 13h. 13m., but she will be in her last quarter, so that her light will only obliterate the faintest class of meteors. She will, unfortunately, be situated near the Sickle of Leo. The planet Mars will be placed a few degrees north-west of Regulus. On November 14, at 5h., the moon and Mars will be in conjunction, the latter being 7½ degrees north.

If the shower proves strong or feeble it should be attentively watched on the three nights of November 13, 14 and 15, if the weather is sufficiently clear for the purpose. Regular meteoric observers will also endeavour to trace some of its meteors on dates preceding and following those mentioned. It is not certain that the radiant moves like the Perseids, and we require more data with reference to the duration of the shower. Meteors certainly fall from the Sickle—and they are, presumably, true Leonids—between November 7 and 21. It will be important, therefore, to determine the exact place of the radiant on every night possible during the fortnight mentioned. This will be difficult this year on dates before the maximum owing to the strong moonlight, but it ought to be easy of attainment for a few dates after the 15th, for the moon rapidly wanes and the long nights permit of watches during the eight hours or so from the rising of the radiant at about 10h. 15m. to between 6 and 7 a.m.

The feature to which ordinary observers may usefully direct their attention, should the phenomenon recur under pretty bright aspects, is that relating to the time of maximum display and the number of meteors visible. They should be counted and recorded at, say, five-minute intervals, and registered on forms previously prepared for the purpose. Where several observers combine to effect observations they will, of course, look to different quarters of the sky and be careful to avoid numbering the same objects.

The radiant point at about the time of maximum can be well left to the care of those who have adopted the photographic method. We have already accumulated a large number of determinations by the ordinary eye method; we now require more correct values, such as it is hoped the camera will afford us.

There are many showers in the region of Leo which furnish streak-leaving meteors, and no object should be included in counts of Leonids if its direction of flight when carried backwards does not cut through the Sickle. The best of these circinal Leonid showers is at $154° + 40°$ from a point about 17 degrees north of the Leonid radiant.

While observers are watching for the Leonid display, it often happens that not only are a few bright Leonids seen, but several large meteors appear from minor radiants. It used to be the custom to term the latter "sporadic" meteors, but they belong to well-defined systems, the great majority of which have now been ascertained. In all cases where a fine meteor is seen its apparent path on the celestial sphere should be as carefully recorded as the circumstances permit, and the time of apparition noted. If this plan were followed in every case a number of multiple observations of the same meteors would be available for computing their real paths in the atmosphere. It is hoped, therefore, that this important feature of the work will not be neglected during the ensuing observations, for it need occupy little time, and will certainly provide some valuable material for after comparison and discussion. Last year, on the morning of November 15, there was a magnificent meteor many times brighter than Venus, and though it was well seen at five or six of the leading observatories in England, its path position was not particularly recorded at any one of them.

The most probable time for the recurrence of the shower will be on the night following November 14, and a watch should be commenced soon after the radiant has risen. As a rule, not many meteors are discharged from a low radiant; but what is lacking in numbers is often compensated for by appearance. The Leonids seen before midnight are usually very conspicuous, owing to their long paths, dense streaks, and apparently more gradual flights than those which appear at a later hour of the night, when the radiant has attained a fair altitude. For my own part, I certainly entertain the hope that the display will put in appearance on November 14, and that, though its splendour may fall far short of that of some previous returns, it may yet prove gratifying to those who have looked for the shower in vain during the last few years. In any case, it is to be hoped that the atmosphere will be favourable, for much depends upon the state of the sky; and it is important that we should ascertain in what strength the event returns. W. F. DENNING.

THE NOBEL PRIZES FOR SCIENTIFIC DISCOVERY.

A BRIEF note upon the prizes endowed by the late Dr. Nobel has already been given (p. 11). A translation into English of the regulations under which the prizes will be awarded is given in *Science*, and the essential parts are here stated for the convenience of investigators unable to see a copy of the official document just distributed by the Board of Education.

The three corporations awarding the Nobel prizes are:

(1) The Royal Academy of Sciences, at Stockholm. The King is the protector of the Academy, which numbers 100 Swedish and Norwegian members and 75 foreign members. (2) The Swedish Academy, at Stockholm. The King is the protector. The members, exclusively Swedish, are limited to 18. (3) The Carolin Institute of Medicine and Surgery, at Stockholm. The number of professors is 22.

The Nobel endowment is based on the will of Dr. Alfred Bernhard Nobel, engineer, drawn up November 27, 1895. The stipulations are as follows:

"The remainder of the fortune which I shall leave shall be disposed of in the following manner: The capital, converted into safe investments by the executors of my will, shall constitute a fund the interest of which shall be distributed annually as a reward to those who, in the course of the preceding year, shall have rendered the greatest services to humanity. The sum total shall be divided into five equal portions, assigned as follows:

"(1) To the person having made the most important discovery or invention in the department of physical science.

"(2) To the person having made the most important discovery or having produced the greatest improvement in chemistry.

"(3) To the author of the most important discovery in the department of physiology or of medicine.

"(4) To the author having produced the most notable literary work in the sense of idealism.

"(5) To the person having done the most, or the best, in the work of establishing the brotherhood of nations, for the suppression or the reduction of standing armies, as well as for the formation and the propagation of peace conferences.

"The prizes will be awarded as follows: For physical science and chemistry, by the Swedish Academy of Sciences; for works in physiology or medicine, by the Carolin Institute of Stockholm; for literature, by the Academy of Stockholm; finally, for the work of peace, by a committee of five members, elected by the Norwegian Stortung. It is my expressed will that nationality shall not be considered, so that the prize may accrue to the most worthy, whether he be a Scandinavian or not."

Each of the annual prizes established by the will will be awarded at least once in the course of every period of five years, commencing with the year immediately following that in which the Nobel endowment enters on its functions, and the sum total of a prize thus awarded will in no case be less than 60 per cent. of the part of the yearly revenues disposable for the distribution of the prizes; neither can it be divided into more than three prizes at the most.

Immediately after the approval by the King of the statute of endowment, the corporations will designate the stipulated number of representatives, who will assemble at Stockholm and elect the members of the board of administration, who will have the management of the endowment fund at the beginning of the year 1901. The executors of the will will take appropriate measures to terminate the settlement of the succession. The first distribution of prizes for all sections will take place, if possible, in 1901. From the endowment resources will be deducted: First, a sum of 300,000 crowns (16,000*l.*) for each section—that is, 1,500,000 crowns (80,400*l.*) in all—which, with the interest commencing from January 1, 1900, will be used to cover, in proportion, the expenses of the organisation of the Nobel institutes in addition to the sum the board of administration shall judge necessary for the acquisition of a special site destined for the administration of the endowment and including a hall for its meetings.

The right of presenting proposals for prizes belongs to—

(1) Native and foreign members of the Royal Academy of Sciences. (2) Members of the Nobel committees for natural philosophy and chemistry. (3) Professors who have received the Nobel prize of the Academy of Science. (4) Ordinary and extraordinary professors of natural sciences and chemistry in the Universities of Upsala, Lund, Christiania, Copenhagen and Helsingfors, in the Carolin Institute of Medicine and Surgery, the Superior Technical Royal School, as well as to the professors of the same sciences in the Stockholm High School. (5) Incumbents of corresponding chairs of at least six universities or high-schools, which the Academy of Science will select, taking care to divide them suitably between the different countries and their universities. (6) Learned men, to whom the Academy shall judge proper to send an invitation to this effect.

The invitations will be sent every year in the month of September. Proposals for the prize must be made before February 1 of the following year. They will be classified by the Nobel committee and submitted to the college of professors. The Nobel committee will decide which of the works presented shall be submitted to a special examination. The college of professors will pronounce definitely on the distribution of the prize in the course of the month of October. The vote will be taken in secret; if necessary, the question may be decided by drawing lots.

The right to present candidates for the Nobel prize belongs to the members of the Swedish Academy, the French Academy, and the Spanish Academy, which resemble the Swedish Academy in their organisation and aim; to the members of the literary departments of other academies, as well as to the members of literary institutions and societies analogous to academies; to professors of æsthetics, of literature and of history in the universities. This order must be published at least every five years.

ELECTRICAL ENGINEERING AS A TRADE AND AS A SCIENCE.[1]

I DO not intend to make this in any sense a report of the progress of our Institution during the last or any number of years. I shall not, therefore, give any account of the exceedingly good work done by Colonel Crompton and the active service corps of our Electrical Engineer Volunteers in South Africa. I shall not describe how we *fêted* our American cousins in England and France, or how they *fêted* us; nor what a wonderful success accompanied all that was attempted by us or by them or by M. Mascart and our French colleagues, although I cannot refrain from bearing my testimony to the great kindness of the Prince of Wales and the British Commission in so generously lending us the British Pavilion for our great reception, and giving us the use of one of its rooms for our office all the time of our visit to Paris.

My brother has tried to get me to introduce to your notice some novel ideas which have come to us during the last ten years in our business of lighting the city of Galway from a fairly constant water-power, using accumulators with a gas plant stand-by. It has almost come to be a practical idea to produce carbide of calcium in wet seasons and utilise it through the gas engine in dry seasons. I was also tempted to discuss the use of large gas engine plant at central stations; and another of several subjects in which I have been recently engaged has been the magnetic effect produced by systems of electric traction. But I have resisted temptation and have chosen a subject which seems to me much more important.

Your president's address is followed by no discussion. He is, therefore, privileged, but his very privileges cause him to address you with a greater sense of responsibility; he may say what he pleases, but he must be very sure that he has the best interests of the Institution at heart; the interests of the Institution as a whole, not the interests merely of a few members, and least of all ought he to think of his own interests. Nevertheless, your president speaks not as an omniscient judge, but rather as a very fallible, very prejudiced, one-sided man who, because he has devoted himself to one part of the work of this Institution, is certain to be unfair in his comments upon other parts of the work.

Your past presidents represent in this way all classes of members of this Institution. You have had scientific men, given some of them to calculation and some to experiment, and some to both; men who have advanced the study of pure science. You have had practical telegraph men, civil and military; men cunning in land and deep-sea telegraphy and telephony; men cunning in railway signalling. You have had electrical chemists. You have had manufacturers and users of all kinds of electrical appliances. You have had men who devote themselves to the teaching of electrical engineers, and who fully appreciate the fact that no good teacher ought to be out of practical touch with the profession. And nearly all of your past presidents have invented things which are now in practical use.

As each of these men has given you at least one address written from his own peculiar point of view, his prejudices are not likely to have done any harm to members who read the other addresses. I know, therefore, that you are good-naturedly prepared to give me plenty of rope. I can predict the twinkle of amusement in the faces of some of my friends when they learn that I am about to take up a subject on which we have had many debates.

In this address I mean to put before you this simple question: Is electrical engineering to remain a profession or is it to become a trade? Is this Institution to continue to be a society for the advancement of knowledge in the applications of scientific principles to electrical industries, or is it to become a mere trades union?

Of course, at the present time the outside public are willing to regard membership of this Institution as a symbol of something more than the membership of a mere trades union. During the early growth of any trade, even such a trade as that of the plumber, it was really a profession. And a common trade may suddenly become a profession, if it suddenly begins to develop, as, for example, stone-masonry of a hundred years ago suddenly developed into civil engineering. Electrical engineering has been developed rapidly, so that in the past it has certainly been a profession and not a trade.

Again, we are an institution of engineers, and the general public are willing to class us with other engineering institutions—for example, the Institution of Civil Engineers. Now the title M.Inst.C.E. is a professional distinction which represents in civil engineering what F.R.C.S does in surgery, or M.R.C.P. in medicine. We owe a great deal to our association with, and recognition by, the Institution of Civil Engineers; our meetings are held in its rooms; many of our members are also its members; our proceedings are modelled on its proceedings.

Now this older Institution, governed by the best thoughts of the best British engineers, has laid it down that its associate members, that important class from which the higher class is mainly fed, shall have passed certain specified examinations in pure and applied science. I am not now suggesting that we ought to adopt this science examination method of admitting any kind of members to our Institution. I do not believe in the wholesale adoption of methods of working from another society. I am asking you early in my address to remember that this greatest of all professional engineering institutions, governed by practical men full of common sense, knowing the wants of their

[1] Inaugural Address, delivered at the Institution of Electrical Engineers on November 8, by Prof. John Perry, F.R.S., President.

profession well, insists upon a knowledge of science in its new members. If this recognition of science did not exist anywhere else in the whole world, I say that its recognition by such a thoroughly good professional society as that of the Civil Engineers ought to recommend it to all professional societies.

In Germany an enormous stride has recently been made in the raising of Engineering degrees to rank with the highest University honours. There is hardly one engineer of eminence in Switzerland, France or Germany who has not passed with honour through the classes of one of their great science Universities.[1] In Great Britain, within the last fifteen years, not only have great engineering schools been established in all the manufacturing towns, but even in Cambridge University there is one of the best schools of civil, mechanical and electrical engineering of which I know anything.

Before we think of imitating the Institution of Civil Engineers, we ought to reflect on certain fundamental distinctions between that Institution and our own, which at first sight seem to make us less professional.

There is a well-known unwritten rule of the Civil Engineers, to which there are only a few exceptions, that no contracting railway or harbour engineer can acquire the title of M.Inst.C.E. I think myself that it is a pity to draw a hard and fast line between consulting engineers and contractors. No doubt it simplifies the labour of the Council in its selection of candidates, but it gives rise to anomalies.

A man, who was once a civil engineer because he served a pupilage under his clever father, and who now is nominally at the head of his father's large practice, the real engineering work being done by many clever employees, this man may be a member. A contracting engineer who shows marvellous ability, not only in rectifying the mistakes of the designer of a large bridge or tunnel or reservoir embankment, but shows the power of Lord Kitchener in directing the work of thousands of men, so that no man need be idle, and the whole contract goes on like clockwork, and is finished well in the minimum of time, this man is ineligible. Now, in our institution, it has been recognised from the very first that manufacturers and contractors and their employees may belong to the very highest ranks of their profession. Of course, I do not mean men who simply receive the profits of businesses, or even men who merely work to obtain orders for themselves. I mean men who are not merely formally, but in reality manufacturing or contracting engineers. I mean men who, in dealing with standardised things, design new methods for quick, good, cheap production of such things. I mean men who improve old forms of things, possibly through their paid subordinates. I mean by a manufacturer fit to be a M.I.E.E., a man who might act as his own manager, and who, perhaps, has a wider outlook than on mere managerial duties. So long as a contractor or manufacturer is really an engineer, we know that we add to our strength with the addition of every such member.

But consider a contractor who only uses ordinary types of machines or electrical plant in well-known ways, surely he can hardly be said to be in the profession at all. Surely the one thing that differentiates us from mere tradesmen is that we do not follow mere rule of thumb methods; we think for ourselves, we weigh advantages and disadvantages. If every new installation required the same treatment as existing ones, the engineer would degenerate into a tradesman, and it seems to me that the electrical engineer ought to have a special fear of such degeneration.

In railway and harbour and river and sanitary engineering, in every new job, there are new difficulties to be dealt with. An engineer who designs many undertakings and sees them carried out must be a thoughtful man; he cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires a somewhat different treatment from any old case. Every case brought before a barrister requires the exercise of all his past experience. In every case a *profession* implies the necessity for the exercise of all one's past experience; because the work one has to do is never the same as any work one has ever done before. And when I say past experience, I really mean certain general principles which one has always in one's mind, principles derived from all that one has done or seen or read about.

[1] I understand also that the great unions of manufacturers in *Germany* are about to make facilities for giving a year of real factory work to the Polytechnic students, thus perfecting the German system. In Japan we found great success in requiring students to spend their summer in real shops, their winters at college. In England it may be that we shall prefer to let apprentices have shorter factory hours than workmen, their masters being responsible for instruction being given in theory.

Electrical engineering is in a curious position. It owes its being altogether to scientific men, to the laboratory and desk-work of a long line of experimenters and philosophers. Even now the work going on in a laboratory to-day becomes the much larger work of the engineer to-morrow. When at length the laboratory experiment is utilised in engineering, we see that there is no other kind of engineering which so lends itself to mathematical treatment and exact measurement. Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made exact measurements may be made to test the accuracy of our theory. For a completed machine or any of its parts can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested.

Contrast this with the calculations it is possible to make in other kinds of engineering. The pressure of earth against a revetement wall is possibly 200 or 300 per cent. greater, or 50 to 70 per cent. less than what we imagine it to be in what some limited men call theory. We use factors of safety 5 or 10 or more on all kinds of iron structure calculations, because we are aware of our ignorance of a correct method of dealing with the problems. The civil engineer never has exactly the same problem as has already been solved. In tunnelling, earthwork, building, &c., in making railways and canals, he is supremely dependent on the natural conditions provided for him; the configuration of the surface of the ground, the geological formation, the structural materials available in the neighbourhood. The story of how the engineer has to study the endlessly different ways of interaction of water and sand and gravel is told by the troublesome bars at the mouths of rivers all over the world, by the difficulties of coast and river-bank protection, by the failure of sea walls and piers. But why should I make a catalogue of the different kinds of work done by civil engineers? Every one of them needs the exercise of general scientific principles due to much experience.

Now of all such natural difficulties the consulting or contracting electrical engineer is greatly independent. Give him a source of power, and tell him what is to be done; whether he is to light a town or a building, whether with arc or incandescent lights; whether he drives a stamp mill near a mine or a pump, or a machine tool, or a spinning frame, the electrical part of the work is carried out in much the same way. Natural conditions affect him mainly in the cost of transport of his materials and the cost of labour. He can make in an easy way the most careful calculations as to the best arrangement of his conductors and machines to give maximum economy, and except for this easy calculation his work is that of a mere tradesman. He is practically independent even of the weather. There are, indeed, some of us who grumble that this easy calculation is not made easier still, who prefer to make arithmetical guesses rather than exact calculation, because perhaps we like to see a little uncertainty introduced into the problem to make it more like a problem in civil engineering. I want members to see clearly that as times go on, as our electrical engineering work gets more and more cut and dried, the man who loses the power to calculate, who loses his grip of the simple theory underlying our work, must sink more and more into the position of a mere tradesman who has no longer the right to call himself an engineer.

An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things. It has become the custom to call this *theory*, and I suppose I must follow the custom. I should prefer to call it *Science*[1] or *knowledge*. Do you remember Huxley's definition of Science? "Science," he said, "is organised common sense"; and this is really what I mean. Well, calling it *theory*, the man who is

[1] What Falstaff said of the word "occupy" we have to say of the word "Science." It is used by many people out of its proper meaning and then condemned, so that one is getting afraid to use it. In Prof. Fitzgerald's splendid inaugural address to the Dublin Section of this Institution he says: "As has recently been pointed out to me by Dr. Trouton, it would be impossible to say the same contemptuous things of *knowledge* as are said of *Science*. In Germany the word used, 'Wissenschaft,' is the one corresponding to our word 'knowledge,' and there nobody of any sense could say that 'knowledge is all humbug,' as is here often said, and still oftener thought, of 'Science.'"

permeated by theory, whose theory is so much a part of his mental machinery that it is always ready for practical application to any problem, he is the real engineer. But you must not mistake me in this matter. Eighty per cent. of the men who pass examinations in mathematics, mechanics and electricity have very little of this theory. Fifty per cent. of the writers of letters in the engineering journals in which mathematical expressions occur have almost nothing of this theory in their possession. It is unknown to foolish men. Books alone, lectures alone, experiments alone, workshop experience alone cannot teach this theory. The acumen of a Q.C. may actually prevent a man from acquiring it. A man may have much of this theory, although he may never have listened to lectures, although he may dislike the sight of a mathematical expression. I have known men who might be called illiterate to possess much theory. I have known many men who might be called good *electricians* who are almost wanting in the theory necessary for the electrical engineer.

I am speaking only of theory. Of the other qualifications for an engineer I need not here speak; they are present to the minds of all of us. A man may have any amount of knowledge; he may know how to apply his knowledge, and yet he may not be able to apply the knowledge from a want of engineering *character*.

The engineer must be a real man; he must possess individuality, the power to think for himself. He must not be like a sheep, knowing only enough to follow the bell-wether. Over and over again in the last thirty years have some of us given our students much the same sort of advice that Baden-Powell gives to scouts in that excellent little book of his. If any of you have not read that book you ought to buy it at once, and you will there find that if a man is to think for himself he must possess all kinds of knowledge, he must be constantly picking up new kinds of knowledge.

Nobody can limit the value of any kind of knowledge, but still one may say that certain things are probably more important than others. To gain what we call "theory" a good general education is most helpful—mathematical knowledge is very helpful; laboratory and workshop experience are extremely helpful. There is one qualification which the electrical engineer must have and without which all other qualifications are useless, and if a man has it no other qualification is supremely important, and this absolutely indispensable qualification is that a man shall love to think about and work with electrical things. He must like these, not because of the money he can make through electrical contrivances, nor even, I think, because of the name he may make before the world—this would be mere liking or cupboard love which has no lasting quality. So long as we have men in this country who have the true love for scientific work of which I speak, so long shall we have a real profession of electrical engineering, for such men are always scheming new contrivances and improving old ones and utilising the services of all helpful people, and especially of capitalists. When we have reached a state in which nobody schemes new things because the existing things are perfect there will no longer be a profession of electrical engineering. Of all ideas surely that of having reached *perfection* is most hateful: the idea of exact knowledge, that nothing is unknown, that there is no need for thought and therefore that to think for oneself is a sin.

And so, although we are all agreed that much standardisation in our contrivances and methods is absolutely necessary for our competition with other nations, we must follow the Americans in this matter and take care that it does not destroy invention. Of course when things are really standardised, when we have our perfect Mauser rifle or dynamo or locomotive or traction engine or electrically driven stamp mill, a Boer can buy or even manufacture them if he has money, and he can use them as well as, or possibly better than, we can. But he is not an engineer. He uses things after the engineer has done his work upon them. A stoker, a common engine-driver, the guard of a train, these are not engineers. You must have noticed that the American engineers, who surely deserve the character of being practical idealists above all other engineers, are the men who are most imbued with notions of standardisation which lead to cheapness of manufacture, and they are also the men most alive to the necessity for occasional scrapping of types of machinery when they become even a little antiquated.

Our chiefs, the men who run us all, our real men at this Institution, may be called Practical Idealists. They have imagination and judgment and individuality. They have the imagination and enthusiasm of inventors, and yet they are more than inventors, for they can estimate the worth of their own inventions and control their imaginations. They are ready to receive all new things, and yet they are not carried away. They are radicals and yet they are conservatives. They have what Mrs. Beecher Stowe called *Faculty*.

A strong imagination well under control, surely it is the greatest of mental gifts. I look round me and wonder how many of us really have it; and how many of us are only dull music-hall loving men, who scorn novels and poetry, who live utilitarian, material lives, whose aim is merely to make money through electricity, who love it not for its own self, who cherish their "tuppeny-ha'penny-worth" of theory because it is sufficient for their immediate wants. Why, even the writers of leading articles in the daily papers can talk of the wonders of electricity and what may yet come to pass; and yet we who make machines and use them and switch the marvellous thing on and off and take all sorts of liberties with it—we are like Calibans oblivious of the wonders of the fairy isle—like soulless priests making a living in the temple of Isis—like Aladdins who rub our lamp only to get the necessaries of life.

Twenty years ago some of us were laughed at for our optimism, and yet everything that we declared then to be doable has now actually been done by engineers, except the thing which was then and is now declared to be the supremely important thing, namely, the electric consumption of coal. We say now, as we said then, "The applied science of the future lies invisible and small in the operations of the men who work at pure chemistry and physics." And think of the wonderfully rapid rate at which laboratory discoveries have been made in the last eleven years, and how as the years go on they become more and more numerous; and yet many of us plod along with our work seeing no farther than our noses. A year is now more pregnant with discovery than a hundred years used to be, and yet the protective stolidity of our ancestors is upon us and we think of the latest discovery as if it were really the very last that can be made. A thousand men are measuring and trying new things in laboratories all over the world. Some of them plodding and soulless; others of them with imagination and clearness of vision. Do you think that nothing is to come from all that work?

And is it not one of the most important functions of the engineer to do as Mr. Marconi has done, to convince capitalists ignorant of science that if the successful laboratory experiment is tried on the large scale, it must also be successful? And are we going to leave all this pioneering work, with all its possibilities of great gain, albeit with possible loss, to foreign engineers, when in most cases the scientific discovery has been made in England? Are we so lacking in the hope and faith which are born of imagination and science? And must we in the future, as in the past, have to rely upon the influx of the clever foreigner like Sir William Siemens? Must we, Boer-like, always depend upon our Uitlander population, Fleming and German, Hollander, Huguenot and Hebrew, for the development of our natural resources?

Some of the best engineers I know are so exceptional that one must class them with geniuses; they have faculty and character, and so they have become engineers, even under the most unfavourable circumstances. They have passed through ordinary schools and yet developed common sense. They were pitchforked into practical work, and their liking for the work, as well as some curious kind of instinct, led them to pick up all sorts of knowledge, which have become part of their mental machinery. They continue to pick up new kinds of knowledge when these become necessary for their professional work. Unfortunately, these men do not realise how exceptional they are, and they advise boys to go direct from school into works. They forget that the other 99 per cent. of men treated in the same way as themselves can only become the hewers of wood and drawers of water to real engineers. Treated in this way, average boys are just like so many sheep: they learn just what seems absolutely necessary and no more; their acquaintance with the scientific principles underlying their trade is a hand-to-mouth knowledge, which becomes useless when their trade undergoes development.

In 1867 I was an apprentice, and when in the drawing office and pattern shop I remember well how I was chaffed for studying such a non-paying, non-practical subject as electricity. When I published my first electrical paper in 1874 before the

Royal Society, and even for some years afterwards, the real students of electricity in England could be counted on the fingers of one's hands. Many of us remember the first gramme magneto machine that came to this country, a scientific toy, in 1874. How many engineers dreamt that a great new branch of engineering had been started? Even in 1878 engineers were as a rule quite ignorant of electricity, and since then every year, although newspaper writers have talked largely of the age of electricity, the men actually engaged in electrical industries have acted as if the greatest of changes were not perpetually going on in it. To be left behind, or to become camp followers, children of Gibeon, this is the usual fate of the men who scorn theory. In 1882-4 we used to have to pay men 200*l*. and 300*l*. a year because they had a slight knowledge of electrical matters. In 1884-6 these very men were not worth twenty shillings a week; they were weeded out of the profession, and their places were taken by men of better knowledge. Two or three years after, these better men were again found to have been weeded out, because men of still better knowledge were available. And so it has gone on ever since. Men learn just enough to get posts; they settle down in these posts and scorn theory. They actually forget what little theory they once did possess. They know a great deal about existing machines, but presently they discover that improvements have been going on, and that they no longer have a right to say that they belong to the engineering profession. In every year one has told men, "You will be left behind. See A and B and C. I told them three years ago, when their names were in everybody's mouths, that they would be left behind like their predecessors, and they laughed Now I tell you and you laugh, and you also will be left behind. Yes, I know that you get a good salary or large fees, and your head touches the sky. Nevertheless, because you neglect theory and the simple mathematics, by means of which theory is made available in practical problems, you will have to take a back seat presently, for our profession is in its early youth and is growing rapidly."

Remember that I do not now refer to the few exceptional heaven-born engineers who, in spite of bad training, do manage somehow to pick up the necessary knowledge. I speak of the average men, many of whom are now living in the same old fool's paradise. They know enough for present needs; they scorn the simple principles which underlie all our work; they scorn the easy mathematics by which these principles are most readily employed in practical problems; they will have their reward.

Just think of what is occurring at the present time. In England we have cheap coal, and it can be carried easily. In Switzerland and other countries where there is no cheap coal the water-power had to be utilised and power had to be transmitted great distances electrically. This needed high voltage, and as it is difficult to get high voltage with direct current machines, alternating currents were used, and on account of motor troubles multiphase working has been introduced. What a revelation it was to almost all of us, that visit of a year ago to Switzerland! We saw enormous schemes of lighting and traction and power. We saw electric trains driven by distant waterfalls sandwiched in among ordinary trains keeping proper time on working railways. We had known that there were great schemes carried out in Germany and America and other countries, and yet all the machines were quite unfamiliar to us. We were very much like what engineers of 1870 would have been if suddenly brought into a generating station. Is it not a fact that some of us, said to be eminent and thought to be practical, asked questions and made remarks which showed that we did not know the most elementary principles of three-phase working. Is it then any wonder that the traction schemes now being developed in England, on lines that are certainly not the best for this country of their adoption, are altogether dependent on the use of foreign electrical machinery and employ foreign electrical engineers? I am not putting this altogether fairly, for municipal procrastination has prevented our development, and yet I am not putting it altogether unfairly. We know too little theory.

I am afraid that just now we are in a rather tight place. I would give something to know how we in this room are going to get acquainted with modern electrical engineering. Our usual way of learning is by actual handling of things. But if the millions of pounds' worth of machinery coming to England every year is all foreign, and is used mainly under foreign superintendence, our usual method of study is made very difficult. True, there are American and German, and, indeed, English publications which would give a knowledge of the theory, but not, I think, to the average English electrical engineer. I know of many men, twenty-five to forty years of age, who seldom come to our meetings, and who say they are silent in discussions because they cannot be understood; perhaps these men will find a way to save us all from being left behind. There is much more that I might say in this connection. An individual Englishman may be left behind other Englishmen, and all English electrical engineers may be left behind the rest of the world, but all electrical engineers of the world may even be left behind other appliers of science. It is not merely that the incandescent mantle of the gas engineer is improving and necessitates improvements in our filaments, but, in spite of the flourishing conditions of our factories just now, I could give many other illustrations of how we shall all suffer if we do not keep adding to our knowledge. Twenty years ago, when giving some lectures in Clerkenwell to workers in the then flourishing watch trade, I ventured to prophesy the decay of that trade. But I am afraid that the case of Jonah and Nineveh is the only one in which prediction of disaster led to reform. I venture on no prophecy, therefore, because it might harden your hearts.

Much of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction, as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters could be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common-sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science; and he learns what he calls mathematics in such a fashion that he hates the sight of a mathematical expression all his life after.

And what is the result? English engineers do make a wonderfully intimate acquaintance with the machines and tools that they work with, but when it comes to the manufacture of new things they do it by fitting and trying, by quite unnecessary expenditure of money through trial and error. A machine is made and tried, and then another better one, until a good result is arrived at. And this method did well enough in the past, and would do well enough in the future if only we had not to compete with foreigners who can really calculate. It is not all smoke; there is a real danger in this foreign competition unless we mend our ways. There is an absolute necessity for great change in English ways; but there are so many people interested in the maintenance of old methods of working; so many people who think they will lose their bread and butter if a change takes place; so much capital, scholastic and other, invested in our old machinery, that it takes a catastrophe to produce changes. Much of the strength and weakness of England has always lain in her conservatism. We have been talking of standardisation of machinery lately, so I may say that things have been standardised in England for a long time. Now to get all the good effect of standardisation, it is occasionally necessary to go in for wholesale scrapping, and it is this scrapping part of the business that we dislike in England. We here all know that the District and Metropolitan Railways might have been worked electrically years ago just as easily as they will be when we are allowed to begin upon them, but of course the scrapping of a lot of steam locomotives was a serious thing. The loss of experience to English electrical engineers, because of this hatred of scrapping, is leading to other incalculable losses. I understand that the whole generating and line plant—the whole machinery of the Boston tramways—has been scrapped several times since they first were driven electrically. Japan has scrapped all her old civilisation just as France did. During the century now dying Germany has made the most sweeping changes in her law and school legislation, and indeed in everything. England and Spain and China, how they differ in this respect, even from England's own colonies.

Of course it may be said that English customs have grown during centuries; they are well tried, and there is no pressing need for sudden alteration. I quite agree, but unfortunately this very perfection and fitness of our customs have bred in us a want of flexibility, so that in cases where a sudden change is really necessary, we are disinclined to make the change merely because it is a change and for no other reason.

No one has ever heard me speak of the decadence of England. When the greatness and the wealth, the manliness and the strength, the healthiness and good life of England are shown forth to the as yet ignorant world in all their magnitude there will be some astonishment. But it is our duty to keep up our high standards. We must change what is bad when we know it to be bad, and not let bad things[1] continue to exist, parasitic growths, maintained because on the whole we are strong and healthy. You will perhaps think that this is a very serious exordium when I tell you that I have introduced it all on account of the state of mathematics in our profession. I feel a sort of degradation every time that I hear a successful, clever old member of this Institution sneering at mathematics. There is a plausibility about his statements; he himself has been very successful in life without much help from mathematics; but indeed his sneer is doing a great deal of harm to the younger members who admire his success, who forget that he has succeeded in spite of, and not because of, his neglect of mathematics.

Our knowledge of electrical phenomena must be quantitative to be of practical use; we must be able to calculate. Mathematics is the science of calculation, and we must therefore be able to employ, and we all do necessarily employ, less or more mathematics every hour of our professional lives. The draper and the grocer and the housekeeper merely need arithmetic. Everybody now knows some arithmetic. Everybody can add and subtract and multiply and divide, and keep accounts in some simple sort of way. This is due to the fact that arithmetic is no longer taught in the old Greek method with its twenty-seven independent characters (for our ten figures), the study of which required a lifetime, so that only old men could do multiplication, and they not only needed many hours to do one easy bit of multiplication, but declared that if the art were not practised every day it could not be remembered. Reading and writing and ciphering are now taught to everybody. It used to be that only learned men and philosophers could read, write and compute. You will remember the charge that was brought against one of Shakespeare's characters, who was said to possess mere bookish theory without practical knowledge. "And what was he?" "Forsooth a great arithmetician." Nowadays, when everybody can compute, we should say of the possessor of mere bookish theory, "Forsooth he knows the calculus."

For in mediæval times things were taught in such a way that only a few men had a chance of knowing how to read, write and cipher. We have been compelled to change all that; the pedagogue has, by compulsion, given up his mediæval methods of teaching in these things, although in all other matters he retains them. But a time has come when we see that ciphering is not enough mathematics for us to be familiar with, we need a little algebra, we need co-ordinate geometry, we need the differential and integral calculus. The pedagogue tells us that we must follow the orthodox course of study, which takes many years; and some of us, many of us, who have followed the orthodox method, find that we have spent so much time and mental power upon it and its thousands of unnecessary tricks and contrivances and philosophy, that we can take in no more ideas. We cannot utilise our mathematics on engineering problems because we are too old and tired and *blasé* to comprehend these problems. Nevertheless we are the only people who know mathematics, and so we publish volumes of unmeaning and useless disquisitions on problems that we do not understand. Or we know just enough mathematics to be able to show our ignorance to experts, but quite enough to impress engineers with our knowledge; and we know just enough about engineering problems to show our ignorance to engineers, but quite enough to impress mathematicians, and what we publish is merely as the crackling of thorns under a pot.

As for the man who does understand electrical problems, he remembers that there was a something called a study of mathematics at his school, that he did pass certain examinations with much difficulty and tribulation, that the subject had no real meaning to him even when he was supposed to know it, and he now hates the sight of anything that looks like mathematics.

I tell you, gentlemen, that there is only one remedy for this sort of thing. Just as the antiquated method of studying arithmetic has been given up, so the antiquated method of studying other parts of mathematics must be given up. The practical engineer needs to use squared paper. What is the use of telling him that he has taken an unauthorised way to the study of co-ordinate geometry, that he cannot approach it except through Euclid and modern geometry and geometrical conics and algebra and trigonometry? He says the youngest child can be made to understand diagrams on squared paper.

So again the idea underlying the calculus is one that every child, every boy, every man possesses and uses every day of his life, and there are useful methods of the calculus that might be taught quite quickly to boys, and which it would be a pleasure to boys and men to use continually in all sorts of practical problems; but of course the subject of the differential and integral calculus is one that must come at the end of a long course of what is to the average boy utterly uninteresting and unmeaning mathematics. Indeed, the average boy never reaches the subject, whose very names, differential and integral calculus, are enough to drive him frantic.

Yes, the schoolmasters say that we must follow the mediæval rules of the game, and all sorts of fine things are said about them; but as a matter of fact we only need to bring a little common sense to bear upon schoolmasters. At present most of us stick to our arithmetic as a safe and well-tried friend. We compute after the manner of the draper and grocer and housekeeper. In finding out what is the best size of conductor, or armature winding or core, or iron and winding of a field magnet, we calculate by mere arithmetic for one size and then for another; perhaps we have weeks of arithmetical computation before we find the right size of thing to use, and we cannot frame general rules. And some foolish person who knows a little mathematics, works at the problem (as we ought to be able to do, but are not), and he frames a general rule and we laugh at it, and sneer at mathematics because he has probably left out of account the most important consideration. We know that the result is wrong, but we cannot say why it is wrong.

Then there are some far-reaching, labour-saving ideas that we simply cannot get into our heads at all; we cannot comprehend them. Am I sinning against the rule as to good comradeship which exists here if I say that some of us are ignorant of the most fundamental facts regulating economy in arranging sizes of conductors? Suppose we find the total cost of installing a conductor of a certain length, using one square inch section of copper. We do the same thing for other sizes, and we plot total cost and weight of mere copper on squared paper. I do not care what system we adopt if it is the same system for all sizes, and if we buy our materials from the same manufacturers and use the same kind of labour, our points will lie very nearly in a straight line on the squared paper. Hence increased cost will be proportioned to increased weight of copper, and, indeed, increased total cost will be like the mere increase in the cost of copper, taking a slightly higher price of copper per ton. Some of us, ignorant of the elementary mathematics involved in the problem, think that the mistake has been made of assuming that the cost of an installed conductor is merely the cost of the copper in it, and, of course, he must feel that it is too absurd a mistake not to be laughed over. With an elementary knowledge of mathematics his mistake would be impossible, and without such a knowledge the clever electrical engineer is constantly discovering mares' nests in the investigations which he criticises.

I know of long misleading accounts of the results of good experimental observations which might have been described in a few clear words by the aid of elementary mathematics. I know men who spend on a particular problem ten times the amount of worrying thought that would enable them to master the easy mathematics that includes all such problems. Quite recently one of our most eminent members declared to me that he had not really grasped the reason for small economy at a power station when there is a small load factor until he studied the common-sense mathematical form which has been given in a recent publication. And yet he is a man who has heard much, and read much, and talked much on this subject.

Every electrical engineer has a correct idea of how a transformer acts, or how the E.M.F. in one of the coils of an armature of a direct current or other generator, or, let us say, a rotary transformer, changes during a revolution, and how the E.M.F.'s of all the coils are combined to produce currents in the external circuits. But through how much mathematical tribulation must most of us have passed from our state of ignorance to our present state of knowledge! It is no wonder that we are disinclined to the study of a new phenomenon which seems as if it

[1] Such as our wretched system of weights and measures. Oh, young America and Australia, is it wise to waste a year of every child's life, and years of the life of every business man, merely because we do it in England? You get many of your pedagogues from us, and of course they say that without cwts., qrs., lbs., and Latin declensions and Euclid, the mind cannot be trained. Do you believe them, or are you with open eyes making a great sentimental sacrifice?

might lead us through the like tribulation. The tribulation is least because it is suffered only once if we first learn the calculus method which underlies all our work; it is greatest if we get it up in a completely new-looking form in every new problem. I speak now of what is most difficult in our study, for there is thought required in applying the calculus method. Thus, for example, in multiphase work at the present time the best mathematicians wonder how it is possible for easy calculation to be made in such a subject. What we want just now is that an electrical engineer acquainted with three-phase current phenomena should be so much a master of ordinary easy mathematics that he has a chance of discovering a very simple way o. putting the matter before us. At present calculation is easy but tedious, and, indeed, repellent; but I am perfectly certain that a competent man might quickly invent methods of calculation which are not only easy but short and thinkable. Mathematicians with the requisite electrical knowledge, again, may be lacking in sympathy and humour. I know a book of more than three hundred large pages on ordinary alternating currents, and all the information in it is given far more simply in two pages of another book with which some of you are acquainted. Possibly, just now, mathematicians who are electrical and who have common sense have too much other work to do, and we must wait their leisure.

The fact is, mathematics ought to be the natural language of the electrical engineer, and at present it is a foreign language; we cannot read or write or think in it. We are at the beginning of our development, like monkeys whose necessities have increased faster than their powers of speech.

Some of you are aware that a new method of teaching mathematics has recently been introduced in nearly all evening classes in science schools throughout the country.[1] I wish I could say that there was a prospect of its being introduced in all schools, for it seems to me that this would lead to the result that all young men entering works would be masters of that kind of calculation which is most important in electrical engineering; not merely a few men having this power, but the average men, just as average men can read and write.

I am addressing engineers, men who utilise the results arrived at by scientific workers, men whose profession is applied science. But surely if we are to apply the results arrived at by scientific men, if the laboratory experiment of to-day is the engineering achievement of to-morrow, we ought to be very much alive to all that is going on in the scientific world.

All men ought to be far more alive to the importance of scientific work. On the psychological side, it is perfectly exasperating to me to see how few are the men who know that Darwin has given a key to almost all the great philosophical problems of antiquity, and that there is a great mental development accompanying the more evident engineering development now going on in the world. Again, it is the fault of our methods of education that all our great men, our most important, most brilliant, best educated men; our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, should remain so ignorant of physical science, the application of which by a few men not ignorant is transforming all the conditions of civilisation.[2] But, of all men, just think what it means for engineers to be ignorant of science, or neglectful of its new developments; and, of all engineers, think what it would mean if electrical engineers sinned in this way.

Except ours, all other branches of industry have taken thousands of years to grow. There were bridge and hydraulic and sanitary and harbour and river engineers in ancient Rome, and such engineers existed thousands of years before the first papyrus was written in Egypt. But no Assyrian tile or Egyptian hieroglyphic or relic from a tomb indicates that telephones or electrical motors or electric lights existed before our time. No gradual improvement in our methods of conquering nature led up from small beginnings in our electrical engineering. Our profession has not grown during thousands of years of time, like other professions. It has sprung suddenly, full grown, from the new spirit which is going to rule the souls and bodies of men, the spirit of research in pure science. The new spirit puts knowledge, mere knowledge of nature, as its highest aim. The scientific student knows that all sorts of good must come to mankind from his studies; all sorts of scientific knowledge are sure to be utilised by engineers, but in the pursuit of science the usefulness and utility of the results are of no importance. And are we—we who have received the first-fruits of the labours of scientific men, we the first-born spoilt children of the great parent of all that is to come, we who form the foremost files of the present time—are we going to turn upon our beautiful young mother and say she is useless and ugly, and she hinders our money-making, and that we are willing to kill her for the sake of the burial fee? Thank God that is the spirit of only a few of us. Have we not as an Institution gone to great expense in the publication of *Science Abstracts* in partnership with the Physical Society? That publication has been and continues to be of the very greatest value to all students of pure and applied science who read our language, for it tells them the results of all the scientific work now being done in all parts of the world. And even if some of us do not read that useful publication, do we not know that it is there to read if we like? Do we not know that it is a symbol of our redemption from the yoke of the Philistine? It is one of many signs that in answer to the question which I have asked in this address, we can truthfully say that we are professional men, that our profession has promise of enormous expansion and improvement, and that we are not mere tradesmen.

I am afraid that you will think that I have a personal interest in putting before you the claims for consideration of the pursuit of pure science, because you know that I am trying to defend Kew Observatory from imminent danger. In truth I have no interest in this matter unbecoming a president of this Institution. For two years I have been trying to reason with traction engineers. Like many other electrical engineers these gentlemen desire to use uninsulated return conductors. If they do so near a magnetic observatory certain records of terrestrial magnetic disturbances are quite spoilt. At Potsdam this sacrilege has been forbidden. At Washington, Toronto, Capetown, and most other important places, the magnetic records have already been rendered useless. Professor Rücker and I were asked by the other members of the Committee of the Royal Society which was in charge of the Kew Observatory to defend Kew, and with the help of her Majesty's Treasury we thought we were able to insist upon the use of insulated returns in all undertakings authorised by Parliament where harm was likely to be inflicted on Government observatories. I may say that the scheme designed by Mr. Clifton Robinson for using an insulated return conductor in the working of the tramways of the London United Tramways Company, in consequence of our action, was a thoroughly good scheme which it gave one satisfaction to look at, not ugly and not expensive. It seemed to me a fit scheme for any tramway system, however complex, in which overhead conductors are used. You are aware that for an electric railway or for a tramway where a conduit is employed, it is in every way better, and is in a large scheme actually cheaper, to use an insulated return. We felt therefore very happy, for magnetic observatories seemed quite safe from interference. We were, however, mistaken, for the only clause which we have been able to get inserted in all Parliamentary authorisations of undertakings leaves it to the Board of Trade to substitute other methods of protection than the insulation of the return conductors in cases where these other methods seem to be sufficiently good for the protection of laboratories and observatories, and this is why the Board of Trade appointed the Committee which met on October 31 probably for the last time.

Prof. Rücker, Prof. Ayrton, and I have made many tests on the magnetic disturbances produced by tramways and railways, particularly by the Stockton tramways and by the Waterloo and City Railway, and we have had many meetings with the traction engineers, but nothing has yet been decided.

I mention this matter, which has given great anxiety to scientific men, because I am afraid that some of you may think when you hear of it that I have been acting against the interests of the electrical industry. I beg to assure you that I have been acting in your best interests. As an electrical engineer I ought surely to regret the use of uninsulated returns, even if we leave Kew Observatory out of account. Suppose we do not now insulate our returns. Electricity will certainly return by gas and water pipes, and

[1] See summary of Lectures on Practical Mathematics; also the Science and Art Directory, and the Reports of Examiners on the Science Examinations of 1899 and 1900, all published by the Education Department, South Kensington, S.W. The reforms now advocated in mathematical and science teaching are all clearly described in a paper read before the Society of Arts in January, 1880.

[2] See articles in NATURE of July 5 and August 2

the amount of harm done to those pipes is merely a question of time. Because of the ignorance of legislators and gas and water companies, nothing is said just now; but will nothing be said at the end of ten or twenty years, when pipes are found to be eaten away everywhere? And if by a slight increase of expense, or rather, as I think, actually no increase of expense, but merely a little increase in inventiveness and common sense on the part of electrical engineers, this evil may be entirely prevented, surely it is in the interests of all of us that insulated returns should be insisted upon. But even if we do not insist on insulating the returns in all systems, surely something may be said for the giving of this protection on lines near such a magnetic observatory as Kew. Even the magnetograph records now being made have been continuous for forty-five years, and if Kew is interfered with no sum of money can compensate for the interference; for if the Observatory were removed the future observations would have no link with the past.

An engineer in this room declared that it seemed to him an injustice to hamper the progress of electric tramways "for the sake of making observations that never have given, and never may give, to the world any important results." Now, it is not so much on account of Kew that I object to this sort of observation, as to its general spirit of antagonism to scientific research.

There is no doubt that the answer to the old question, which Gilbert might have asked three hundred years ago, "What is the cause of terrestrial magnetism?" is very jealously hidden from us by Nature. The earth probably contains much iron, but its great internal heat seems to forbid our imagining the iron to be magnetic. The assumption that a negative electric charge on the rotating earth will explain things requires such an enormous charge that this assumption has been discarded. There are annual and diurnal variations of a fairly regular kind; there are storms which have some relation to the Aurora Borealis, to sunspots and to earth currents. There are small sudden changes which seem to occur almost instantaneously all over the earth. Observations of these things may be useless from some points of view, but scientific men have been, and continue to be, willing to give up time and much money for this object. Utilitarians had to be cajoled through superstition to allow observations of the stars to be carried on in ancient times, and we have no such cajolery to offer. We simply say that it has been through this sort of useless-looking method of working that all our progress in science has come.

Engineers descended from men who sneered at Cavendish and Franklin and Volta and Oersted and Ohm and Faraday, are you who utilise the results of the work so sneered at, and pile up fortunes in consequence of it, are you the men to sneer at and ridicule the scientific work of the present day because it seems to you useless?

Tell us a better method of observation; give us better suggestions as to what these magnetic phenomena may mean; but the past record of scientific observation enables us to laugh at you when you say that magnetic observations may never give the world any important results. Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much? How very little we know of electricity and magnetism! Does the mere motion of the earth, taking no account of electric charges at all, cause it to be magnetic? Almost anything is on the cards. Surely I need not appeal to your cupidity, but it is quite possible that our knowledge of this secret may enable us to tap a tremendous store of Nature's energy.

Gentlemen, this is not a trades union, and it is not a society for the furtherance of pure scientific research, but it is a society of professional men who recognise the past services of scientific observers with gratitude and respect, and hope for greater ones in the future. And shall it be said of us that our gratitude is not greater than that of Judas, to whom indeed thirty pieces of silver was doubtless a large sum; that "we have given our hearts away a sordid boon"; and that as to our future hopes we are willing to sell our birthright for a mess of pottage?

THE NEW SCIENTIFIC LABORATORIES AT KING'S COLLEGE, LONDON.

ON the afternoon of October 30 the new scientific laboratories at King's College were opened by Lord Lister, in the presence of the Lord Mayor and a large and distinguished gathering of men of science. Lord Lister, after his introduction by Dr. Robertson, the principal of the college, said the occasion marked an event of great importance in the higher education of the metropolis. The necessity of practical instruction to supplement mere lectures was now fully realised; and it was in order to satisfy this want in every particular that the new laboratories had been added to King's College. In many branches the college had long been well equipped for this purpose; the Wheatstone Museum in particular would bear witness to this; but the dissecting-room, and the accommodation for the practical teaching of physiology had been very defective. But now all this had been remedied; the bacteriological laboratory and the geological department had also received many improvements; and, in short, it might safely be said that King's College was now fully abreast of the age in the opportunities it afforded for practical teaching in all departments.

The Lord Mayor proposed a vote of thanks to Lord Lister; and in seconding, the Hon. W. F. D. Smith, M.P., treasurer of the college, stated that the new buildings, together with their equipment, would, when completed, cost 20,000*l.*, and reminded his audience that only one-fifth of this sum had so far been subscribed.

Lord Lister having declared the laboratories open, they were inspected by those present.

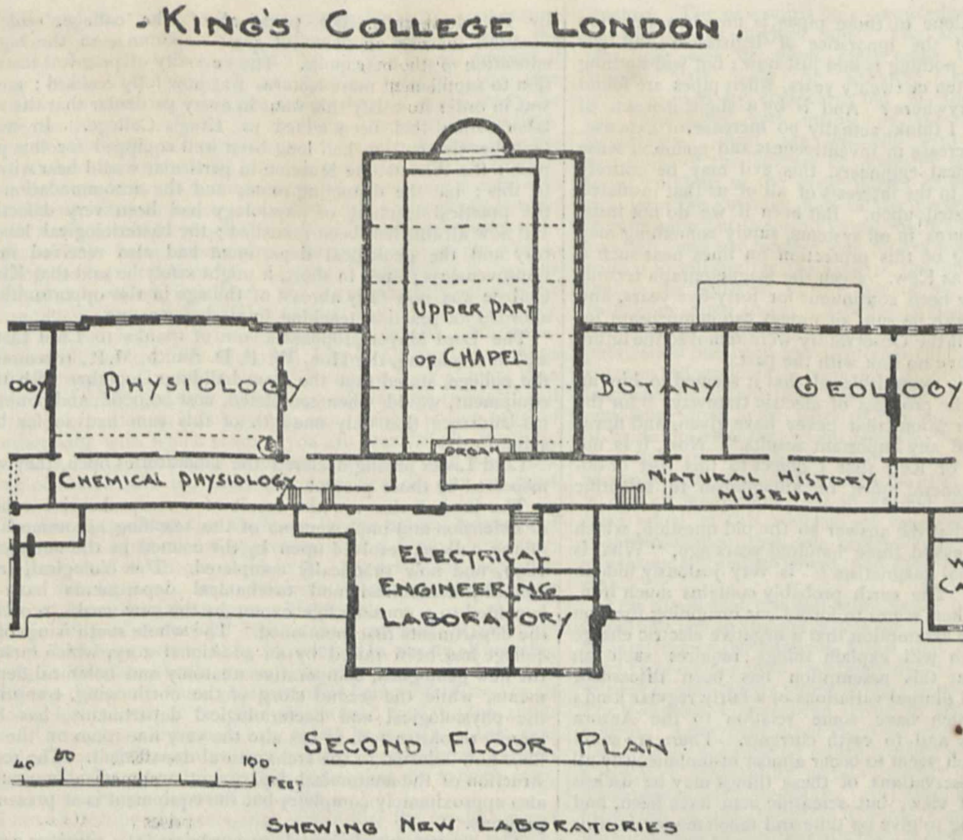
The laboratories are the result of a comprehensive scheme of extension and improvement of the teaching accommodation of the college, resolved upon by the council in the summer of 1899, and now practically completed. The biological, architectural, anatomical and mechanical departments have all benefited to a considerable extent by the new works, especially the departments first mentioned. The whole south wing of the college has been raised by an additional story, which includes the new geological, comparative anatomy and botanical departments, while the second story of the north wing, comprising the physiological and bacteriological departments, has been largely reconstructed, as has also the very fine room on the first floor now allotted to the architectural department. The reconstruction of the anatomical department and medical museum is also approximately complete, but the equipment is at present in progress.

The department of physiology comprises (1) a spacious central laboratory, seating over 100 students; the work tables are suited either for microscope work or for practical work in chemical physiology. There are in addition sixteen separate tables provided with shafting and all the necessary electrical apparatus for the study of experimental physiology, a branch of the science which is becoming every year of greater importance; (2) a large room for investigations in chemical physiology; (3) a spacious and well-fitted room for experimental physiology; (4) a dark room for photographic and galvanometer work; (5) a private workroom for the professor. These, with the necessary storerooms and accommodation for the laboratory attendants, make up a very complete suite of rooms.

In the anatomical department the dissecting room has been nearly doubled in size, and all the accessory rooms necessary in a well-equipped anatomical department are now provided. The section of the college museum which relates to pathology will also be housed in part of the old physiological rooms in the basement, and a new room has been built for the anatomical portion of the museum.

The department of bacteriology contains a practical class-room devoted to the technical education of post-graduate and other students from all parts of the world. Every student with his own hands goes through the whole practical course, and is further assisted by lectures and practical demonstrations. Several students have been especially trained with a view to investigating plague, cholera, yellow fever, madura and other tropical diseases, as well as the diseases of farm stock which are prevalent in our colonies and in foreign countries. In the technical laboratory, research work has been undertaken for the Board of Agriculture and for colonial Governments, while a number of workers have published researches on various bacteriological subjects. The new research room and library is used by advanced students and by the professor. A new feature is the bacteriological library of about 1000 volumes and pamphlets, lent by the professor for the use of the senior students. A lecture theatre has been built for the use of the bacteriological and physiological departments, and will accommodate about 200 students.

The general geological laboratory and lecture room will accommodate fifty students. The room is fitted both for lecturing



purposes and practical work, gas, water, and the electric light being laid on. In the practical class the engineering students are divided into several sections; one set of students use the petrological microscope, another set make blowpipe and chemical examinations of minerals, a third draw sections from geological maps, while a fourth set examine and draw fossils; the work of each class follows a regular schedule. The geological research laboratory is used by the professor and the more advanced students who wish to do original research. The room is fitted up similarly to the large laboratory, and contains a portion of the teaching collection and the nucleus of a library of geological works and reports.

The botanical laboratories consist of two rooms—the general laboratory for elementary work, and the research laboratory for advanced work and private research. The general laboratory provides table accommodation for twenty-four students, and is equipped with all the necessary appliances for the practical study of plants, either fresh or dry. The botanical research laboratory provides accommodation for twelve students. In this laboratory provision is made for the practical study of the chief physiological processes of plants, and for chemical investigations.

The materia medica and pharmacological collection of specimens used in teaching is contained in the upper part of the corridor, and is open to students for purposes of study; the lectures are given in another part of the building.

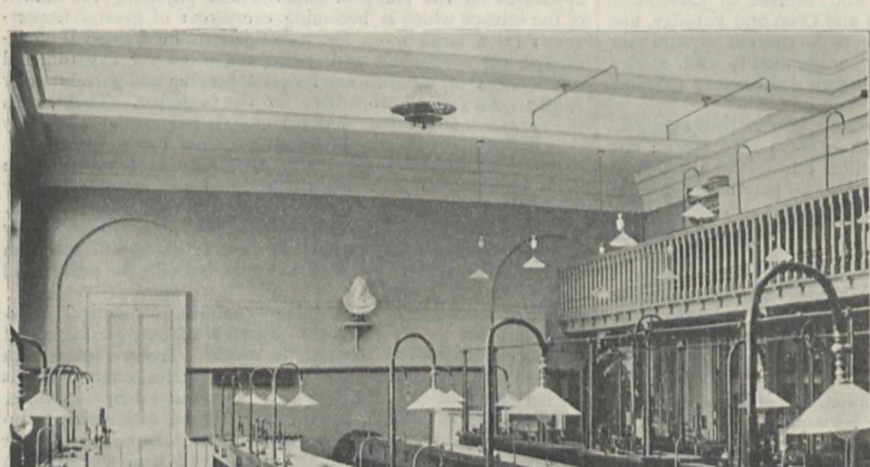


FIG. 2.—The general laboratory and classroom in the Physiological Department.

The Wheatstone Physical Laboratory is well equipped for delicate balance work, heat and electrical measurement, and the determination of the general physical constants. A new dark room for spectroscopic work has been specially constructed, and a room set apart for magnetic work.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The annual grant to the Botanic Garden has been raised to a sum which will make the income of the garden 670*l.*, instead of 650*l.* as formerly.

The examiners for the Burdett-Coutts Scholarship in geology have not awarded the scholarship this year.

The Board of the Faculty of Natural Science have recommended that certificates should be issued entitling the following to supplicate for the degree of Doctor of Science:—Prof. Poulton, for researches on the influence of environment upon the colours of lepidopterous larvæ and pupæ; Prof. Turner, for researches on stellar photography; Prof. Miers, for researches on the red silver ores; Prof. Love, for researches on the theory of elasticity, theoretical mechanics, and the application of mathematics to physics; Prof. Weldon, for researches on natural selection; Mr. Hatchett Jackson, for researches on comparative anatomy and the morphology of lepidoptera; Mr. Lloyd Tanner, for researches on the theory of differential equations, theory of cyclotomic functions, &c.; Mr. F. A. Bather, for researches on fossil echinodermata, pelmatozoa, and blastoidea. These gentlemen will doubtless be the first to take the new research degree, which has at present only been conferred as an honorary degree.

CAMBRIDGE.—Mr. J. G. Leathem, St. John's College, has been appointed Chairman of the Examiners for the Mathematical Tripos, Part I.

Mr. R. W. H. T. Hudson, Senior Wrangler 1898, Smith's Prizeman 1900, son of Prof. Hudson of King's College, London, has been elected to a Fellowship of St. John's College.

A meeting for the purpose of establishing a memorial of the late Prof. Sidgwick is to be held in Trinity College Lodge at 3 p.m. on November 26.

The Vice-Chancellor has published a list of donations to the Benefaction Fund, bringing up the total to over 66,000*l.* Donations to the Agricultural Education Fund, for the special purpose of equipping the experimental farm, amount to nearly 1600*l.*

It is proposed to alter the regulations for Part II. of the Natural Sciences Tripos so as to permit of a candidate being placed in the first class provided he shows a sufficiently good knowledge of two subjects combined. Hitherto a first class has been awarded only for special proficiency in one subject.

DR. ERSKINE-MURRAY was appointed, at the beginning of the present session, lecturer and demonstrator of physics and mathematics at the University College, Nottingham.

THE extent of the work of the London Technical Education Board is shown in the current number of the *Technical Education Gazette.* Particulars are given of evening classes conducted under the auspices of the Board during the session 1900–1901, and though they are closely tabulated, the tables occupy 127 pages.

DR. OSCAR LOEW, for some time expert physiologist in the division of vegetable physiology and pathology of the United States Department of Agriculture, has resigned (says *Science*) in order to accept a position in the Agricultural College of the Imperial University of Tokyo, Japan, as lecturer on physiological chemistry.

SEVERAL months ago the Senate of the University of London asked the London County Council to give the name University Avenue to the road in which the university buildings are situated, now known as Imperial Institute Road. The governing body of the Imperial Institute has, however, strongly objected to the suggested alteration, and the County Council has decided to let the old name remain.

SPEAKING at St. George's Hospital on Tuesday, Sir Michael Foster referred to the inadequate provision made in our hospitals for the scientific investigation of disease. The analysis of the phenomena presented at the bed-side and in the *post mortem* room is not carried out as exactly, as completely, as fully, and as systematically as it might be. The use of the thermometer is a type of the exact analysis of clinical phenomena. In addition there is now chemical analysis, physical analysis, bacteriological analysis, but in none of our great hospitals is that analysis as complete, systematic, and exact as it should be. Such a complete analysis of all the phenomena in each case can only be carried on by means of thoroughly equipped laboratories in connection with the hospital—chemical, physical, biological, bacteriological, and other laboratories. In London the hospitals are less properly equipped in this direction not only than the hospitals of other countries, more especially America and Germany, but than even the hospitals of the provinces. It may or may not be desirable to attach to our hospitals chemical, physical and biological laboratories for the instruction of the student in introductory science; but each hospital ought to have its properly equipped clinical laboratories established for the welfare of the patient, the cost of which was as much a proper charge on the funds of the hospital as the bill for drugs or surgical appliances.

THE University College of North Wales has numbered, and still includes, among its professoriate the names of men of "light and leading" in the worlds of science, art and literature; hence its courses and laboratories, as described in the Calendar for the session 1900–1901, are worth examination. The physical, chemical, and biological laboratories occupy a large area, and the appliances provided are sufficient to enable the college to offer complete courses of work in their sciences. There is a department of electrical engineering maintained by means of an annual grant made by the Drapers' Company; and a course of lectures and experimental work, suitable for students of this branch of applied science, has just been commenced. Efforts are being made to establish a department of mining, and a conference in support of this object was held a few days ago at Rhyl. The conference was attended by representatives of the county councils, urban and rural district councils, and the technical instruction authorities of North Wales, as well as the owners and managers of mines, quarries, brick, steel and iron works in the northern half of the Principality. Students in the proposed department would, of course, attend the college lectures bearing upon their subject, but it would also be necessary to add to the staff a professor of mining and mine surveying, a professor of geology and mineralogy and an additional assistant lecturer in the chemical department, to take charge of the subject of metallurgy. It is estimated that, in order to meet the additional expense thus thrown upon the college, and for the proper maintenance of the new laboratories, an annual income of not less than 1100*l.* should be assured to the department. The establishment of mining and geological laboratories, and the provision necessary for the teaching of metallurgy would also render necessary a capital expenditure, including buildings, of about 8000*l.* All the speakers at the meeting, including Prof. Le Neve Foster, agreed in thinking that mining in North Wales would be benefited by the establishment of the department suggested, and resolutions were eventually adopted expressing support of the scheme, and pledging the conference to exert all possible means to carry it into effect.

THE work of the examinations department of the City and Guilds of London Institute is so extensive that the only satisfactory way to obtain an estimate of it is to read the annual report, which can be obtained for threepence from Messrs. Whittaker and Co., Paternoster-square, E.C. It appears, from the report just issued, that during the session 1899–1900 the total number of classes registered by the institute was 2460 as compared with 2087 in the previous session. The number of candidates' papers worked at the recent examinations was 15,557, as compared with 14,978 in the previous year, and whilst, only a few years ago, all the examinations were held on two days, they extended this year to twenty days. Mention has already been made of the desirability of closely associating the work of the technological department of the institute with that of the branch of the Board of Education dealing with technology. On August 24 an official announcement was made that an assistant secretary for technology had been appointed, and that "in the ensuing autumn it is proposesd to appoint a departmental committee, on which the County Councils and the City and Guilds of London Institute will be represented, to consider, *inter alia*, the co-ordination of the technological administration of the Board of Education with the technological work at present carried on by educational bodies other than that board." Examinations are held in India and in several of the colonies as well as at home. The report shows that Bombay sent up this year thirty-eight candidates in cotton manufacture and dyeing, against eighteen last year. Earnest efforts are being made to provide technical instruction for operatives engaged in cotton mills in or near Bombay, and, with the further development of the cotton industry, the number of candidates from India who present themselves for the institute's examination is likely to increase. The work of the department also includes the direction of instruction and the conduct of examinations in technology and manual training. The instruction in manual training is intended exclusively for those who are preparing to become teachers in elementary or secondary schools. The difficulty of arranging for the special instruction in the methods of teaching, of which artisan students stand in need, has for some time engaged the serious attention of the institute, and, with a view of indicating the kind of lessons which it was thought desirable that County Councils might provide, a letter, enclosing a suggested scheme of instruction, was addressed in November last to the organising secretaries, and secretaries of local committees having manual training classes under their charge.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, October.—Prof. F. N. Cole gives an account of the proceedings at the seventh summer meeting of the Society, which was held in June last at Columbia University, New York City. The occasion was one of the most successful in the Society's history, having been attended by upwards of fifty members. Abstracts are given of many of the papers read. These papers will subsequently appear either in the *Bulletin* or in the *Transactions*. In connection with this gathering, the final session was devoted to an organised discussion of the following question:—What course in mathematics shall be offered to the student who desires to devote one-half, one-third or one-fourth of his undergraduate time to preparation for graduate work in mathematics? An abstract of papers read by Profs. Moore, Harkness, Osgood, Morley and Young is given by Prof. W. H. Maltbie. The discussion suggests many points of interest. Prof. (Miss) C. A. Scott furnishes an interesting article on a memoir by Riccardo de Paolis. This mathematician about twenty years since published a series of memoirs dealing with the (2, 1) transformation of the plane (cf. *Atti d. r. Accad. dei Lincei*, vol. i. (1877) pp. 511–544; vol. ii. (1878) pp. 31–50; and pp. 851–878). An exhaustive treatment is given, and Miss Scott ends thus: "the intrinsic interest of de Paolis' work is surely excuse enough for devoting some little space to it" in the *Bulletin*. References are freely made to the writings of other geometers on cognate lines. The "Notes" are full of the "Courses in Mathematics" for the winter semester at most, if not all, of the German Universities. Other details of interest to mathematicians fill up the remainder of the number, together with a long list of recent publications.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"Energy of Röntgen and Becquerel Rays and the Energy required to produce an Ion in Gases," by E. Rutherford, M.A., B.Sc., Macdonald Professor of Physics, and R. K. McClung, B.A., Demonstrator in Physics, McGill University, Montreal. Communicated by Prof. J. J. Thomson, F.R.S.

The primary object of the investigations described in the paper was the determination of the energy required to produce a gaseous ion when X rays pass through a gas, and to deduce from the result the amount of energy radiated out into the gas by uranium, thorium and the other radio-active substances.

In order to determine this "ionic energy" it has been necessary to accurately measure the heating effect of X rays and the absorption of Röntgen radiation in passing through a gas.

The method adopted to determine the ionic energy was briefly as follows:—

The maximum current between two electrodes produced by the ionisation of a known volume of the gas by the rays was determined.

In order to ionise the gas energy has to be absorbed, and the intensity of the radiation falls off more rapidly than the law of inverse squares. Assuming that the energy of the radiation absorbed in the gas is expended in the production of ions, then, knowing the coefficient of absorption of the rays in the gas, the total current produced by the complete absorption of the whole radiation given out by the bulb into the gas can be deduced.

Let i = maximum current produced by the total ionisation of the gas by the rays,
n = total number of ions produced per sec.,
e = charge on an ion.
Then $i = ne$.
Let H = heating effect per sec. due to the rays when absorbed in a metal,
E = total energy of the rays in ergs,
Then E = JH, where J = Joule's equivalent.
If W = average energy required to produce an ion, then

$$nW = E = JH,$$

$$\therefore W = \frac{JH}{n} = \frac{JHe}{i}.$$

The values of H and i are experimentally determined, and, assuming the value of e, namely, 6.5×10^{-10} electrostatic units, determined by J. J. Thomson, the value of W is found in absolute measure.

Heating Effect of the Rays.

An automatic focus tube was employed, excited by a large induction coil with a special form of Wehnelt interrupter giving 57 breaks per second. The bulb gave out intense rays of a very penetrating character.

The heating effect was measured by determining the variation of resistance in a specially constructed platinum bolometer when the rays fell upon it. The heating effect was standardised by observing the change of resistance caused by the passage of a known current through the bolometer. Special precautions were taken to screen off all heating effects except that due to the X-rays employed.

About ·55 of the incident rays were absorbed in the platinum bolometer. The energy dissipated in exciting secondary radiation at the surface of the platinum was neglected in comparison with the total energy absorbed.

The rate of supply of heat to the bolometer surface (area 92·2 square cms.) at a distance of 26 cms. from the source of the rays was about

0·00014 gramme-calorie per sec.

The total energy of the rays given out from the front surface of the platinum antikathode (omitting absorption of rays in glass of bulb, air, and screens, &c.) was

0·011 gramme-calorie per sec.

Absorption of X-Rays in Gases.

A null method was employed, as the absorption of the rays in air at atmospheric pressure was small. The rays passed through two long brass tubes with aluminium ends, and the current produced by the rays, after passing through one tube, was balanced against the current due to the other. On exhausting one tube the electrometer balance was disturbed. From measurements of the deflection per second from the balance and the deflection per second due to the rays after passing through one tube, the absorption can be calculated. The mean value of the coefficient of absorption of the rays in air at atmospheric pressure was found to be

0·000279,

or the rays would pass through 24·7 metres before absorption reduced the intensity of the radiation to one-half.

The absorption was found to be proportional to the pressure from a half atmosphere to three atmospheres.

The coefficient of absorption in carbonic acid gas was found to be 1·59 times the absorption in air.

Energy required to produce an Ion.

The current produced when a given volume of the gas was ionised by X rays was determined by means of an electrometer. In order to get rid of the secondary radiations set up when X rays strike on a conductor, the rays passed between two charged parallel plates without striking them. A guard-ring method was employed to ensure uniformity of the electric field.

The value of the ionic energy was deduced from the determination of the current, heating effect and absorption of the rays. The mean value of the energy required to produce an ion in air at atmospheric pressure and temperature was found to be

$$1 \cdot 90 \times 10^{-10} \text{ ergs.}$$

This value is much greater than the energy required to produce hydrogen and oxygen ions in the decomposition of water.

The ionic energy of air was found to be approximately the same from pressures of one-half to three atmospheres.

The method of determining the ionic energy for other gases is described, and the evidence that the "ionic energy" is the same for all gases is discussed.

Emission of Energy from Radio-active Substances.

The velocity of the ions produced by Röntgen and uranium radiation in air has been shown to be the same. The ions are thus probably the same, and it is a reasonable assumption that the same energy is required in both cases to produce them. On this assumption the energy radiated by the radio-active substances can be determined.

The radio-active material was spread over a known area and the maximum current produced between the parallel plates determined. The number of ions produced, and consequently the energy to produce them, can be calculated.

For a thick layer of uranium oxide (3·6 grammes spread over a surface of 38 cm.) the energy radiated into the gas for 1 sq. cm.) of the surface is

$$10^{-11} \text{ calories per second.}$$

This amount of energy would suffice to raise 1 c.c. of water 1° C. in 3000 years, assuming no loss of heat by radiation. From observations on the current due to a very thin layer of uranium oxide it is shown that the energy radiated into the gas is not less than 0·032 calorie per year for every gramme of the substance.

The energy radiated from thorium and radium is also considered, and the presence of the rays from radium deflected by a magnet is taken into account.

In the case of radium, which is 100,000 times more radio-active than uranium, the emission of energy per gramme of the substance is not less than 3000 calories per year.

Distance between the Charges of the Ions in a Molecule.

On the assumption that the energy absorbed in producing an ion is due to the work done in separating the ions against the forces of their electrical attraction, it can be shown that the mean distance between the charges of the ions in the molecule is

$$1 \cdot 1 \times 10^{-9} \text{ cm.}$$

This is only 1/30 of the probable diameter of the atom. This result is in accordance with the view recently advanced by J. J. Thomson, that ionisation is produced by the removal of a negative ion from the molecule, and that the negative ion is only a small fraction of the mass of an atom.

Minimum Potential required to produce a Spark.

If the production of ions is necessary before a spark can pass, it can readily be deduced from the value of ionic energy that a spark cannot pass for a potential difference less than 175 volts. Experiments have shown that the minimum value is over 300 volts The theoretical value is of the same order, but from the complexity of the phenomena a very close agreement could not be expected.

Efficiency of a Fluorescent Screen.

Photometric comparisons were made of the light from a fluorescent screen, excited by the X-rays, with the standard Hefner-Alteneck amyl lamp. The energy of the visible radiation from the amyl lamp has been determined in absolute measure by Tumlirz (*Wied. Annal.*, vol. 38, p. 640), and the energy of the rays was measured by the method explained earlier in the paper. From these results the efficiency of the transformation of X-rays into visible light (compared with the amyl lamp) was found to be

$$4 \cdot 4 \text{ per cent.}$$

A method of determining the intensity of X-rays in absolute measure by photometric observations is explained.

Entomological Society, October 17.—Mr. G. H. Verrall, President, in the chair.—Mr. A. H. Jones exhibited a series of *Pararge maera*, a light form resembling *P. megoera* from the Basses Alpes and the Cévennes; a dark form approaching *P. hiera* from Cortina; and an intermediate form from the Italian Lakes; also a variety of *Lycaena corydon*, female, in which the under wing showed a decided blue coloration, taken at Lago di Loppio near Riva. Dr. Chapman suggested that the union between the three named species of *Pararge* was very near, if the species were not indeed identical.—Mr. A. J. Scollick exhibited a specimen of *Cethosia cyane*, a species inhabiting North-West India, which had been taken this year on the wing near Norwich. It was suggested by Mr. Distant that this was a case of accidental importation, probably in the pupal condition.—Mr. H. Rowland-Brown exhibited specimens of *Erebia glacialis*, taken this year on the Stelvio pass, showing transitional forms to the var. *Alecto*. He said that the typical form and the variety were not found flying together, but on opposite sides of the valley. Dr. Chapman observed that the darker specimens approached to the form of *E. melas* found in the neighbourhood of Cortina-di-Ampezzo. Specimens of *E. glacialis* also exhibited from Saas Fée and Evolena showed marked inferiority in size and brilliancy of colour.—Mr. W. L. Distant exhibited a piece of Hawkesbury sandstone from Australia, showing the borings of Termites, and in connection with the same communicated a note from the *Proceedings* of the Linnean Society of New South Wales (Pt. iii. 1899, p. 418), as follows:—"Mr. D. G. Stead exhibited specimens of Hawkesbury sandstone (1) From the sea-shore between tide marks showing the tunnelling of Marine Isopods (*Sphaeroma*) with the living animals *in situ*; and (2) from the hill-tops overlooking Port Jackson, offering examples of the borings which so often attract notice and the production of which has been attributed to Hymenoptera, and also to the Termites. Since last meeting Mr. Stead reported that he had investigated the matter and that, after breaking up a quantity of stone, he had come upon Termites, of a species at present undetermined, actually at work, specimens of which he exhibited —Mr. M. Burr exhibited a male and female specimen of *Anisolabis colossea*, Dohrn., from New South Wales—the largest known earwig in the world.

PARIS.

Academy of Sciences, October 29.—M. Maurice Lévy in the chair.—On a method of Riemann and on linear partial differential equations, by M. R. Liouville.—The application of the interference method to the measurement of wave-lengths in the solar spectrum, by MM. A. Perot and Ch. Fabry. The method described permits of the direct comparison of the wave-length of a given dark line in the solar spectrum with a known cadmium ray, a single experiment requiring only the measurement of the diameters of two rings.—On the ammoniacal arsenates of nickel, by M. O. Ducru. Nickel forms three ammoniacal arsenates corresponding to those previously described for cobalt.—On the selenides of cobalt, by M. Fonzes-Diacon. Cobalt combines with selenium giving according to the conditions of the experiment $CoSe_2$, Co_2Se_3, Co_3Se_4, and $CoSe$. At a high temperature all these selenides are reduced by hydrogen to Co_2Se, which, after prolonged contact with the gas, loses all its selenium.—Modification of the chemical properties of some simple bodies by the addition of very small proportions of foreign substances, by M. Gustave LeBon. Magnesium and aluminium amalgams behave differently, from either of their constituents taken singly, towards water and air.—Cellulose, precipitated cellulose and hydrocellulose, by M. Leo Vignon. The reducing properties, velocity of saccharification, and heats of combustion of cellulose that had been submitted to different modes of treatment were determined. Solutions of strong alkali produced apparently a polymerisation, and similar effects were caused by dilute acids, but none of these celluloses possessed any reducing properties, and thus were sharply differentiated from the oxycelluloses.—On two ketones containing the acetylene grouping, acetyl-œnanthylidene and benzoyl-œnanthylidene. Transformation into β-diketones by hydration, by MM. Ch. Moureu and R. Delange. Amylacetylene $CH_3.(CH_2)_4—C\equiv CH$ is converted into its sodium derivative, and this, suspended in ether and treated with the acid chloride, gives the corresponding ketone. With strong sulphuric acid these ketones are hydrolysed, giving the β-diketones $C_5H_{11}.CO.CH_2.CO.CH_3$ and $C_5H_{11}.CO.CH_2.CO.C_6H_5$.—Transformation of α-amido-acids into phenylhydantoins, by M. A. Mouneyrat. A description of the preparation and properties of γ-phenylhydantoin, phenyl-methyl-hydantoin, phenyl-ethyl-hydantoin, phenyl-isobutyl-hydantoin, and phenyl-benzyl-hydantoin.—On the regeneration of a confined volume of air by means of sodium peroxide, by M. George F. Joubert.—On the gaseous exchanges between plants and the atmosphere, by M. Th. Schlœsing, junr. An extension of previous work on the same subject to plants growing in soils containing ammonia salts as the only available source of nitrogen, and free from the nitrifying organism.—A case of rapid transformation of wood into a substance resembling a combustible fossil, by M. G. Arth.—On the examination of contaminated waters for cystine, by M. M. Molinié. The author has repeated the experiments of M. Causse on this subject, and finds that the reagent proposed as a test for cystine gives a permanent orange coloration, not removable by sulphurous acid, even in distilled water. Further examination of the reaction showed that the tint is produced only when the test solution has an acid reaction. The test would thus appear not to be a characteristic one for cystine.—On a new sporozoa from the larvæ of Diptera, by M. Louis Léger.—Precocity and sexual periodicity in man, by M. Gustave Loisel. An attempt to explain the phenomenon of sexual periodicity by the periods in the evolution of spermatogenesis in man and the higher vertebrates.

NEW SOUTH WALES.

Royal Society, August 8.—The President, Prof. Liversidge, F.R S., in the chair.—The President announced that the third science lecture of the Royal Society of New South Wales' series for 1900, viz. a Study of the Mechanics of the Human Frame-work, by Prof. T. P. Anderson Stuart, would be given in the Royal Society's House on August 22.—The following papers were read: Notes on rack railways, by C. O. Burge.—On the damage done to the Seal Rocks lighthouse by lightning on July 10, by C. W. Darley. The author said that the lighthouse tower was fitted with a solid copper lightning conductor extending half round, and was attached at the top to the copper roof of the lantern. The electricity evidently entered the vane on top of the lantern dome, the end being bent and fused, and thence passed down the lightning rod. A portion of the current was communicated to the electric bell wires on the middle floor. These wires led to the principal and assistant light-keepers' quarters, and were laid underground in a 1-inch iron pipe for a distance of 300 feet. The current had tried to make earth at three places, for the pipe was burst and the earth above blown away.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 8.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—On the Transmission of Force through a Solid: Lord Kelvin, G.C.V.O.—In a Simple Group of an Odd Composite Order every System of Conjugate Operators or Sub-groups includes more than Fifty: Dr. G. A. Miller.—Prime Functions on a Riemann Surface: Prof. A. C. Dixon. (i) Further Note on Isoscelians; (ii) On Two In-triangles which are similar to the Pedal Triangle: R. Tucker.—(i) A General Congruence Theorem relating to the Bernoullian Function; (ii) On the Residues of Bernoullian Functions for a Prime Modulus, including as Special Cases the Residues of the Eulerian Numbers and the I-numbers: Dr. Glaisher, F.R.S.—On Green's Function for a Circular Disc: H. S. Carslaw.—On the Real Points of Inflexion of a Curve: A. B. Basset, F.R.S.—On Quantitative Substitutional Analysis: A. Young.—On a Class of Plane Curves: J. H. Grace.—On Group Characteristics, and on some Properties of Groups of Odd Order: Prof. Burnside, F.R.S.—(i) Conformal Space Transformations; (ii) Dynamical and other applications of Algebra of Bilinear Forms: T. J. I. Bromwich.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address: Prof. J. Perry, F.R.S.

FRIDAY, NOVEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Observations of Nebulæ made at the Chamberlin Observatory, University Park, Colorado: Prof. H. A. Howe.—On the Appearance of Saturn's Crape Ring in 1900: E. M. Antoniadi.—Observations of Jupiter and his Satellites made at Mr. Crossley's Observatory, Bermerside, Halifax, 1899-1900: J. Gledhill.—Photographic Measures of the Ring Nebula in Lyra and of the Neighbouring Faint Stars: F. P. Leavenworth.—(1) Ephemeris for Physical Observations of the Moon for 1901; (2) Note on the Moon's Eclipse Diameter: A. C. D. Crommelin.—The Occultation of Saturn, 1900 September 3: Rev. S. J. Johnson.—Variable Stars in Star Clusters: A. W. Bickerton.—On the Disappearance from Photographic Films of Star Images, and their Recovery by a Chemical Process: Isaac Roberts.—Note on the Total Eclipse of the Sun, 1900 May 28, observed at Algiers: Rev. C. D. P. Davies.—Micrometric Measures of the Diameter of Neptune and Satellite made with the 28-inch Refractor: Royal Observatory, Greenwich.—*Probable Papers:* Stationary Meteor Radiants: an Alternative Explanation: H. H. Turner.—Photographic Observations of the Planet Eros: a Close Approach to a Small Star: F. A. Bellamy.—On the Variable Velocity of α Persei: H. F. Newall.—On the System of ζ Herculis as deduced from Micrometric Measures and Meridian Observations: T. Lewis.—Kinematograph Photographs of the Total Solar Eclipse of 1900 May 28: Nevil Maskelyne.

PHYSICAL SOCIETY, at 5.—Electromotive Force and Osmotic Pressure: Dr. R. A. Lehfeldt.—On Astigmatic Lenses: R. J. Sowter.—(*a*) On a Phase-turning Apparatus for use with Electrostatic Voltmeters; (*b*) On a Method of Measuring Power in Alternate-Current Circuits; (*c*) Note on obtaining Alternating Currents and Voltages in the same Phase for Fictitious Loads: A. Campbell.—On the Refraction of Sound by Wind: Dr. E. H. Barton.

MALACOLOGICAL SOCIETY, at 8.—Morphological and Descriptive Notes on the Genus *Cryptoplax*: H. A. Pilsbry.—Notes on a Remarkable Nudibranch from N.W. America: Sir Charles Eliot.—On the Anatomy of some Agnathous Molluscs from New Zealand: R. Murdoch.—Fate of the Type Specimen of *Voluta Roadknightae*, McCoy: W. Baldwin Spencer.

MONDAY, NOVEMBER 12.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Introductory Address: The President.—Expedition through Somaliland and between Lake Rudolf and the Nile: Dr. A. Donaldson Smith.

TUESDAY, NOVEMBER 13.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Metropolitan Terminus of the Great Central Railway: George A. Hobson and E. Wragge.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—An Improved Form of Three-Circle Goniometer: G. F. H. Smith.—A Simple Proof of the Rationality of the Anharmonic Ratio of Four Faces of a Zone: Harold Hilton.—Sulpharsenites of Lead from the Binnenthal. Part II. Rathite: R. H. Solly.

THURSDAY, NOVEMBER 15.

ROYAL SOCIETY, at 4.30.—The following Papers will *probably* be read: Further Note on the Spectrum of Silicium: Sir Norman Lockyer, F.R.S.—On Solar Changes of Temperature and Variations in Rainfall in the Region Surrounding the Indian Ocean: Sir Norman Lockyer, F.R.S., and Dr. W. J. S. Lockyer.—Argon and its Companions: Prof. W. Ramsay, F.R.S.—Data for the Problem of Evolution in Man. VI. A First Study of the Correlation of the Human Skull: Dr. Alice Lee and Prof. K. Pearson, F.R.S.—Mathematical Contributions to the Theory of Evolution. IX. On the Principle of Homotyposis and its Relation to Heredity, to the Variability of the Individual and to that of the Race. Part I. Homotyposis in the Vegetable Kingdom: Prof. K. Pearson, F.R.S.—On Retinal "Blaze" Currents: Dr. Waller, F.R.S.

LINNEAN SOCIETY, at 8.—Contributions to the Comparative Anatomy of the Cycadaceæ: W. C. Worsdell.—On a New Parasitic Copepod: Miss Alice L. Embleton.

CHEMICAL SOCIETY, at 8.—The Bases contained in Scottish Shale Oil: F. C. Garrett and Dr. J. A. Smythe.

FRIDAY, NOVEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Capacity of Railway Waggons as affecting Cost of Transport: D. Twinberrow.

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