THURSDAY, FEBRUARY 22, 1906.

THE ACTION OF SULPHUR-DIOXIDE ON PLANTS.

Untersuchungen üb. d. Einwirkung schwefliger Säure auf die Pflanzen. By Prof. Dr. A. Wieler. Pp. vii+427. (Berlin: Gebr. Borntraeger, 1905.) Price 12 marks.

THIS work is a monograph dealing with the injurious action of sulphur-dioxide on plants, especially forest trees. The aspect in which the subject is regarded is primarily an economic one, although matters of purely physiological interest arise necessarily as offshoots of the main quest. The subject is an important one, since the destruction of trees owing to pollution of the air due to commercial undertakings is in places considerable. The author has written his book in a style such as he hopes may render it useful both to botanists and primarily to those technically and commercially interested in the subject.

The text is divided into eight chapters; of these the third occupies the greatest space, forming more than half the volume, and dealing with the experimental examination of the action of the gas on plants. The remaining chapters are devoted to its demonstration in leaves from affected areas, the proof that it enters through the stomata, its action on soil, the relation between height of trees and constitution of soil, the resistance of plants to the gas, the amount of it in the air of contaminated regions, and a final chapter on "Rauchexpertise." The results and conditions of the various experiments follow in tabulated form, then an appendix of ten pages by Oster. There are finally a few curves, and scattered throughout the book are a few rather poor prints from photographs.

Sulphur-dioxide was found in the leaves of all plants examined so far as eight kilometres from any known source of pollution; but no relation between degree of injury and concentration of the poison in the air was found, and no clear connection was detected between quantity of dioxide in leaves and distance of these from centres of contamination.

In agreement with F. Oliver, the author found that the gas penetrated into leaves solely through the stomata, a fact that had been disputed by v. Schroeder and Reuss.

The study, on a small scale, of the mode of action of the poison on plants forms the next step of the work. Throughout the volume the author distinguishes, as nearly every other observer had previously done, between acute and chronic affection of plants, the former being due to corrosive action of high percentages of dioxide within a short period, the latter to slow action of low percentages within a longer one. Prof. Wieler directed his attention almost entirely to the latter class of injury. Different plants and organs were found to react in very dissimilar manner, and to be unequally sensitive. The author points out that it is necessary to distinguish between sensitiveness of organs and resistance of plants as wholes. The reaction advanced by R. Hartig as a specific one of leaves to the gas is shown to be valueless. A possibly specific reaction of angiospermous plants may be green coloration of injured cells of the mesophyll with methylene-blue. In the case of an unnamed variety of vine a specific reaction was found, namely, formation of a red pigment.

Normal respiration is held to be a periodic function. A distinctly adverse effect of the dioxide was found on photosynthesis, but no critical concentrations of affection could be established for different species. An inductive action of the poison was frequently noticed. The partial inhibition is shown to be due to direct action of the gas on the chloroplastids, not to closure of stomata. In addition to corrosions due to acute affection, the characteristic effects of a chronic nature observed in forests were obtained; these are precocious autumnal coloration and fall of leaves; similar effects resulted from partial starvation. The dioxide was found to inhibit metastasis of photosynthetic products, and to lessen the height of trees. No effect was exerted on transpiration.

The author proceeds to discuss the mode of action of the poison on plants. He believes that it unites with metabolites, especially aldehydes, and that sulphuric acid is liberated on consumption of these, injury being due to this acid; this hypothesis is held to explain the facts satisfactorily, especially those of induction.

The appearance and structure of chronically injured trees are next considered. The general features of such are strikingly similar to those due to defective nutrition, and could be satisfactorily explained on the supposition of direct action of the gas were it not that the concentration in the author's experiments was far higher than that of polluted areas. Hence Prof. Wieler attributes the effects to indirect action of dioxide on soil resulting in removal of basic constituents and consequent acidification due to humic acids. This view is amply discussed; it is pointed out that, correlated with this acidity, there will result change of the subterranean flora and of the physical constitution of soil, consequently also of the nutritive value of the latter. As a remedy for chronic injury, application of manures, especially basic ones such as lime, is recommended, the author being strongly of the opinion that the injury is almost entirely due to impoverishment of soil. Acute affection is to be considered as beyond control.

It is shown that no scale of resistance can be drawn for different species, since resistance of individuals varies with locality; the explanation of this is probably to be found in the natures of the particular soils and the special requirements of the plants, as suggested by Haselhoff and Lindau.

Concentration of sulphur-dioxide in the air of contaminated regions is shown to vary with direction of the wind, but no obvious relation with distance from the source of pollution was found, the content remaining approximately the same for different distances.

In conclusion, Prof. Wieler states that no simple and certain means of recognising injurious concentration has been found, except in the one case of the colour-reaction in an unnamed variety of vine; this he suggests might be used as an indicator. He repudiates determination of the dioxide in leaves as a test, and does not favour that of sulphuric acid; but he thinks that evaluation of the concentration of the gas in the air would be of some importance in determining the extent of its deleterious influence, the minimal lethal content being apparently somewhere near 1:500,000. Injection of the intercellular spaces of leaves is a certain sign of injurious action of the gas, but not a specific one; this is also an induced effect.

Limitation of space forbids more than the shortest critique of this monograph. Its literary style and practical value would have been greatly enhanced had the author written it in a shorter manner; the wording is diffuse, and there is too much recapitulation. Prof. Wieler has, moreover, an unfortunate habit of interpolating the results of his experiments in the text, which consequently resembles a note-book in these parts; one result of this is intolerable weariness in the reader. The modes of application of many of the methods are susceptible of improvement, and conclusions are not infrequently drawn from results that are too ambiguous for the purpose.

But it is easy for a reviewer to be captious or hypercritical. The problems that Prof. Wieler has endeavoured to solve certainly involve considerable practical difficulties, and necessitate expenditure of much time and labour. His rehabilitation of an old hypothesis is ably done, and it is probable that subsequent work may confirm his results and conclusions, and raise the hypothesis to the rank of a theory.

F. ESCOMBE.

SOME SIDE ASPECTS OF MATHEMATICS.

L'Algèbre de la Logique. By Louis Couturat. *Scientia,* No. 24. Pp. 100. (Paris: Gauthier-Villars, 1905.)

A Geometrical Political Economy. By H. Cunynghame, C.B. Pp. 128. (Oxford: Clarendon Press, 1904.) Price 2*s.* 6*d.* net.

THERE are very few branches of study which cannot be made the subject of exact reasoning, and such reasoning can almost always be made, if not more exact, at least more simple and precise in its mode of expression by the adoption of mathematical language and the application of mathematical methods.

M. Couturat's work affords a general *exposé* of the symbolical analysis of logic founded by George Boole (1815–1864), and developed and perfected by Ernst Schröder (1841–1902) and other writers. It is an interesting study, not only to the logician, but also to the mathematician, who here is brought into contact with an algebra differing completely in its laws from the various algebras invented in connection with the study of directed and undirected magnitudes. Its symbols, in fact, do not denote magnitudes, but concepts or propositions. Its signs are based on those of algebra with the exception of the accent denoting negation, but the operations follow laws of their own. The discussion of these laws given in the present book is based on the works, not only of Boole and Schröder, but also of Venn, Stanley Jevons, Poretsky, Macfarlane, Whitehead, Müller, Johnson, and Huntington. While the treatment appears suitable to a beginner, it must not be forgotten that in commencing the study of *any* algebra great difficulty is in general experienced in forming a tangible conception of the symbols involved. This criticism applies quite as much to ordinary algebra as to the subject-matter of the present work. Among all the algebras for beginners that have been written, we have not yet come across one which does exactly what is wanted, viz. base the subject on the *use of formulae* in numerical calculations relating to concrete quantities. On the other hand, readers of the present book are usually of maturer years, and may be better able to supply the illustrations for themselves.

In logic we have to deal with a discrete series of concepts or propositions, and it is natural that the language of algebra should be well suited to their treatment. The second book under review deals with quantities which are capable of continuous variations not necessarily expressible by any exact law, and for the study of these graphical methods are the most suited. Mr. Cunynghame's book does not require any knowledge of mathematics except such geometry as has been acquired at school, and very little of that. When we add that this particular knowledge mainly consists in the capacity to represent on squared paper the fluctuations in the price of wheat, the national debt, or the income tax, and that special stress is laid on this capacity in modern school examinations, it will be seen that the present is a very favourable time for introducing a book of the kind. We may not live to see the time when electioneering addresses take the form of mathematical lectures illustrated by diagrams, but we may be certain that, if any nation ever rises to this state of intelligence—and at the present time Germany is the most promising—that nation will outstrip all others in efficiency and prosperity. It is only by methods such as those here described that fiscal questions can be studied, and it is much to be hoped that the present book will teach a *few* English people how misleading it is to rush to conclusions based on *isolated* statistics, which can be turned about in such a way as to prove anything.

The method of this book was introduced into England by Prof. Marshall, Fleming Jenkin, and Stanley Jevons, and the author is also indebted to Prof. Foxwell for much information. The subjects treated include supply and demand, surplus value, taxation, monopoly, international trade, and Marshall's curves.

Mathematical teachers may well reflect on Mr. Cunynghame's reason for avoiding the words "graph" or "graphical." According to his interpretation, a "graph" is to be regarded as "a curve which merely aims at presenting a collection of facts to the eye without any known law behind it. . . ." "When, however, a law can be discovered governing the form of the graph it ceases to be a mere graph and becomes promoted to the dignity of a curve." And yet "graphs" were introduced into elementary mathematical syllabuses with a great flourish of trumpets not so very long ago, and were regarded by many people as something quite *chic* and up to date!

In conclusion, Mr. Cunynghame may claim to have presented us with a very clear and well expounded introduction to the important subject of which his book treats. G. H. B.

TWO EGG-BOOKS.

(1) *Ootheca Wolleyana: an Illustrated Catalogue of the Collection of Birds' Eggs formed by the late John Wolley.* Edited by Alfred Newton. Part iii., Columbæ to Alcæ. (London: R. H. Porter, 1905.) Price 2*l.* 2*s.*

(2) *Eggs of the Native Birds of Britain and List of British Birds, Past and Present.* By W. J. Gordon. Pp. 64; 398 illustrations. (London: Simpkin, Marshall and Co., Ltd., 1905.) Price 3*s.* 6*d.*

IN the first of these two books Prof. Newton makes good progress with the catalogue of the unrivalled collection of eggs to which it is devoted, dealing in this instance with the pigeons, game-birds, rails, cranes, bustards, waders, gulls, and auks. Needless to say, it is written in the same style as its two predecessors, consisting almost entirely of Mr. Wolley's original notes, with such comments as the editor considered it advisable to intercalate here and there. To review the fasciculus is impossible within the limits of our space, and we can only refer to a few points of special interest. One of these relates to the eggs of the knot, of which a presumed specimen, laid in confinement, was given to the author by Lord Lilford; the correctness of this identification has been recently confirmed by the discovery of "wild" specimens. Equally interesting is the record of the first known egg of the stint, obtained by Middendorf in Siberia in 1843. The culminating interest of this fasciculus is, however, concentrated on the superb series of eggs of the great auk possessed by Mr. Wolley, which included no less than seven actual specimens, together with several casts. The first of the originals the author bought in 1846 for twenty-eight shillings; it may, perhaps, be now worth ten times as many pounds! Coloured figures (two of each) of the seven auks' eggs and of one of the casts form the illustrations to this fasciculus; and in the execution of these plates Mr. H. Grönvold has surpassed himself, having succeeded not only in showing the colouring and markings to perfection, but also in imitating to a nicety the very grain and texture of the shell. The eight specimens show very clearly the range of variation to which the colour and markings of the eggs of the species were subject.

Mr. Gordon's little book, which is, of course, a work of quite a different class from the last, is a well-intended attempt to place before the public, at a very low price, a satisfactory means of identifying the eggs of those birds which nest in the British Isles, or did so until within a comparatively recent period. That the author has taken great pains in grouping and photographing these eggs is perfectly evident, and if the colouring of the figures is in some instances not quite so true to nature as might be desired, this can scarcely be considered his fault, while, if the low price at which the book is published be taken into consideration, it would be almost unfair to lay the blame on the lithographer. We cannot have perfection combined with cheapness in matters of this sort, and, considering its price, the book is a very creditable production.

In including extinct species of British birds in the list at the end of his work, Mr. Gordon has, we think, been ill-advised, as the majority of these are very imperfectly known, and they are not likely to interest the class of readers to whom this volume will appeal. Still, the inclusion is evidence of broad views on the part of the author. Both Prof. Newton and Mr. Gordon, we are glad to find, remain staunch conservatives in the matter of nomenclature, both as regards the use of generic terms in a wider and more comprehensive sense than is now, unfortunately, the fashion, and above all in eschewing the detestable "*Pica pica*" system. In both these respects, we venture to think, Mr. Gordon's work (the other does not, of course, appeal to the same class) will be far more acceptable to the general public than would have been the case had the author been induced to yield to the prevalent (and we trust fleeting) fashion

R. L.

OUR BOOK SHELF.

Engineering Chemistry: a Manual of Quantitative Chemical Analysis for the Use of Students, Chemists, and Engineers. By Thomas B. Stillman. Third edition. Pp. xxii+597. (Easton, Pa.: The Chemical Publishing Co.) Price 4.50 dollars.

AT the present day chemical knowledge is so important a factor in the successful conduct of nearly all technical work that such books as Stillman's "Engineering Chemistry" appeal to a very large audience, and so well has the professor of analytical chemistry in the Stevens Institute done his work that the third edition will be as warmly welcomed as its predecessors. In it much of the work has been revised, the most modern standard methods introduced, and a considerable amount of new matter added, those portions on lubricating oils and the technology of the blast furnace being especially noticeable.

In so excellent a work criticism always seems ungracious, but there are a few points the author would do well to correct in the next edition. For instance, on p. 169 the author gives as a typical analysis of London coal gas

Hydrogen	27·70
Methane	50·00
Carbon monoxide	6·80
Ethylene	13·00
Nitrogen	0·40
Oxygen	0·00
Carbon dioxide	0·10
Aqueous vapour	2·00
	100·00

and calculates that it would have a heating value of 870·15 B.T.U.'s gross.

Such an analysis is so absurdly wrong that it can only have been inserted by error, the main constituents more nearly approximating to hydrogen 50 per cent., methane 36 per cent., and ethylene 4 per cent.

Moreover, the author on p. 183 says that London coal gas has an illuminating value of 16 to 17 candles, and a calorific value of about 668 B.T.U.'s, which is much more nearly true for the gas supplied by the Gas Light and Coke Co. The error is of importance, as an engineer working at the problem of the gas-engine and consulting records of efficiency made with London gas might be seriously misled.

In dealing with water gas, no mention is made of the more modern processes such as the "Dellwik," now so largely used for the production of blue gas for welding, as well as for diluting coal gas.

It is admitted in the preface that the article on practical photometry has not been brought up to date, and this is a pity, as more than seven pages are devoted to the Bunsen photometer and the manipulation of candles, now practically extinct in all but name as a standard of light, whilst a couple of pages on pentane standards would have been of real value.

In spite of a few blemishes, the whole work is so good that no engineering chemist can afford to be without it.

Die Photographie im Hochgebirg. By Emil Terschak. Second edition. Pp. xxiii+62. (Berlin: Gustav Schmidt, 1905.) Price 2.50 marks.

EVERYONE who is of a roving disposition, and takes his camera to Switzerland or the Tyrol, or any other region where mountain climbing is pursued, should, if he wishes to gain by the experience of others, read this book. It is written by a photographer to photographers, and is not only very interesting to read, but contains a great amount of very useful photographic information of a particular kind.

The successful photography of mountain scenery, of ice, snow, and clouds at high altitudes requires not only forethought, but much experience. As it is necessary to carry all the apparatus that is required, the equipment must be well attended to, and since also one does not necessarily wish to climb high altitudes to take again a particular view that has not turned out photographically successful, one must be sure of securing a good negative at every exposure.

The first edition of this book appeared in 1900, but the author has since gained much more useful knowledge, which he has embodied in the present edition. The book is clearly printed in Roman characters on good paper, and the illustrations are numerous and well reproduced.

The Royal Medical and Chirurgical Society of London. Centenary 1805–1905. Written at the request of the President and Council by Dr. Norman Moore and Stephen Paget. Pp. 337. (The Aberdeen University Press, Ltd., 1905.)

THOUGH not the oldest of the medical societies of London, the Royal Medical and Chirurgical Society holds a position second to none, and the present volume of chronicles will not only be welcomed by its Fellows as giving a history of their society, but forms a useful record of the art and science of medicine during the nineteenth century, with comments by the compilers. A noteworthy feature of the volume is the list which is given for each year of the principal papers read before the society, both published and unpublished, extracts being given from the more important ones. Thus, for the year 1833, we find Hilton's unpublished account of *Trichina spiralis* in human muscle, which ante-dated Paget's discovery of this parasite. Short bibliographies of all the presidents and a full index complete this interesting volume, which contains several illustrations of the various premises occupied by the society and a photogravure frontispiece of William Saunders, the first president.

R. T. HEWLETT.

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.]*

Tidal Researches.

IN NATURE for January 11 (p. 248) appear some criticisms upon my paper entitled "Cotidal Lines for the World."

The critic says:—"The construction of these charts is, unfortunately, but vaguely indicated." In reply to this it may be said that the charts embody all data known to me at the time of their construction, and to such data references as copious as space seemed to permit are given. What is meant by cotidal lines is given in § 17. Notions relating to the local modifications or peculiarities of cotidal lines have been given in considerable detail by means of lemmas and examples. In the construction of these lines, large detailed charts showing soundings wherever known were employed, and these depths were carefully considered in each step of the process. The ranges of tide written along the shore-lines simply represent data, and in no way depend upon any theory or hypothesis. The same is essentially true of the cotidal lines where observations or data are sufficient. Wherever harmonic constants are available, the length of the series analysed is of secondary importance in the construction of cotidal lines, the results from two months being about as satisfactory as those from twenty years.

If we are not permitted to extend cotidal lines outward from the shore, we might about as well draw them upon the land as upon the water, for in either case they would only serve to point out the shore values. The reviewer thinks well of Berghaus's chart, and so do I. However, it is difficult to believe that a philosophical critic could long rest content with cotidal lines extending but a short distance off shore, and forming no connected or consistent system. Of course, the attempt, on my part, at covering all seas does not imply that all charts are equally good. In some instances the data were very meagre, and attention was directed to this fact more than once in the paper.

It seems strange that any serious misunderstanding could exist in reference to the method employed in inferring the times when the water particles are at elongation in particular directions. Does anybody doubt the conclusions reached in § 56, part iv. A? If these conclusions are wrong, let us hear the correct ones. If §§ 60–65, part iv. A, are not clear as they stand, it seems as if § 24, part iv. B (to say nothing of a reply to former criticism, NATURE, April 23, 1903), ought to remove all obscurity.

Perhaps the following remarks may be of some service in this connection:—

Unless the free period of a body of water, or of some portion of this body, approximately agrees with the period of the tidal forces, the tide in the body proper must be small, and generally smaller than the theoretical equilibrium tide for the body in question. But in many parts of the oceans the tide is several times greater than that which could be raised by the forces, even if we could suppose sufficient depths and sufficiently complete boundaries for enabling equilibrium tides to occur. Hence regions the dimensions of which approach critical values must exist in the oceans and account for the principal tides. If the aërial vibrations accompanying a musical tone act upon a series of resonators suited to various pitches, the one or more constructed for the given tone will respond to it, while all others will be practically silent; that is, the dominant impressed motions belong to resonators having critical dimensions, and not to the resonators in general.

That stationary oscillations of unexpectedly large amplitude exist in the oceans there is abundant evidence. In fact, a glance at the charts under criticism will show regions of large ranges over each of which the time of tide varies but little. As a nodal line is approached the range diminishes, and the time of tide changes rapidly in a comparatively short distance. Moreover, the dimensions of the oceans are such that areas having nearly critical lengths can be readily discovered; these respond well to the forces, and their tides must be the ruling semi-diurnal tides of the oceans. The charts prove the existence of large stationary oscillations. To doubt this fact would be scarcely more reasonable than to doubt the existence of the tide itself. The large ranges of tide imply critical lengths, and critical lengths imply that the phase is controlled by the resistance to the movement.

In a second approximation it may be possible to take into account the actual departures from critical lengths, to make some numerical estimates of the resistance, and to fix more accurately the modes of oscillation having regard to the deflecting force of the earth's rotation. In my paper the latter effect has been considered only in reference to arms or bodies of water tidally dependent upon larger bodies.

As soon as my critics develop their tidal theories sufficiently far for making definite suggestions, I shall be pleased and bound to give such developments careful consideration. In the meantime, I believe that nothing is gained by criticism which does not constantly revert to such facts as have been brought out through observations upon the tides. These constitute the final test of all theories. R. A. HARRIS.

Washington, D.C., January 26.

IT is Mr. Harris's theory with which we were, and continue to be, at variance. We were unable to gather the part played by this theory in the construction of his series of cotidal charts, and hence our statement that this construction was but "vaguely indicated"; but we are glad to be assured that the theory has only been employed in regions where observational data were entirely wanting, and has not been allowed to vitiate, as we feared, results obtained direct from observation.

In reference to the phase theorem which we selected for special comment, Mr. Harris now states that "the large ranges of tide imply critical lengths, and critical lengths imply that the phase is controlled by resistance." The latter part of this theorem we are not prepared to admit unless it be further contended that the critical conditions implied are mathematically *exact*, especially in consideration of the comparatively small frictional influences which can be brought to bear on the motions of the sea. Any departure from the ideal critical state, and we contend that such departures must inevitably occur in a complex system like that of the ocean, will render the determination of phase dependent on such departures as well as on frictional influences, and we differ from Mr. Harris in regarding the former rather than the latter as the more powerful controlling influence in regard to phase. Whence can the large resistances to motion, implied in Mr. Harris's theory, arise? S. S. H.

Atomic Disintegration.

ACCORDING to the investigations on radium, especially by Prof. Rutherford, there can be no longer any doubt that the formation of helium from radium is due to spontaneous disintegration of the radium atom, and it is the same with the other radio-active elements. Most competent investigators have not hesitated to apply the same point of view also to all the other elements.

The enormous amount of energy set free in the formation of helium—about 10^9 great calories for a gram-atom of helium—must render hopeless any attempts to reverse this process. Considering the conformity of the other gases of the helium type—neon, argon, krypton, and xenon—it seems probable that they owe their existence to a similar disintegration of atoms. It is not surprising, therefore, that all attempts have failed to obtain a chemical compound of those gases, and I do not think such attempts likely to succeed in future. That, as yet, those gases, excepting helium itself, have not been recognised as products of atomic disintegration may be due to their difficult test.

Now it seems to me there is nothing contrary to the view that *disintegration of atoms is an irreversible process, strictly analogous to dissipation of heat.*

Considered in this way, there exists a parallelism not only as regards the first law of thermodynamics—conservation of energy—with the principle of conservation of matter, but also regarding the second law—dissipation of energy, on the one hand, and atomic disintegration on the other. And as it has been stated by Clausius that the world's entropy tends towards a maximum, we may say that likewise the quantity of free helium and the similar "Edelgase" tends towards a maximum.

This parallelism in material and energetical law appears to me well worthy of notice. W. MEIGEN.

Freiburg i/Br.

Phosphorescence of Pyro-soda Developer.

SOME time ago (January, 1904) you were good enough to publish a note on the "Phosphorescence of Photographic Plates," and the following additional particulars of this phenomenon may be of interest. The developer used is the ordinary pyro-metol-soda solution.

If a bromide plate is exposed in the camera, developed, washed for a few moments only, and then placed in aluminium sulphate solution in the dark, the picture becomes luminous and shows forth as a *negative*, the high lights being dark, whilst the shadows are bright, the darkest ones phosphorescing most strongly. If, however, the plate (after having been exposed and developed) is washed thoroughly for half an hour by means of a jet of water under pressure, no phosphorescence is observed on treating it with Al_23SO_4 solution, from which it appears that a trace of the developing solution is necessary to cause phosphorescence in the plate.

If a few spots of unused developing solution are placed in the bottom of a porcelain dish and Al_23SO_4 solution is added (in the dark), the mixture will phosphoresce. But if the developer has been used for developing exposed plates, then its power of phosphorescence is weakened, and if the same portion of solution is used repeatedly for developing, and tested periodically for phosphorescence between the developments, it will be found that its phosphorescing power is diminished after each development, and that it finally vanishes altogether. This explains the production of the phosphorescing negative. The most strongly lighted part of the film is that which will destroy the phosphorescing power of the developer it has absorbed, and the unlighted portion or shadow is that in which the absorbed developer will be least changed, and therefore most strongly phosphorescent.

The addition of various substances to the aluminium salt modifies its phosphorescing power, and some prevent it altogether, even when added in very small quantities. Among those substances which strongly counteract the phosphorescence may be mentioned the salts of thorium, uranium, copper, lead, bismuth, iron, tin, cobalt, nickel, chromium, zinc, cadmium, mercury, platinum, and silver in the order named, while the salts of potassium, sodium, ammonium, lithium, calcium, barium, strontium, magnesium, and manganese seem to have little influence one way or the other.

The only substance found which has the effect of much increasing the brilliancy of the phosphorescence is gold. A solution of $AuCl_3$ alone, in fact, gives a more brilliant phosphorescence than Al_23SO_4. The gold is reduced to the black metallic form, and while this reduction is proceeding light is emitted. Other reducing agents, however, do not appear to emit any light during the process of reduction of $AuCl_3$. The influence of the other metals on the phosphorescing power of the gold solution seems to be practically the same as for aluminium.

Other aluminium salts, such as the nitrate, phosphate (dissolved in HCl), chloride, &c., phosphoresce with pyrometol developer, but none so brilliantly as the sulphate.

T. A. VAUGHTON.

Ley Hill House, Sutton Coldfield, February 13.

Emission of Light by Kanal-strahlen Normal to their Direction.

IN a former publication (*Physik. Zeitschrift*, vi., 892, 1905) I have proved that the stream of positive ions which form the Kanal-strahlen show the Doppler effect. In these rays we have, therefore, a positive charge, and at the same time velocity, and also, as a result of the vibrations of the negative electrons, emission of light. Therefore it is exerting a pressure on the ions against the translation resulting from radiation; besides this force an electromagnetic force—of second order of the ratio of velocity of translation to velocity of light—may arise from the moved charges of the ions and act on the vibrating electrons. The experimental research of the light of Kanal-strahlen emitted normally to their direction has given the following results. The observations have been made on hydrogen; the velocity of the Kanal-strahlen was $0{\cdot}9.10^8$ and $1{\cdot}2.10^8$ cm. sec.$^{-1}$. The spectrograms were taken with a prism-spectrograph and with a concave grating of 1 metre radius.

The total radiation of the line spectrum (Hα, Hβ, . . .) is partially polarised, and the electrical vibrations parallel to the direction of translation have a greater intensity than the vibrations at right-angles to the direction of translation. The difference of intensities is very small.

The lines of hydrogen (when observed normal to the Kanal-strahlen) are displaced towards the red, when compared with the lines emitted by the slow ions in the negative glow. The displacement seems to be proportional to the wave-length, and also proportional to the square of velocity. The displacement of the centre of Hβ is approximately 0·8 Ångström unit for a velocity of $1{\cdot}2.10^8$ cm. sec.$^{-1}$.

Besides this displacement there is observed a broadening of the lines; it seems also to be proportional to the square of velocity, and to increase somewhat with decrease of wave-length. The observations as to the splitting up into components of the broadened line, and also as to the polarisation of its edges, are not concordant enough in the different spectrograms, and are therefore not ready for publication.

J. STARK.

Göttingen, January 6.

Inversion-point of the Joule-Kelvin Effect.

IN discussing the Joule-Kelvin effect for a fluid like hydrogen, which shows an inversion point above which heating takes place on free expansion, it is usually assumed that this point is unique. Thus, for example, Olszewski has fixed it experimentally at $-80^{\circ}{\cdot}5$ C. An examination of the consequences of any of the usually assumed equations of state (such as Van der Waals's or Dieterici's) easily reveals the fact that it must in reality be a function of the pressures to which the gas is subjected. But this is not all. If these consequences are examined for the inversion point corresponding to an infinitesimal change in pressure, it is seen that all the equations of state (which at the same time indicate a critical point) demand that there shall be *two* inversion points (if any) for any given pressure, and that, moreover, for sufficiently high pressures no inversion point will exist. Different equations of state, while unanimous in the above respects, indicate very different temperatures at which inversion should occur. I desire to point out, therefore, that a complete determination of the inversion points corresponding to various pressures affords an exceedingly sensitive means of discriminating between characteristic equations and of indicating the direction in which these require modification.

This matter is discussed in detail in a paper shortly to be published.

ALFRED W. PORTER.

University College, W.C., February 19.

A Definition of Temperature.

A BODY containing heat is in a condition from which it tends to release itself (by radiating or conducting away heat), and this tendency only ceases when the body has passed into a heatless condition. The temperature of a body is the *measure* of its tendency at any instant to recover this heatless state (*cf.* Maxwell, "Theory of Heat," 10th ed., p. 32). This suggests a mechanical analogy; a body containing heat is analogous to an elastic medium in a state of strain, from which it tends to release itself in virtue of its restitutional forces; the magnitude of the restitutional force when a body is in a given strained condition measures its tendency to release itself from that strain, and so is analogous to the temperature of a body when in a given thermal condition. The quantity of work stored up in producing this strained condition, and which can be given out again when the body returns to its unstrained condition, is analogous to the quantity of heat the body contains when at a given temperature; it is quite easy to show that we can completely represent the thermal condition of a body by means of a model consisting merely of an elastic rod subjected to a tension. *A temperature, therefore, is analogous to a tension or pressure.* We are now in a position to give a real physical meaning to the "temperature" of a body, and so enable it to be measured in *absolute* units like a mass or a length. Let us take a molecular body devoid of all heat motion and plunge it into a medium the temperature of which is T. Then the medium will exert an intermittent pressure or force on the molecules, thus setting them into motion and generating heat motion in the body. It can easily be shown that this force cannot be infinite, or a cold body placed in a hot medium would *instantly* acquire the temperature of the medium, whereas it always takes a definite time to do so.

The *maximum force* which the medium exerts on a molecule at rest when placed therein is the numerical value of its temperature. Hence we arrive at the following definition of temperature:—

A molecule at rest when placed in a medium possessing temperature is subjected to an intermittent pressure; the greatest value of this pressure is the correct measure of the temperature of the medium in the neighbourhood of the molecule. Another method of stating the same thing is to say that the greatest force required to hold a molecule at rest when placed in a medium is the measure of the temperature of the medium. Still another statement is to say that the temperature of a medium is the magnitude of the force tending to drive heat motion into an absolutely cold body placed therein. A temperature, therefore, should be measured as a pressure in *dynes* per sq. cm. All the ordinary laws of thermodynamics, the flowing of heat from bodies of higher to bodies of lower temperature, Waterston's hypothesis, &c., follow quite simply as a consequence of this definition, as the reader can doubtless work out for himself.

GEOFFREY MARTIN.

Kiel, February 10.

Chinese Names of Colours.

IN reply to the letter of Mr. Alfred H. Crook contained in your issue of January 11, I would say that it is possible that the explanation of the Chinese colour-name is to be found in the violet coloured halo which is very commonly noticed by Alpine climbers surrounding moving objects. Dr. Ellis attributes it, I believe, to fatigue of the eye (see discussion in NATURE, May, 1897).

REGINALD A. FESSENDEN.

IN your issue of January 11, Mr. Alfred H. Crook, of Hong Kong, asks why the Chinese should call a bright purple (almost a mauve) "snow green," and he adds that the term "green" is sometimes applied to the colour of the sky, which I take to mean blue. The following is a possible explanation:—

One of the commonest places in nature to find purplish hues is in shadows, and shadows on the snow, when the sky is clear, are decidedly purple. If purple is to be classified among the colours, it will go with the blues, hence "snow green" as meaning "snow blue" would not be such a misnomer as might at first sight appear.

Pittsburg, Pa., February 7. ALFRED SANG.

Sounding Stones.

MR. ALFRED TINGLE (January 4, p. 222) and Mr. Carus-Wilson (January 11, p. 246) may be interested to know that at the caves of Ellora, near Aurangabad, one of the pillars in the rock-cut temples has the same property of sounding under a blow.

The pillar is a massive one close to, or part of, the doorway leading to an inner shrine, and if struck with the clenched fist emits a deep note.

So far as I recollect, this property was confined to a portion of the pillar.

W. G. BARNETT.

Poona, January 29.

THE NILE QUEST.[1]

THE story of the search for the sources of the Nile is the longest and most interesting in the annals of geographical exploration. It dates from the earliest days of geography; it has ever presented new problems; and the quarrel over the boundary between the Congo Free State and British East Africa, in the Upper Nile basin, is the latest example of political muddles due to geographical ignorance. The sources of the Nile roused speculation in the earliest days of Egyptian geography, owing to the mysterious rising of the Nile at the driest and hottest time of the year. The view that the river rises owing to the melting of equatorial snows was for long accepted; but it is now known to be the effect of the rainy season on the Abyssinian Mountains, as the contribution from the equatorial snowfields is insignificant, and even the great reservoir, the Victoria Nyanza, gives only a minor addition to the Egyptian floods. The story of the Nile is of especial interest to British students of geography, as the larger share to the solution of its problems has been contributed by British explorers, and practically the whole of the Nile basin, with the exception of Abyssinia, is now under British administration.

The story of the exploration of the Nile is here well and interestingly told. Sir Harry Johnston is known for his literary skill, and for the artistic sense which leads him to denounce (p. 161) "the unspeakable barbarism of the British Administration" in cutting down the fine trees that once grew beside the Ripon Falls; and his distinguished success in the administration of Uganda has given him an especial personal interest in the sources of the Nile, and full access to the latest information. His volume is worthy of a place among the excellent geographical handbooks in Dr. Scott Keltie's "Stories of Exploration." Sir Harry Johnston begins his narrative in the times when, as he tells us (p. 18), 2500 years ago, Phœnicians or Sabæans worked the goldfields of Rhodesia, and with the story of Diogenes, told to Marinus of Tyre in the first century, and preserved to us by the record of Ptolemy in the second century. He continues the history to recent surveys made under the British and Anglo-Egyptian administrations. The story is so long and so full that in 318 pages the author is able to give only brief sketches of the various expeditions. But he gives an exceptionally complete list of them, and his short, critical sketches are a most useful introduction to the original literature. The most valuable part of the book is its account of the minor expeditions, and especially of those carried on from Khartoum from 1840 to 1860. The author writes with wide sympathy for the explorers of all races and all nations, and he gives foreign workers their full share of praise, including Mademoiselle Tinné, "the gracious demi-goddess" of the Egyptian Soudan, and Georg Schweinfurth, "one of the greatest of African explorers." He defends d'Abbadie against the unjust attacks of Beke, and reminds us that Paez and Lobo were predecessors of Bruce. He describes the journey of Marchand (p. 245) as "one of the most splendid feats in African exploration." The author perhaps somewhat underrates the early contributions of the Portuguese; but he reprints a copy of Dapper's map of 1686; so he enables the reader to judge for himself as to the extent of the facts then known about tropical Africa, and as to the nature of the mistakes made by European cartographers in their interpretation of the verbal reports of the untrained Portuguese travellers. D'Anville's map, which is much praised by the author, is less accurate in regard to the Upper Nile and the Victoria Nyanza than Dapper's, though issued nearly a century later, and nearly a century and a half later than some of the authorities whom Dapper copied. The Portuguese mistake of giving several outlets from Tanganyika, which Sir Harry Johnston says shows that the Portuguese were "ignorant of the simplest principles of hydrography," was a similar mistake to that made by his own hero, Speke, in giving too many outlets from the Victoria Nyanza. The author quotes with praise Scott-Elliot's "very neat and truthful little map of the eastern and southern flanks of Ruwenzori, a map which until quite recently has been somewhat overlooked by those who have compiled charts of this

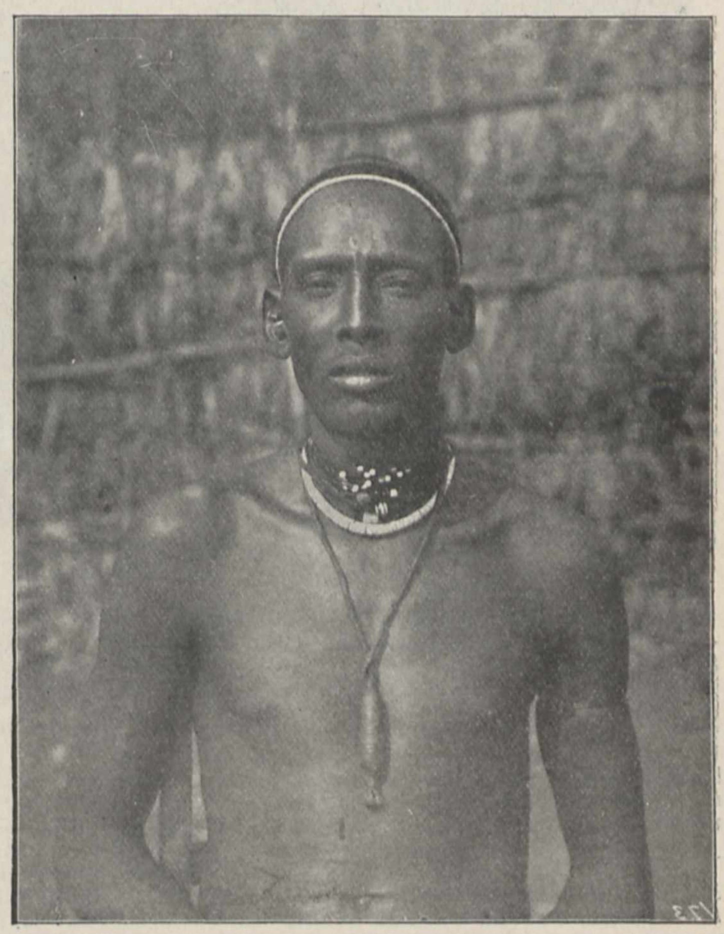


FIG. 1.—A Hima of Mpororo, near Karagwe. From "The Nile Quest.

[1] "The Nile Quest, a Record of the Exploration of the Nile and its Basin." By Sir Harry Johnston, G.C.M.G., K.C.B., in "The Story of Exploration," edited by Dr. J. Scott Keltie. Pp. 365 (London: Alston Rivers, Ltd.)

region" (p. 269). The ethnographical and zoological references in the book show high expert knowledge, but it may be noticed, perhaps with surprise, that on pp. 297 and 298 he accepts the theory of the marine origin of the fauna of Lake Tanganyika.

The illustrations in the book are numerous and excellent, and it is illustrated by two fine maps by Bartholomew, showing the orographic features, and the characteristics of the surface and vegetation in north-eastern Africa.

J. W. G.

FIG. 2.—In the Libyan Desert. From "The Ni e Quest."

THE FORM OF THE ATOMS IN RELATION TO THEIR SPECTRA.

SINCE Balmer's important discovery in 1885 that it is possible to calculate the wave-lengths of the first nine lines of the hydrogen spectrum by means of a simple formula, the existence of series of lines, obeying simple mathematical laws, has been established in the case of the spectra of several other elements, notably by the researches of Rydberg and of Kayser and Runge. Among the various attempts that have been made to account for these series of lines, and, in general, for the different spectra, the most promising seems to be that of Prof. F. von Lindemann, of Munich, who in some recent papers[1] has more fully developed an idea that he was first led to enunciate in 1888, after the publication of Lord Kelvin's Baltimore lectures on molecular dynamics. Prof. von Lindemann's method consists, not in deriving an empirical relationship between the wave-lengths or frequencies of the spectral lines, but in investigating mathematically the possible waves which a hypothetical atom can send out into the luminiferous ether.

His assumptions are the simplest possible. His atom consists of a certain amount of elastic isotropic matter of definite shape. The mathematical theory of the different kinds of vibrations of which such a body is capable is well understood, but the actual working out for any special case is difficult because it depends on functions which have to be discovered for each shape, and are, generally speaking, new to mathematicians. The wave-lengths of each kind of vibration sent out into the ether appear always as roots of a transcendental equation involving those functions. Such an equation has an infinite number of roots, each when real corresponding to a definite line. One equation thus corresponds with a "series" of lines. The theory gives for one body a number of such equations, and therefore a number of such "series" of lines, which together form the whole spectrum. This agrees with observed facts.

Prof. von Lindemann investigates, in the first paper quoted, the case of a spherical atom, filled throughout with matter of a definite density and elasticity. In this case, which is comparatively a simple one, the

[1] "Zur Theorie der Spectrallinien," *Sitzungsber. Math. phys. Classen der Kgl. Bayer. Akad.*, 1901, xxxi., 441; 1903, xxxiii., 27; a lecture, printed in the *Süddeutsche Monatshefte* for September, 1905, of which a translation is published in the *Monist* for January of this year, contains a popular summary of the earlier work and an outline of results not yet published in detail.

calculation can be carried fairly far, but it is found that the spectral lines so deduced obey a law of distribution simpler than any that has yet been found by experiment to characterise any substance. Although atoms are usually assumed for physical calculations to be spherical, such a shape apparently is not really possessed by the atom of any substance; but by using the result established in this case, a simple relationship is shown to be necessary between the wave-lengths of the spectral lines of two *similar* elements and their atomic weights. If these two elements are conceived as being built up of the same material, having the same form, density, and elasticity, and only their size different, the wave-lengths of corresponding spectral lines of the two elements are shown to be proportional to the cube roots of their atomic weights; given the lines of one of the elements, those of the second element can be calculated from the equation

$$\frac{\lambda}{\lambda'} = \sqrt[3]{\frac{W}{W'}},$$

where λ and λ' are the corresponding wave-lengths, W and W′ the atomic weights of the two elements. The elements of the following groups are found to obey this rule with a greater or less degree of approximation:—

(1) Zinc, cadmium, and mercury.
(2) Magnesium, calcium, barium, and strontium.
(3) Silver, copper, and gold.

As an illustration, the following series of lines of magnesium and calcium may be given. The arrangement and wave-lengths are those adopted by Kayser and Runge.

Magnesium. Mg=24·4			Calcium. Ca=40·0.				
Subordinate Series.	*n*	Observed	Calculated	Observed	Difference	*n*	Subordinate Series
I	4	3838·46	4526·1	4527·1	−1·00	—	—
I	5	3097·06	3651·9	3653·62 3644·48	−1·72 +7·42	— 5	— I
I	6	2852·22	3363·1	3361·92	−0·82	6	I
I	7	2736·14	3226·2	3225·74	+0·46	7	I
I	8	2673·15	3152·0	3152·08	−0·08	8	I
I	9	2633·13	3104·8	3101 87	+2·93	9	I
I	10	2605·40	3072·1	—	—	—	—
II	3	5183·84	6102·1	6102·99	−0·80	—	—
II	4	3336·83	3934·5	3933·83	+0·67	—	—
II	5	2942·21	3477·2	3474·98	+2·32	5	II
II	6	2781·35	3279·8	3274·88	+4·92	6	II
II	7	2698·44	3181·8	3181·40	+0·40	7	II
II	8	2649·30	3123·9	3117·74	+6·16	8	II

From the similarity of their spectra, the elements in each of the foregoing groups appear to be similarly constructed, and the probability of this is strengthened by the analogy of their chemical properties. On the other hand, chemical analogy does not necessarily imply similarity of form in the elements, as is shown in the case of the alkali metals (lithium, sodium, potassium, rubidium, cæsium); these elements, in spite of their close chemical similarity, do not exhibit the simple relationship connecting wave-length and atomic weight found in the groups already named. Either these elements may be considered as built up of different kinds of matter, or if of the same material as possessing different shapes.

Assuming that matter is uniform, the shape of the atom may be varied, and instead of the simple sphere the case of an elongated ellipsoid of rotation, formed by revolving an ellipse round its major axis, may be considered. The mathematical theory shows that the spectral lines of such a luminous ellipsoid depend on three numbers, and that therefore these lines will be capable of arrangement in groups according to three principles. These numbers are obtained as the roots of certain transcendental equations, and are to be calculated from the lengths of the axes of the ellipsoid, its density and elasticity, a calculation, however, which on account of its difficulty is hardly practicable. The first of the three numbers determines a group of corresponding lines, a so-called series; the different possible values of the number determine a certain sequence of such series. The second number determines in each series a subordinate group of lines, and the third number a single definite line in each subgroup. The manner in which this third number enters into the calculation shows, moreover, that the frequencies of the single lines in the subgroups will exhibit among themselves constant differences, differences, that is, depending solely on the nature of the given ellipsoid. A type of distribution of the spectral lines is thus afforded by the theory which corresponds with the well known law of distribution established by Rydberg and by Kayser and Runge in the case of the alkali metals. The atoms of these metals (Li, Na, K, Cs, Rb) may therefore be considered as elongated ellipsoids of rotation, the axial lengths being fully defined in the case of each element, and different in the different elements.

A flattened ellipsoid of rotation, the so-called spheroid, is by calculation found also to give rise to groups, series, and subgroups, but the law of constant differences is not so generally applicable. The roots of the transcendental equations are, in this case, partly imaginary, so that several groups consist of a single strong line, others of a limited number of lines. Such a grouping is actually found in the case of the metals gold, silver, and copper. Hydrogen is also of this type, its atom probably consisting of a thin, round plate, which is to be considered as the limiting case of a flattened ellipsoid.

In the more general type of ellipsoid, that with three unequal axes, the wave-lengths of the spectral lines also depend on three numbers, defined by certain equations, but in this case the lines cannot be arranged in series and groups, but range over the whole spectrum. Only when the form of the ellipsoid approximates to that of an ellipsoid of rotation will a few series arise. Such a distribution appears to obtain in the spectra of the alkaline earths (barium, strontium, calcium, and magnesium), that is, with elements lying intermediate in chemical behaviour between the alkalies and ordinary metals; the form here approaches that of the elongated ellipsoid of rotation. With zinc, cadmium, and mercury, the form approximates to the flattened type of the rotation ellipsoid.

Perhaps the most striking consequence of the theory is that which follows from an alteration in the shape of one of the simple ellipsoids of rotation. Such a solid can be imagined as being gradually strained in such a way that it passes into the more general ellipsoid with unequal axes. During such deformation the spectral lines will gradually and continuously change, and the mathematical theory predicates that out of each single line eight others can arise. It appears, indeed, that the Zeemann effect, or the resolution of a single line into two or more other lines under the influence of a magnetic field, is explicable on this hypothesis. It may be observed that the normal triplet which should result according to Zeemann's simple theory does not, as a matter of fact, occur by any means frequently, the arrangement of the resolved lines having been shown by recent work to be of a more complex character than was originally supposed. Such a complexity finds a simple explanation in Prof. von Lindemann's theory of strain.

Two other types of solids in addition to those already mentioned are susceptible of mathematical treatment, namely, the solids derived by the rotation of a circle round an axis not passing through its centre. When the axis does not cut the circle a ring with a circular section is produced, such as an ordinary finger ring, which is open at the middle. When the axis cuts the circle, a solid, which Lindemann calls a "*Wulst*" or roll, and resembles in form an orange or an apple—is generated. A particle having the first of these shapes, when rendered luminous, would, according to the mathematical theory, give rise to lines having wave-lengths dependent on four numbers, to each of which a series of values can be given. The kind of spectrum which results can best be explained by imagining the spectrum due to a luminous particle of the elongated ellipsoidal type to be displaced several times in succession, the relative position of the lines being slightly modified in each shift. Such a spectrum has already been found to characterise oxygen and helium; the oxygen spectrum, indeed, according to Runge and Paschen, appears as if derived from that of an alkali metal by a series of successive displacements. An atom of the second type, with a shape similar to that of an apple, when rendered luminous, would, according to the calculations, give rise to a spectrum such as would be produced by successive displacements of the lines due to a flattened ellipsoid. The spectra of sulphur and selenium seem, indeed, to be of this type, being derived from a spectrum like that of oxygen by substituting single strong lines for certain groups of lines. The atom of oxygen thus appears to have the form of an open ring, the atom of sulphur or selenium that of a "Wulst."

Certain interesting consequences concerning the chemical properties of the elements follow from a consideration of their shape, and have been developed by Prof. Lindemann. That the ring-shaped oxygen atom, for example, is a dyad with regard to hydrogen at once follows from the plate-like shape of the hydrogen atoms, two of these being necessary to close the two apertures of the ring. A distinction, moreover, such as is actually found to exist, is introduced at the outset between valency with regard to hydrogen and valency with regard to oxygen. Apart from speculations of this kind, Prof. von Lindemann's work has great significance at the present moment, in that it demonstrates the possibility to derive those physical constants which most clearly define and characterise the individual elements from the conception of a single kind of matter merely by introducing the idea of shape. It is, of course, possible that the atoms do not possess strictly, but only approximately, the simple shapes which can be treated mathematically. If this were so, slight changes would be introduced into the transcendental equations, and the deduced values, for example those in the table given, can be considered only as a first approximation; but the approximation is sufficiently close to justify the belief that the general type of the transcendental equations is correct.

W. A. D.

THE TIME OF FRANCE.

A NOTE from the Paris correspondent of a daily journal stating that the proposal to adopt Greenwich time in France is again being brought forward, a desirable reform which would bring our nearest neighbour into harmony in this respect with almost the whole of Europe, may be considered a sufficient reason for giving some facts on the subject under discussion.

Without going back to the earliest proposals for establishing a time-system which should be common to the whole world, an early stage in the movement was the calling of a conference by the Government of the United States to be held at Washington in October, 1884. At this meeting, which was attended by representatives of twenty-five nations, but who, it must be remembered, had no power to bind their Governments to any plan of action, it was resolved that "the Conference proposes to the Governments here represented, the adoption of the meridian passing through the centre of the transit instrument at the Observatory of Greenwich as the initial meridian for longitude." This resolution was voted for by representatives of twenty-two countries, one representative took the opposite view, and two countries, of whom France was one, abstained from voting.

Following on this, a resolution was passed at the meeting adopting the principle of a universal day which should begin at mean midnight of the initial meridian, a scheme containing the germ of the present hourly zone system. But a more practical step had already been taken by the managers of the American railways, who, in November, 1883, had adopted the now well-known system in which the American continent is divided into five zones, the time used in each of which is respectively 4, 5, 6, 7, and 8 hours slow on Greenwich. It says much for the breadth of view of the American railway managers, who thus rose above all consideration of national feeling and selected a zero which was likely to suit the convenience of the greatest number, and set an example which must have done much to forward the scheme.

Since 1884 there has been no open international intercourse on the subject, but gradually the zone time system has made its way. In 1892 Belgium and Holland began to use Greenwich time; in 1893 mid-European time, one hour fast on Greenwich, was made the legal standard time in Germany and Italy; in the next year the same time was adopted in Switzerland and Denmark, and in 1895 in Norway. Mid-European time had already been in use in Sweden many years, and on the Austrian, Hungarian, Servian, and Macedonian railways since 1891, but, strangely enough, Vienna, the home of Dr. Schram, who was one of the leaders of the movement for the unification of time, has not adopted any legal standard time. The meridian of Pulkowa happens to be 2 hours 1 minute east of Greenwich, and since the time of this meridian is used for telegraph work and on the railways of Russia, it may be considered that this country uses east European time, two hours fast on Greenwich, which is also used for some purposes in Turkey. Since Greenwich time was made the legal time of Spain in 1900, it will be seen that almost the whole of Europe has fallen in line. France has not held aloof for want of consideration of its merits. In 1896 the proposition that the Greenwich meridian should be adopted in France was brought by M. Deville before the Chamber of Deputies, and being voted on was accepted by that body, but the matter went no further, the reason for which may be inferred from the proceedings at the meeting of the Astronomical Society of France held on December 2, 1896. At that meeting several of the leading scientific men of France were present, and among them M. Bouquet de la Grye, who, after expressing his astonishment that scientific men had not been consulted before such a proposition was made, proceeded to raise objections. It was true, said he, that the meridian of Greenwich had been chosen as initial because of the greatness of England's sea-power; but, he asked, how long would this continue? England's supremacy in this respect might pass away just as had that of other nations, and what then?

Also he urged that Greenwich was too far north as a situation for an observatory to fix the standard meridian, and again, that the position of Greenwich with respect to the observatories of the Continent was not then accurately known. Another speaker, whose opinions are worthy of respect, remarked that France was not alone among the countries in not joining the movement, for Spain used its own time, and also—it is to be feared that here he made a strong point—Ireland, even, still used Dublin time. It was affirmed that the motives which influenced the French authorities in this matter were purely of a scientific nature, but it may be noted that since that meeting the proposition has been brought forward in other words, namely, that the legal standard time of France shall be 9 minutes 21 seconds slow on the time of the meridian of Paris, which is not unlike the former proposal, except verbally, and it might be thought that the alteration was made so as not to hurt some susceptibilities. However, the change has not yet been made. Some of the objections above quoted have vanished, for England's naval power has as yet suffered no reverse, Spain has adopted Greenwich time, and the difference of longitude between Greenwich and Paris has been again determined, with a result which may be accepted as final. Ireland still continues to use Dublin time, it is true, but even this ought not to outweigh any advantages that might accrue from the change.

H. P. H.

THE COLOMBIAN EARTHQUAKE.

ON January 31, we learn from vague messages, an earthquake of unusual severity occurred in the north-west part of South America. The report stated that towns and villages had been destroyed, and islands had sunk. The disappearance of the latter was, however, so gradual that the inhabitants had been able to escape in boats. Later information told us about the interruption of cables, and reported that in consequence of huge sea waves a long line of coast between Buenaventura and Tumaco and the western coast of the Republic of Colombia had been devastated for many leagues. A great catastrophe had evidently occurred, but until sixteen days later the East knew but little as to what had actually taken place. The seismographs in Britain and in other countries have, however, told a story. Later we shall have another story from our Consuls and our newspapers.

In the Isle of Wight the record of some great earth adjustment commenced, as reckoned in our time, at 3h. 47m. p.m. Its maximum occurred some thirty-five minutes later. From these facts the distance at which the mass displacement had originated was known, and by a simple computation, based upon this distance, the time at the origin would be in Colombian time approximately 10h. 9m. a.m. Better that the disturbance occurred in the morning, when heavings of the ground could be felt and high waves suggesting refuge on higher ground could be seen, than it should have occurred when the inhabitants of towns and villages on a seaboard were at rest. Two hours later the effects of the initial impulses had reached their antipodes, and in the interval between these times every inhabitant of the world had been moved for at least three or four hours on a true ground swell. All the instruments in the world designed to record teleseismic motion had written records, the bubble in every spirit level had been fitfully oscillating to and fro, many magnetic needles had been caused to swing, balances had oscillated, pendulums had been accelerated or retarded—the whole world, not only on its surface, but in its depths had been shaken. The internal constitution of our planet had been disturbed, that which is hypogenic may have produced its effect upon that which was epigenic, there was a flicker in the life-history of the earth.

At this moment it is not for us to enter into the whys and wherefores of the Colombian disaster. It suddenly came upon the scene in the last day of January, but it is not yet ended. Shocks continued for the next five days, and although we are without information, they will doubtless continue for many days to come. Among other things beyond these immediate effects on life and property, we learn that volcanic stress was relieved at Cumbal. Further, we learn that on February 16 severe shocks were experienced in the Antilles. At 1.40 p.m. on that date walls were cracked in St. Vincent; similar reports come from Fort de France, and cables have been broken.

History repeats itself, and this is particularly illustrated in the seismic and volcanic history of the Central American and West Indian subterranean activities. A convulsion in the one is followed by a reaction in the other. The last illustration, which is only one of a long series, occurred in 1902, when terrific re-adjustments of strata in Guatemala were quickly followed by the holocaust of St. Pierre. The Colombian disaster of January 31, to which we particularly refer, is the last of a series with which seismologists are familiar. We do not know for certain, but its origin was probably suboceanic off the mouth of the Esmeralda River. We can at least say that on the line we have indicated there is a rapidly descending suboceanic gully, and that cables crossing this line have frequently been interrupted. To this we may add that here we have a district where submerged land slopes are unusually steep, and where those who lay deep-sea cables tell us that soundings have from time to time been greatly changed. Out of fifteen cable interruptions which have taken place in the district under consideration, nine of them occurred at the time when seismographs or instruments which would record teleseismic effects were set in motion in Europe. Interruptions to cables come in many ways, but from time to time we know that they have come about by sudden changes in the form of ocean floors, and off the mouth of the Esmeralda River we know that this has often happened.

NOTES.

THE appointment of officers for the seventy-sixth meeting of the British Association, which is to be held at York, has now been completed. The meeting will open on Wednesday, August 1—when the president, Dr. E. Ray Lankester, F.R.S., will deliver the presidential address—and be concluded on August 8. The following are the names of the presidents of the various sections:—A (mathematical and physical science), Principal E. H. Griffiths, F.R.S.; B (chemistry), Prof. Wyndham Dunstan, F.R.S.; C (geology), Mr. G. W. Lamplugh, F.R.S.; D (zoology), Mr. J. J. Lister, F.R.S.; E (geography), Sir G. Taubman-Goldie, K.C.M.G., F.R.S.; F (economic science and statistics), Sir George S. Gibb; G (engineering), Prof. J. A. Ewing, F.R.S.; H (anthropology), Mr. E. Sidney Hartland; I (physiology), Prof. Francis Gotch, F.R.S.; K (botany), Prof. F. W. Oliver, F.R.S.; L (educational science), Prof. M. E. Sadler. Subscriptions to the amount of more than 700*l.* have been promised to the fund started for the purpose of founding a medal to commemorate the visit of the association to South

Africa last year. The council of the association has resolved to add to the fund the balance of the special funds raised to meet the expenses of the South Africa meeting, so that the total sum to be disposed of is between 1500*l.* and 1600*l.* It is proposed that the medal, struck in bronze, together with the balance of the income on the fund after paying for the medal, shall be awarded "for achievement and promise in scientific research in South Africa," and that, so far as circumstances shall allow, the award shall be made annually.

PROFS. F. KOHLRAUSCH AND A. A. MICHELSON have been elected honorary Fellows of the Physical Society of London.

AN International Exposition, in which discoveries and inventions relating to medicine and hygiene will have a prominent place, is to be held at Antwerp in April and May of the present year, under the patronage of H.R.H. the Countess of Flanders. Communications should be addressed to the secretary's office, 26 Rue d'Arenberg, Antwerp.

THE anniversary meeting of the Geological Society was held on February 16. Sir Archibald Geikie, Sec.R.S., was elected president. The medals and funds awarded, as announced already (p. 274), were presented. The president delivered his anniversary address, which dealt with the influence of the geological structure of English lakeland upon its present features—a study in physiography.

IT is stated in the *Globe* of February 17 that the first wireless telegraph station at Machrihanish, Argyllshire, is now completed, and communication has been commenced with other stations in Great Britain. The tower, which is 400 feet high, has been built to the order of the National Electric Signalling Company, of Pittsburg, by the Brown Horsting Company, New York. The diameter of the column is about 5 feet, and consists of pipe-shaped tubes, inside of which are the ladders for ascending.

THE Milan Chemical Society has appointed a committee to undertake the compilation of a catalogue of the Italian chemical industries.

AT the invitation of the committee appointed to consider the foundation of a Chemische Reichsanstalt, a meeting was to be held yesterday in the Aula of the University of Berlin to hear an account of the steps which have already been taken by the committee, and the reasons put forward for such a chemical institution.

BY a decree of the German Chancellor, an advisory committee of specialists is to be appointed to the Imperial Biological Institute for Agriculture and Forestry. The following appointments, amongst others, have now been made to this committee, and hold good until the end of 1910:—Prof. J. Behrens, Baden; Prof. Buchner, Berlin; Prof. Delbrück, Berlin; Prof. Gärtner, Jena; Prof. Gerlach, Bromberg; Dr. Hiltner, Munich; Prof. Hollrung, Halle; Prof. Kellner, Leipzig; Prof. Kirchner, Würtemberg; Prof. Ludwig Klein, Karlsruhe; Prof. A. Koch, Göttingen; Prof. Kühn, Halle; Prof. Möller, Eberswalde; Prof. P. Wagner, Darmstadt; Prof. Wortmann, Geisenheim. The director of the Imperial Institute for Agriculture and Forestry has been elected president of the advisory committee.

ON Thursday next, March 1, Mr. Francis Darwin will deliver the first of three lectures at the Royal Institution on the "Physiology of Plants," and on March 3 Prof. J. J. Thomson will commence a course of six lectures on "The Corpuscular Theory of Matter." The Friday evening discourse on March 2 will be delivered by Dr. R. Caton, the subject being "Hippocrates and the Newly Discovered Health Temple at Cos," and on March 9 by Dr. R. Hutchison, on "Some Dietetic Problems."

THE thirty-third annual dinner of old students of the Royal School of Mines was held on February 16. After the loyal toasts, the chairman, Prof. S. H. Cox, was asked to present to Prof. J. W. Judd a service of plate with an address and an album containing the signatures of 400 of his pupils and friends in all parts of the world as a mark of their esteem on his retirement from the office of dean of the school. In the address warm appreciation is expressed of Prof. Judd's services to geological science during his tenure of the chair of geology from 1877 to 1905, and the interest he invariably showed in the work and welfare of his students. Prof. Judd, in reply, alluded to the recently published report of the Government committee, which, he said, has outlined measures that will form a basis for the re-organisation of the school as a great and flourishing institution worthy of the Empire. The wants of a technical institution are not, he continued, identical with those of a university, either of the ancient or modern type, and it will be a calamity if the distinctive features of their school are lost by its being drawn into the vortex of a university. In proposing the toast of "The School," the chairman also alluded to the report of the departmental committee, and said those associated with the school are desirous of preserving its identity and the degree of Associate of the Royal School of Mines. They one and all dread being absorbed by a huge scientific institution, of which they will become only a subsidiary branch.

AT a meeting held at the Mansion House last June it was decided to commemorate the achievements of the late Sir Henry Bessemer by a memorial, which should have for its object some educational work so far-reaching in its beneficent influence as are the results of Bessemer's invention. The memorial committee deferred the active prosecution of the scheme until the publication of the report of the departmental committee on the work of the Royal College of Science, and, now that this report has been issued, it is possible to proceed actively with the memorial scheme. The committee is confident that no memorial could be more appropriate than one which has for its object the scientific advancement of the metallurgical and mining industries, and that none would be more likely to have met with Bessemer's warm approval. It has been arranged that the objects of the memorial fund shall be:—(1) The establishment of open international memorial scholarships for post-graduate practical work tenable (except such as it is intended to allocate to the Royal School of Mines, the Sheffield and Birmingham Universities, the Armstrong College, Newcastle-upon-Tyne, or other approved British institutions) in any part of the British Empire, in the United States of America, and in Europe. It is intended that these scholarships shall be of such value, and shall be awarded under such conditions, that they will be regarded by students of any nation as a prize worth striving for, and as an incentive to the highest scientific attainment. (2) The equipment of mining and metallurgical memorial laboratories in the Royal School of Mines at South Kensington as the centre of the memorial. The land and the cost of the new buildings and maintenance for the school will be provided from Government and other sources. (3) The erection of a statue of Bessemer in the new Royal School of Mines at South Kensington. Subscriptions amounting to about 8000*l.* have already been received towards the large sum which will be required. Communications should be addressed to the Hon. Secretary, Bessemer Memorial Fund, Salisbury House, E.C., and all cheques should be made payable to the "Bessemer Memorial Fund," and crossed "Bank of England."

WE have received from the Philosophical Institute of Canterbury, New Zealand, copies of four papers by the late Captain Hutton published in the *Transactions of the New Zealand Institute* for 1904. Their respective titles are:—"The Formation of the Canterbury Plains," "The Occurrence of *Grauculus melanops* in New Zealand," "Revision of New Zealand Tertiary Brachiopoda," and "Three New Tertiary Shells."

No. 8 of vol. ii. of the zoological section of the *Publications of the University of California* is devoted to the first paper of a memoir of the "Dinoflagellata" of the San Diego district, by Mr. C. A. Cofoid. It appears that investigations carried on during the last few years at the San Diego station have brought to light amid the "plankton" of the Pacific a number of species of flagellate animalcules which cannot be referred to any known genus, and for which the new name Heterodinium is proposed.

RECENT issues of the *Proceedings of the Academy of Natural Sciences of Philadelphia* contain papers on the following subjects, viz.:—a collection of birds from British East Africa, by Mr. W. Stone; Hawaiian species of the molluscan genera Endodonta and Opeas, by Messrs. Pilsbry and Vanatta; Pacific Cerithiidæ, by the same authors; and notes on, and descriptions of, Costa Rican Orthopoda, by Prof. Rehn. In the last of these the author describes a very remarkable species of stick-insect of the family Phasmidæ, which is referred to the genus Olcyphides, Griffini, with the name of *O. viridipes*. This species, of which the figure is reproduced, is allied to Westwood's *O. venilia*, of Bogota, but differs in the shorter mesothorax and metathorax, and the much greater elongation of the abdomen and limbs, as well as in details of coloration and other points.

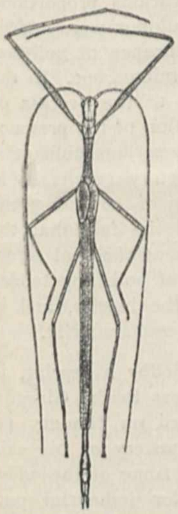


FIG. 1.—*Olcyphides viridipes*, from Costa Rica (½ natural size).

IN the November (1905) issue of the *Nature-study Review* Miss A. M. Fielde gives an interesting illustrated account of the communal life-history of ants, primarily intended for the information and guide of those who keep these insects under observation in the cases invented by the author. There are, however, many observations of special interest. Among these is the statement that ants of different species—which always display deadly hostility to one another—can be trained to live together in friendship. Mr. C. W. Wild discusses the study of deciduous trees in winter; while Mr. M. A. Bigelow ridicules the theory that certain groups of plants develop tubers or bulbs in order to escape destruction by animals.

WE have received from the author, Prof. F. Eulenburg, of the University of Leipzig, a copy of an article on society and nature ("Gesellschaft und Natur"), reprinted from the *Archiv für Sozialwissenschaft und Socialpolitik* for 1905. The subject is treated, after some introductory considerations, from the following points of view:—(1) the determination of the objects of science, especially social science; (2) the importance and necessity of social laws; (3) the threefold relation of society to nature; (4) special problems; and (5) the relations of social science to biology and practical politics.

THE felted beech coccus, *Cryptococcus fagi*, is the subject of a leaflet, No. 140, issued by the Board of Agriculture and Fisheries. The scale insects are provided with a long sucking tube by which they draw off the sap; they are stationary, and cover themselves with a white waxy secretion. The larvæ also drain the juices of the tree. Although the insects are conspicuous objects on the bark, and are principally found on the main trunk and larger branches, their waxy coverings shelter them effectively, and treatment with such insecticides as paraffin emulsion, Gillander's mixture, or caustic alkali wash must be thorough to prove efficacious.

IN the *Indian Forester* (March, 1905) Mr. R. S. Pearson stated that he had obtained satisfactory results in the Panch Mahals, Bombay, in rearing young teak plants by subjecting the seed to a preliminary treatment in pits, in which layers of seed an inch deep were arranged alternately with layers of soil, and the pit was flooded with water every other day until germination commenced. This and other experiments with seed of *Anogeissus latifolia*, described in the November issue, appear to depend upon the maintenance of a regular and sufficient, but not excessive, supply of water. Another fairly successful method consists in subjecting the seed to a slight fire that produces artificially the effects of a light forest fire in a dry teak zone.

AMONG the contributions to the *Journal of the Royal Horticultural Society* (December, 1905), Dr. M. Cooke writes an article on the fungoid pests of forest trees; Mr. G. S. Boulger, dealing with the preservation of wild plants, adduces a number of specific instances of damage done by ruthless collection; and Mr. W. G. Freeman discusses a few of the important features of the West Indian fruit industry. The method of producing new potatoes out of season from old tubers, as described by Mr. J. J. Powell, is a valuable hint to private gardeners, the essential points being retardation and a variety that keeps well. Fruit growers will be interested in the publication of the report of the committee appointed to inquire into the fruit industry, and in the notes by Mr. T. E. Sedgwick on methods of fruit preserving.

THE use of wood-pulp for paper-making was dealt with in a paper read by Mr. M. C. Phillips before the Society of Arts, and published in the Journal of the society last May. A machine for grinding wood into pulp was patented by Keller in 1844, but the modern method of making *mechanical* pulp has developed out of the machine constructed by Henry Voelter in 1858 that not only disintegrated but also assorted the fibre. The mechanical process is largely practised in Norway, Sweden, and Canada, and provides the bulk of journalistic paper. Better paper is produced by chemical processes in which the wood is treated with various chemicals that remove the ligneous and mineral constituents, leaving wood-cellulose. Tilghman (1857), Ekman, and Mitscherlich were the pioneers in this branch of the industry. The paper has been reprinted by the Government of India in connection with the experiment of producing wood-pulp in that country.

A BULLETIN on "The Mineral Constituents of the Soil Solution," by Messrs. F. K. Cameron and J. M. Bell, has been received from the U.S. Department of Agriculture (Division of Soils, Bulletin 30, 1905, pp. 70). This latest publication of the division over which Mr. Whitney presides deals with the problem that has been the subject of so much of the recent work on soils done by the United States Department of Agriculture—the composition of the solution formed by the water in the soil. It is generally recognised now that plants feed on this solution and are incapable of attacking the solid constituents of the soil, so that the composition and mode of origin of this solution must furnish the interpretation of many of the difficulties regarding the relationship of crops to soils. The Bulletin is more of a general discussion and a bibliography than a record of new investigations; it sets out a brief account of most of the work that has been done on such matters as the solubility of the minerals composing the soil, the hydrolysis and similar changes then taking place, adsorption and absorption by finely powdered materials, flocculation, surface reactions, and such other phenomena in the borderland of chemistry and physics as must play a leading part in the reactions going on in the soil. The main thesis of the Bulletin is that the soil materials hydrolyse and form a solution in equilibrium with the portion which remains solid; this position of equilibrium will be continually restored or maintained whenever it is temporarily disturbed, as by the addition of manures or the withdrawal of substances by growing plants. We fail to perceive, however, that all the parade of authorities lend any support to the extraordinary doctrine which the American official soil chemists seem to have adopted as an article of faith—that all soils, whatever their origin or treatment, yield the same soil solution, and therefore possess the same nutritive power. Putting aside this "conclusion," which is brought in at the end, though nothing particular seems to have led up to it, all workers in this field will be glad to possess the Bulletin as a guide to the scattered literature on a difficult subject.

WE have received from Mr. G. Henriksen, of Christiania, a translation of his pamphlet, written in Norwegian, on the iron-ore deposits of Sydvaranger, in Finmarken, Norway. Iron ore occurs in large quantities in gabbro. It consists exclusively of magnetite. The deposits are considered by the author to have been formed by the action of pressure on eruptive rocks.

IT is reported in the *Engineering and Mining Journal* (vol. lxxxi., No. 4) that great development has taken place in gem production in Brazil. Exploration in Minas Geraes has led to discoveries of tourmaline which have furnished red, blue, and green gems, and of beryls which have furnished magnificent blue and green stones. A large quantity of Brazilian amethyst has been obtained from the great geode, the bulk of which was shown at the Düsseldorf Exhibition in 1902.

UP to the present time the manufacture of chilled rolls has remained purely empirical; and a paper by Mr. E. de Loisy in the *Bulletin de la Société d'Encouragement* (vol. cvii., No. 10), describing his researches made to ascertain the scientific rules that should guide the iron-founder, is therefore well worthy of careful attention. For chilled rolls for rolling steel sheets or wire rods the composition sought should be as follows:—carbon, 2·9 to 3; silicon, 0·7 to 0·9; manganese, 0·5 to 1·0; and phosphorus, 0·35 to 0·45. The addition of steel scrap to pig-iron is recommended, but the proportion should not be much above 15 per cent. The author gives a large number of analyses of chilled rolls that have lasted well in the rolling-mill.

AN interesting note on prospecting in the Transbaikalian goldfields has been communicated by Mr. R. Farina to the Institution of Mining and Metallurgy (Bulletin No. 17). The district has long been famous for its gold placers. Platinum and cinnabar are also met with. The gold veins vary greatly in character. Those rich in gold are very porous, friable, and highly oxidised. The other veins are of the hard white quartz type. The best time for prospecting is March and April, when the snows have almost gone. The rocks of the country are chiefly quartz porphyry, granites, andesites, diorites, and gneiss. In a note, in the same Bulletin, on tin in Tringganu, on the east coast of the Malay Peninsula, Mr. C. G. Warnford Lock records the occurrence, in the alluvial tin fields, of monazite and xenotime in pot-holes in the granite beds of the streams.

THE *Journal of the Society of Chemical Industry* (vol. xxv., No. 2) contains an interesting paper by Mr. A. H. Hiorns on the effect of certain elements on the structure of cast iron. He gives a summary of previous researches on the subject, and describes some experiments made by himself with pure cast iron to which various proportions of silicon, manganese, phosphorus, and sulphur were added. He gives illustrations showing the appearance of polished and etched surfaces examined under the microscope. In the discussion, Mr. W. Rosenhain referred to the process of heat tinting in connection with the detection of the presence of phosphorus, and pointed out two very serious difficulties that had to be overcome before satisfactory results could be obtained. These were the difficulty of obtaining the surfaces in a perfectly clean state, and the fact that the actual surface very often did not represent the real structure of the metal, because the very act of polishing tended to spread the softer constituents over the harder, and in all cases produced a definite layer of altered material.

WE have received from Mr. G. T. Beilby a reprint, in pamphlet form, of his presidential address to the Glasgow University Engineering Society, delivered on January 11. In it he discusses, with a thorough mastery of his subject and with conspicuous literary skill, some of the wider aspects of modern power production for industrial purposes, more particularly with reference to the fuel resources of the country. He shows that the annual coal consumption of the United Kingdom is 167 million tons, the various channels of consumption being as follows, in millions of tons:—railways, 13; coasting steamers, 2; factories, 53; mines, 18; iron and steel industries, 28; other metals and minerals, 1; brick-works, potteries, glass-works, and chemical works, 5; gas works, 15; and domestic, 32. Taking the consumption of coal for power purposes at mines and factories as 52 million tons, a saving of some 42 million tons could be realised with time and enterprise. There are in Great Britain steam engines and boilers with a yearly output of at least 5 million horse-power. The coal consumed by these is not less than 5 lb. per indicated horse-power hour, or on the whole 40 million tons. By the use of gas engines and steam turbines the coal consumption might be reduced to 1½ lb. per indicated horse-power hour, or on the whole to 12 million tons. The saving in coal, therefore, is equal to 28 million tons, valued at 9,800,000*l*. The cost of making the change need not exceed 50,000,000*l*., or, if the power is to be delivered as electricity, 60,000,000*l*. The saving in the coal bill is equivalent to a return of 16·3 per cent. on the higher capital expenditure. In these estimates no credit has been taken for the reduction in working costs which would result from the installation of more efficient plant. In many cases this would amount to as much as the saving on coal.

ACCORDING to the *Teknisk Tidskrift*, the development of the Swedish chemical industries last year was but slight, but the following points may be noticed:—the manufacture of beet sugar has been pushed further north by the opening of a sugar factory at Linköping; the preparation of "peat spirit" has been a subject of wide and searching discussion; the increased uses of acetylene and of acetylene-acetone solutions, and the process of welding with acetylene, have much favoured the carbide industry; the manufacture of paper from wood has improved both quantitatively and qualitatively; great strides are said to have been made in electrochemical industries; much attention has been given to improving methods of producing pig-iron—a number of Gröndal, American, and newer native type combustion furnaces have been built or arranged for; in the manufacture of steel we are told that several innovations and changes have been witnessed, though no official statistics are yet available for comparisons with previous years—but it is to be noted that the Bessemer process is gradually yielding to the Martin method; an experimental electrical steel furnace has been arranged at Nykroppa; many works have introduced Bildt's method of heating boilers with generator gas; suction gas plants, combustion and petrol motors, and steam turbines have risen in popularity.

IN connection with the shortage of rainfall for 1905 in the British Isles, it is interesting to note the state of affairs at the antipodes. With regard to the rainfall of South Australia, Sir Charles Todd states that throughout the whole of the Northern Territory, the interior of the continent, the pastoral country to the northwards, and as far south over the more settled districts as Petersburg, the total rainfall of the year failed to reach the average. The summer season (November, 1904, to March, 1905) was, on the whole, dry all through the settled districts and most of the pastoral country, many stations in the southern areas having only about half the annual supply. The total for the agricultural season (April to October) was, however, generally in excess of the normal fall for this period, from Wilmington and Petersburg southwards, but north of these stations it was rather below the average.

THE construction of magic squares is a recreation which has diverted even such minds as those of Euler and Fermat; with kindred problems it still maintains its popularity. Frost extended the notion to three dimensions, and wrote a paper on "nasik cubes" (*Quart. Journ.*, 1878); in "The Theory of Path Nasiks" (Rugby: Lawrence) Mr. C. Planck has quite recently developed Frost's theory, and given several examples. His method involves the solution of sets of simultaneous linear congruences, and he considers the problem in *n* dimensions.

IN No. 5, vol. xxii., of the *Astrophysical Journal*, Mr. R. E. Loving, of the Johns Hopkins University, publishes the results of an interesting research concerning the nature and action of the metallic arc in high vacua. Having previously proved that the spectrum was characteristic of the anode only, he employed various metals as anodes in conjunction with the same platinum kathode, and on photographing the more refrangible end of the spectrum found that it was not similar to either the ordinary arc or spark spectra, but was much more like the latter than the former. The relative intensities of the lines obtained did not agree with the spark intensities or with those observed for the same lines in the chromosphere. Mr. Loving gives a tabular statement in which the relative intensities of magnesium, calcium, chromium, manganese, titanium, and iron lines in the ordinary arc and spark, the chromosphere and the arc in vacuum are compared. Other important points regarding the mechanical action of the discharge, the action of a magnetic field, and the luminosity of the anode are dealt with in Mr. Loving's paper. Brief reference might be made here to one peculiar result. The violent kathode discharge was found to have a marked deteriorating action on the glass of the tube. After being used for several days the glass was found to crack much more readily when put into a flame, and the fragments were so friable that they could easily be broken between the fingers.

MR. JOHN GOLDING AND DR. FEILMANN direct attention to a peculiar mealy flavour which occasionally develops in milk (*Journ. Soc. of Chem. Industry*, December 30, 1905). Experiments showed that copper is acted upon by milk, especially in the presence of air, and that small quantities go into solution in the milk (from 1 part to more than 100 parts per million). Fresh milk when thus contaminated is very liable to the development of a peculiar mealy flavour in sixteen to eighteen hours. This flavour seems to be due in part to the development of micro-organisms in the presence of copper, which both checks the development of the lactic organisms and plays a more direct part in the actual development of the flavour.

COLONEL FIRTH AND DR. MACFADYEN contribute to the *Journal of the Royal Sanitary Institute* (xxvii., No. 1) a record of experiments made on behalf of the Disinfectant Standardisation Committee from which they consider that the "drop" method of Messrs. Rideal and Walker is the most practical and accurate method yet devised for the testing and comparison of disinfectants, and make some valuable suggestions for carrying it out. Profs. Kenwood and Hewlett also contribute a paper on the standardisation of disinfectants, in which they show the variations which may obtain in practice and the modifying effect of organic matter on germicidal power, and urge that a large margin of safety should be allowed for all disinfectants.

THE *Journal of the Röntgen Society* (December, 1905) contains an interesting paper by Mr. Butler Burke on the action of radium and other bodies on gelatin, and the production of the so-called "radiobes," which have some likeness to micro-organisms. At first these look like mere air-bubbles, but in course of time they expand or grow, appear to contain a nuclear structure, but in the course of a fortnight or so begin to break up, and later on disappear. They are also soluble in warm water and varnish at a temperature of 35° C. Mr. Burke expresses the opinion that they are on the border-line between crystalline and organic bodies, that they cannot properly be called living, but correspond possibly to some simple form of life that existed in a far distant age.

UNDER the title of "La Fin de la Matière," Prof. H. Poincaré gives in the *Athenaeum* for February 17 a brief *résumé* of recent views of the ultimate nature of matter. The essential purpose of Prof. Poincaré's article is to define how far the idea of mass or inertia has been compromised by the results of Abraham and Kaufmann, by the speculations of Lorentz, and by the doctrine of electrons. Prof. Poincaré is careful to emphasise the assumptions on which recent views are based, but if the assumptions are correct the final result consists in stripping from matter the attribute of mass by which it is usually defined. Mass appears purely as the result of electrical action, or, in Prof. Poincaré's own striking words, "dans ce système il n'y a pas de vraie matière, il n'y a plus que des trous dans l'éther."

SOME time ago Prof. Nernst described a simple form of torsion balance capable of measuring weights of a few milligrams with an accuracy of 0·001 milligram. In the current number of the *Berichte* Mr. H. v. Wartenberg gives an interesting application of this instrument to the determination of the molecular weight of silver vapour. The method used was a modification of the well known apparatus due to Victor Meyer, the vessel being made of iridium, coated internally with a mixture of the oxides of yttrium and zirconium. This iridium vessel was heated in an electric furnace to about 2000° C., the weight of silver used in each experiment varying from 0·905 to 0·322 milligram. The values obtained for the molecular weight of the silver were between 107 and 147, indicating that silver is monatomic.

MESSRS. DAWBARN AND WARD, LTD., have published in their "Home Worker's" series a little book by Mr. Joseph E. Dangerfield on "Brass and Iron Founding." The price is 1*s*. 6*d*. net.

THE "Swincam" camera stand enables a camera to be fixed on the tripod in almost any position, so that photographs can be taken in situations which present insurmountable difficulties with ordinary stands. A revised pamphlet showing some of the possibilities and performances of this speciality in tripod stands has been issued by the maker, Mr. W. Butler, Southport.

MESSRS. WHITTAKER AND CO. have published a second edition of Mr. S. R. Bottone's "Radiography and the 'X' Rays." The book was reviewed in our issue of July 28, 1898 (vol. lviii. p. 292); and it is only necessary to say here that recent improvements in Röntgen-ray apparatus, and interesting matter connected with the therapeutic effects of the rays, are dealt with in the new edition.

OUR ASTRONOMICAL COLUMN.

COMET 1906*a*.—The following is taken from a continuation of the daily ephemeris for comet 1906*a* (Brooks), published by Herr M. Ebell in No. 4075 of the *Astronomische Nachrichten* :—

Ephemeris 12h. M.T. Berlin.

1906	α (true) h. m. s.	δ (true) ° ′	log *r*	log Δ	Brightness
Feb. 22	6 45 35	+78 30	0·2047	0·0024	0 82
24	6 21 29	+75 12	0·2094	0·0150	0·76
26	6 7 28	+71 59	0·2140	0·0288	0·69
28	5 58 38	+68 55	0·2187	0·0435	0·64
Mar. 2	5 52 47	+66 1	0·2234	0·0589	0·58
4	5 48 50	+63 19	0 2282	0·0748	0·53

It will be seen from the above that the comet is now travelling rapidly down the constellation Camelus towards Perseus, and is becoming much fainter.

A set of parabolic elements of the orbit of this object has been computed by M. E. Maubant, and appears in No. 6 (1906) of the *Comptes rendus*.

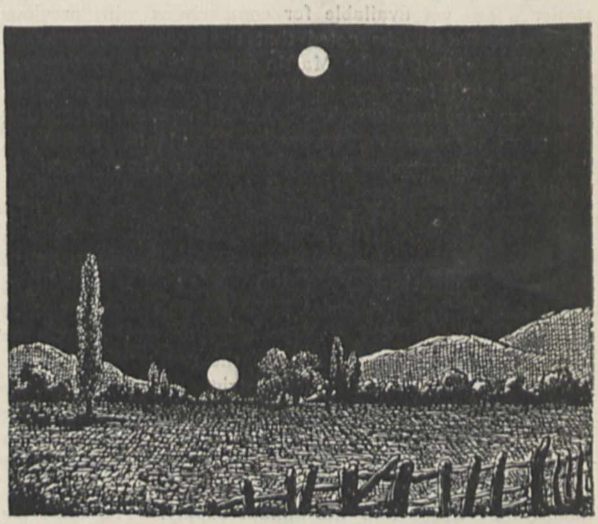
COMET 1905*c*.—Photographs of Giacobini's comet (1905*c*) obtained at Greenwich early in January showed that the magnitude was about 3·0, and that this object had a tail about 2° in length.

A note in the February number of the *Bulletin de la Société astronomique de France* quotes M. Giacobini, who, in a letter to a correspondent, stated that the comet was visible to the naked eye during the whole week preceding January 9, and that it then had a tail about 1° in length, the position angle of which was 45°. The nucleus was estimated as being of the second or third magnitude. The nearest approaches of this object to the earth took place on January 6 and February 2, the respective distances being 1·102 and 1·150 astronomical units. Its distance from the sun at perihelion was 0·2154 unit.

THE APPARENT ENLARGEMENT OF THE MOON AT THE HORIZON.—In the *Archives de Psychologie* (vol. v., No. 18, October, 1905) M. Ed. Claparède publishes an interesting paper on the causes which produce the impression that the sun, moon, and other celestial bodies are larger when near to the horizon than when seen at the zenith.

After discussing a number of theories propounded by previous writers on this subject, from Aristotle onwards, he examines several possible causes, and recounts the results of various experiments he has made whilst considering the matter.

Finally, he arrives at the conclusion that when we see the moon, or sun, at the horizon, we are surprised into believing it to belong to things terrestrial—to come into the class of objects which are by far of the greatest interest to us. As such we notice it with much greater attention,



and for this reason overestimate its size. When at the zenith the moon is of little interest in comparison with the terrestrial objects which belong to our daily life, and we therefore think of it as relatively unimportant; consequently we underestimate its size. This correlation of importance and size is always common, and, as an illustration of it, M. Claparède quotes the fact that boys are always astonished when they learn for the first time that Napoleon was below the average height.

M. Claparède used the illustration we reproduce, in his experiments with individuals. Covering one of the moons shown, he asked his subjects to draw the other one the same size, and then asked them to draw the second whilst the first was covered. Of twenty couples of drawings thus obtained, from thirteen subjects of all ages, the moon at the horizon was shown as the greater on fourteen, as equal on five, and as less on one. The greatest difference was shown on two drawings by the same boy, where the moon was 9 mm. (horizon) and 4·5 mm. (raised) respectively, the actual diameter on the copy being 4·5 mm.

M. Claparède's paper may be obtained, as a separate brochure, from MM. Kündig et Fils, Geneva, price 1 franc.

MAGNETIC OBSERVATIONS DURING THE TOTAL ECLIPSE OF THE SUN.—We have received from Father P. Cirera, of the l'Ebre Observatory, an extract from the *Comptes rendus* giving an account of the magnetic records obtained at that observatory during the total solar eclipse of August 30, 1905, and the days immediately preceding and following it.

Extraordinary deviations from the normal diurnal curves were registered in all three elements, and these are plainly shown on the photographic copy of the records which accompanies Father Cirera's communication.

OBSERVATIONS OF JUPITER.—Major Molesworth's report of his observations of Jupiter, made at Trincomali, Ceylon, during 1904–5, appears in No. 3, vol. lxvi., of the *Monthly Notices R.A.S.*, and records the times of rotation of, and the changes in, most of the Jovian features.

One especially remarkable observation was that the following and preceding ends of the large mass of dark matter, known as the Great S. Tropical Dark Area, appeared, on comparing the observations, to have crossed the whole Red Spot bay simultaneously. As it seems impossible that there could be any such instantaneous transference of material, Major Molesworth explains the phenomenon by the suggestion that the movement of the dark area into the belt following the bay caused the extrusion of an equal amount of dark material from the belt preceding the bay.

GRANULATIONS ON THE SOLAR SURFACE.[1]

AN interesting research which promises fair to lead us to an increased knowledge concerning the nature of the sun's photosphere has recently been instituted by Prof. Hansky at the Pulkowa Observatory. On examining the splendid collection of photographs of the solar surface obtained by Prof. Janssen at Meudon, Prof. Hansky was not able to satisfy himself that the whole of the *réseau* seen on the negative was actually of solar origin; it seemed probable that some parts of it were produced by waves in our atmosphere, and on no two consecutive negatives, nor even on two taken simultaneously, could the same granules be recognised. For this reason he attacked the problem at Pulkowa, bringing into operation the astrographic telescope in order to obtain photographs on a large scale.

The solar image at the focus of this instrument has a diameter of 3 cm., which by the use of a concave lens was increased to about 54 cm. (*i.e.* 21·3 inches). With this apparatus numerous photographs were obtained during May and June, 1905, and showed many of the finer details of the granulations which cover the solar surface; but even on this scale it was impossible to recognise the same features on successive photographs. A further improvement was then made, so that the intervals between the exposures might be appreciably shortened—in no case had it been less than five minutes—and with the new arrangement adapted to the astrograph it became possible to take eight consecutive photographs with intervals of fifteen to thirty seconds' duration. These showed the changes taking place in the sizes and relative positions of the granules very plainly, and from them the author has chosen six for reproduction in his circular. Fig. 1 is a copy of one of these reproductions, and shows the general nature of the photographs which Prof. Hansky is obtaining, and from which he hopes to derive valuable results. The scale is such that the solar diameter would measure about 0·6 m., or 23·5 inches. The large black portions represent parts of sun-spots which came within the region photographed.

Although on this scale obvious changes in the size and arrangement of the granules took place in twenty-five seconds, it was impossible to measure their magnitude, so Prof. Hansky intensified the photographs by successive copying, and finally obtained positives showing portions of the disc on such a scale that the length of the solar diameter would be about 6 m. (19·7 feet), that is to say, 1 mm. = 0″·32, or 233 km. on the solar surface.

An examination of these positives showed that the primary desideratum had been attained; the same granules were recognisable on successive photographs, and the scale was large enough to enable measurements of the granules themselves and of their movements to be made. The displacements were measured with the stereo-comparator, and were referred to a neighbouring small spot, movement towards the spot being indicated by the negative, and away from the spot by the positive, sign. The diameter of the actual sun was taken as 1,400,000 km., and on June 21 this gave 1″ = 740 km. The mean variation of any two settings on the same object was ±0″·12, and the probable error for the relative displacement ±0″·10.

The displacements of the granules during the twenty-five seconds which elapsed between two successive photographs taken on June 25 were very diverse. In that interval five of the granules had moved −0″·9, −0″·55, −0″·77, −0″·48,

FIG. 1.—June 25, 1905, 5h. 6m. 20s.

and −0″·80 respectively, which in the mean gave −0″·70, or −518 km., *i.e.* about −21 km. per second. Another group gave −38 km. per second, whilst for a third the comparatively low velocity of −14 km. per second was recorded.

Comparisons of other photographs showed that some granules were moving away from the spot with various velocities, and, as shown by the following figures, it appeared that the periodic movement of the granules materially affected the size of the spot. The diameter of the spot is given for different times on June 25:—

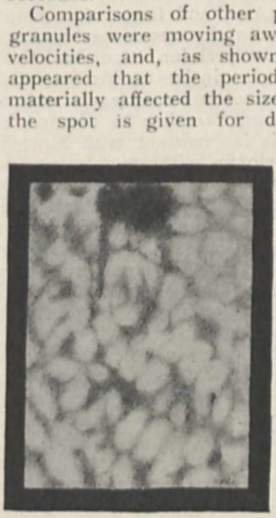


FIG. 2.—June 25, 1905, 4h. 17m. 15s.

FIG. 3.—June 25, 1905, 4h. 17m. 40s.

4h. 17m. 15s., 2″·64; 4h. 17m. 40s., 2″·25; 5h. 3m. 15s., 3″·03; 5h. 4m. 15s., 1″·35; 5h. 5m. 50s., 2″·70; 5h. 6m. 20s., 2″·88.

On consecutive photographs taken with an interval of one minute the same granulation was recognised with difficulty, whilst with a three-minute interval the whole *réseau* was practically re-arranged beyond recognition, although in one or two cases it was possible to trace a granule after this interval, and in two cases it was remarked that gemination had taken place.

The dimensions of the granules varied greatly between

[1] "Photographies de la Granulation solaire faites à Poulkowa." By A. Hansky.

670 km. and 2000 km., the mean diameter being 1″·9, or about 1400 km. Figs. 2 and 3 illustrate the type of photograph on which the measures were made. These were taken with an interval of twenty-five seconds, and even a cursory glance will show that during that time the arrangement and forms of the granules have altered considerably; on this scale the diameter of the sun would be about 3 metres.

It seems probable that these researches will lead to most important conclusions concerning the nature and the periodicity of the changes in the granules themselves, their influence on the solar spots and faculæ, and, in general, to the resolution of many outstanding problems concerning the nature and action of the photosphere, which are at present unsolved. Prof. Hansky intends, therefore, to pursue this line of research, but, as he points out, it will only be during the comparatively rare moments of atmospheric calm, and with such a powerful equipment as he now possesses, that fruitful results are likely to be obtained. In any case, he is to be warmly congratulated upon those he has already published. W. E. ROLSTON.

PRACTICAL SCIENCE FOR SCHOOLS.[1]

PROF. PERRY said that in the early days of the society, when he had the honour of acting as a secretary, and when Guthrie and Foster, Kelvin and Fitzgerald were presidents, no presidential addresses were delivered, and he questioned whether we were not overdoing the business of requiring general addresses, which must almost always have as their theme the progress of science. Seldom did we find in such addresses new accounts of important original work, and he felt the inappropriateness of such an address in speaking before a society the Proceedings of which were more intense with original work of the best kind than any other society known to him with the exception of the Royal Society. He thought that every young reader of a paper before a scientific society made the mistake of assuming that his audience knew a great deal of the subject so familiar to himself, and hence his paper was not understood. Writers of books on physics assume their readers to be all truly logical students; they use words properly in a technical sense, and forget that many of their readers may use them in the newspaper writer's sense. For example, take the expression "adiabatic expansion." There are people who insist on finding that Rankine, Maxwell, and all others of our most exact writers are not only inconsistent with one another in the use of the expression, but that each is inconsistent with himself. If a portion of fluid expands slowly without gain or loss of heat, we know the way in which its p, v, and t alter as it changes state; this was originally called "adiabatic expansion," and the term has become a technical term for that kind of alteration of p, v, and t, however it may occur. Steam or air may be throttled through a non-conducting reducing valve, but the expansion is not adiabatic, although there is no gain or loss of heat. Steam or air passing along a pipe with friction, if it can only be made to lose heat through the metal of the pipe at exactly the proper rate at every place, is expanding adiabatically. When it is assumed that steam or air flows without friction from a vessel through an orifice, it is said that the expansion is adiabatic although it is rapid.

Referring to the teaching of physics to students entering upon the engineering profession, the president remarked that such teaching was nearly always slipshod. Many men enter a science college at the age of eighteen or more, knowing nothing of physical science. In the case of a great percentage of such men, it is impossible that they should acquire the scientific habit of thought. It is because so much of this kind of material is dealt with that much of our teaching is slipshod. Every pupil entering a science college ought to have been experimenting and working graphically and numerically on physical science problems from a very early age, and then our science classes would deal with them in a scientific way. The causes of the unfitness of the average student are two: one that his instincts and habits of thought were not trained from early youth; the other that his teachers in science colleges have absurd and uninteresting courses of study for him. In physics we are dealing with ideas which are not familiar to young students, ideas which can only become familiar in the laboratory. For example, such a simple mathematical idea as that of a decimal cannot be given in elementary schools in less than five or six years, whereas one week of weighing and measuring would give young children familiarity and clear ideas about decimals. Numerous examples could be given to prove that the principles of physics cannot be understood unless there has been early experimental training, and this is the reason why the professors of science in colleges of university rank and the professors in technical colleges obtain such poor reward for their labour. Referring to the many hundreds who every year take science degrees at the universities, and the thousands who pass the London University matriculation examination, Prof. Perry remarked that if that was the standard of excellence of those present, his address could serve no useful purpose. Nothing ought to be compulsory in schools except the study of English and of natural science. The object of a matriculation examination is to test whether a student entering a college will be able to benefit by the course of study there. The only language which ought to be compulsory in the science department of a university is English. A professor of science ought to be allowed to teach his students in the way that seems best to him, and he should examine his students himself. Hedge him round with rules and regulations framed by boards of studies; tie him down to a syllabus, and the work he will do might be much better, certainly much more cheaply, done by a grinder at low wages. There is no one general elementary course in physics which all students ought to take; neither by their previous training nor from the uses which they will make of the principles of physics are they fit to be taught together. What is wanted is more classes, more rooms, and more teachers.

[1] Abstract of the presidential address delivered before the Physical Society on February 9, by Prof. J. Perry, F.R.S.

THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION.

THE New Orleans meeting of the American Association for the Advancement of Science, as stated in our issue for January 25 (p. 303), began on December 29, 1905, and continued for five days. At a meeting of the general committee it was decided to hold a special summer meeting at Ithaca, New York, to close on or before July 3, 1906, and an ordinary winter meeting in New York City to begin on December 27, 1906. The presidential and vice-presidential addresses will be omitted at the summer meeting and given at the winter meeting. The officers elected at the New Orleans meeting will, therefore, hold office until the close of the New York meeting. Chicago was recommended as the place of the winter meeting of 1907.

The following officers were elected for the Ithaca and New York meetings:—President: Dr. W. H. Welch, Baltimore, Md. Presidents of sections: A, Dr. Edward Kasner, New York City; B, Prof. W. C. Sabine, Cambridge, Mass.; C, Mr. Clifford Richardson, New York City; D, Mr. W. R. Warner, Cleveland, O.; E, Prof. A. C. Lane, Lansing, Mich.; F, Prof. E. G. Conklin, Philadelphia, Pa.; G, Dr. D. T. MacDougall, Washington, D.C.; H, Prof. Hugo Münsterberg, Cambridge, Mass.; I, Mr. Chas. A. Conant, New York City; K, Dr. Simon Flexner, New York City. General secretary: Mr. John F. Hayford, Washington, D.C. Secretary of council: President F. W. McNair, Houghton, Mich.

The following resolutions were adopted by the association:—(1) That the association instructs its president and secretary to communicate to the president of the Senate and to the speaker of the House of Representatives of the United States its strong conviction that Niagara Falls should be preserved as a natural wonder, and further expressing the earnest hope that the congress now in session will take prompt and energetic action looking toward an international consideration of the impending danger to Niagara Falls. (2) *An Appalachian Forest Reserve.*—That the association again respectfully calls attention to the rapid rate at which the forests of the

Appalachian Mountain region are being destroyed, and to the fact that, as a result of such destruction, the streams tributary to the Mississippi, as well as those flowing into the South Atlantic, are becoming continuously more irregular in their flow, and hence of less value for navigation and power purposes. (3) That the association respectfully petitions the Congress of the United States to make such provision as may be necessary for the protection of these mountain forests.

The following grants were made at this meeting of the association:—40*l.* to Messrs. Parsons, Kinnicutt, and Venable to assist in the publication of Prof. Parsons's "Bibliography of Beryllium," and 20*l.* to "The Concilium Bibliographicum Zoologicum."

The committee on electrochemistry reported as follows:—A study has been made of the behaviour of platinum and iridium in chlorine water and in dilute hydrochloric acid. Smooth platinum foil brought about no evolution of gas even after standing 168 hours in chlorine water. In precisely similar circumstances an iridium foil caused an evolution of 44·4 [? c.c.] of gas, 55 per cent. of which was oxygen. The oxygen results from the reaction

$$Cl_2+H_2O=2HCl+O,$$

while the chlorine came from the solution, the original vapour pressure having been about half an atmosphere. This series of experiments showed that iridium was a more powerful catalytic agent than platinum. A number of electrolytic experiments were made with hydrochloric acid of different concentrations. In all cases more oxygen was evolved from the iridium anode than from the platinum anode. The question as to the final equilibrium is still in doubt.

The Popular Conception of the Scientific Man at the Present Day.[1]

The traditional scientific man has disappeared almost as completely as the traditional Yankee of the stage. The change came gradually, but the proof that it had come was brought before us suddenly. In 1902 there was called in New York a meeting of those who were designated by the picturesque expression captains of industry. To that meeting representatives of science were invited, not as lions to be stared at, but to sit with the leaders of the industrial and commercial world as representatives of science, and not only of applied science, but of pure science. As the captains of industry were supposed to be men of force in organising and to have a keen insight into men and things, we had a right to feel that science was honoured, perhaps not more than ever before, but for a reason for which it had not been honoured before in the United States. The fact that since that date the reputation of some of the captains of industry has suffered an eclipse does not alter the fact that to be considered a captain of industry was, in the eyes of the public, enviable. The conception of a scientific man as a captain of industry means simply the acknowledgment that science has a practical relation to the world, and that fortunately the public have advanced far enough to see, although perhaps somewhat dimly, that pure science sooner or later develops into applied science. The leaders of science are to be placed in the class of organisers, managers of a sort of scientific trust. This is science up to date, and the public are right when they regard science as an organisation. But they are only partly right. There is a good deal more than that in science, and, although good managers and directors are necessary, it is true that the power of organising and the power of investigating are two different things, and often exist in inverse ratio to each other, and it is the latter which is at the basis of science. An organiser is of no use until there is something to organise, and the materials on which the organiser in science must work are not made by machinery, but by the brains of individual workers, and it is important that they should be placed under the most favourable conditions for work. If hitherto there has been perhaps too little organisation, there is a danger that in the future there may be too much. In a mill many men are doing the same kind of work, but in science one man should not duplicate the work of another. The object of organisation in the one case is to secure uniformity of product, in the other to encourage diversity of work.

[1] From the address of Prof. W. G. Farlow, president of the Association.

The ways in which the public may aid scientific men are directly by endowments for paying salaries and indirectly by providing properly equipped laboratories and other necessary equipment, and especially for paying for the services of assistants. Both forms of help are necessary, for a man capable of managing and getting the greatest amount of good work out of a well equipped establishment deserves more than a meagre salary. On the other hand, those with what appears to be a respectable salary may have to spend a good part of it to make good the deficiencies in their equipment. In deciding whether a man is well paid or not, it is necessary to ask not only what salary he receives, but what are the means of work provided for him. It is not my intention here to direct attention to the special ways in which scientific establishments would be benefited by gifts from the public nor to discuss the question what is a proper salary for a scientific man. The latter depends upon too many complicated conditions, and cannot be separated from the more general question of what those in equally important positions in other walks of life are paid. The question of proper equipment, including the question of assistants, has already been brought before the public on a good many occasions and in a good many ways, and a good deal has been given in recent years, although by no means enough.

If, as it appears, the public have reached a better conception of the position of the scientific man and of his pecuniary needs, it may be added that he has the right to hope that he can appeal to the public not only for pecuniary, but for moral support, for, in many cases, the public are the final arbiters where differences arise, and unfavourable conditions often disappear quickly as soon as it is felt that one side or the other is backed by public opinion. It may, therefore, be well to state somewhat explicitly some of the conditions which are unfavourable to the progress of science in the United States or which tend to retard it. Here it is not so much a question of money as of a just appreciation of the true position of scientific men in their relation to those for whom their work is undertaken. That work, using a rough classification, may be considered as that done in technical and commercial concerns, that done for the Government, and that done in universities, including under that general term all colleges, scientific schools, and similar institutions which have a permanent endowment of some kind.

The Relation of Mechanics to Physics.[1]

We find the physicists of the beginning of the nineteenth century still very strongly attached to the idea that all natural phenomena not only may, but must, be explained on the basis of Newton's laws[2] by central forces acting instantaneously at a distance. Newton's mechanics had done such admirable service in astronomy that it had come to be regarded as the only possible means of describing and discussing the actions of nature. The gradual abandonment of this position and the change to the modern view, according to which all actions in nature are transmitted through a continuous medium and require time for their transmission, was accomplished only after a long struggle that occupied the greater part of the nineteenth century.

It is well known how the ideas of Faraday, of Maxwell, of Hertz, gradually gained ascendency over the older views and led to the abandonment of the idea of central forces acting instantaneously at a distance, in almost all branches of physics except in the theory of gravitation. It is also known that Maxwell, by a brilliant analysis, succeeded in establishing the connection between his electromagnetic theory and the analytical mechanics of Lagrange. Thus, at the end of the nineteenth century we find a general attitude toward physical phenomena essentially different from that prevailing at the end of the eighteenth century.

With the rise of the electron theory in the course of the last twenty-five years a new element has been introduced

[1] From the address of Prof. Alexander Ziwet, president of Section A, Mathematics and Astronomy.

[2] See, however, Laplace, "Mécanique Céleste," livre i., chap. vi. ("Œuvres," vol. i., 1878, pp. 74-79), a passage to which E. and F. Cosserat have recently directed attention.

into this development, an element which seems destined to affect very radically, not only our interpretation of physical phenomena, but also our general views about the principles of theoretical mechanics.

There seem to be two things underlying all the phenomena in the physical world—the ether and matter. To attain the unification of physical science, shall we consider the ether as a particular kind of matter? Or shall matter be interpreted electromagnetically? The older mechanics dealt exclusively with matter; and when it first became necessary to introduce the ether, this new medium was often endowed with properties very much like those of matter. The hydrodynamic analogy by which the apparent mass of the moving charge was interpreted illustrates this tendency. The physics of the ether has, however, reached so full a development that the properties of the ether are now known far more definitely than those of matter. These properties are contained implicitly in the fundamental equations of Maxwell and Hertz which in their essential features are adopted in the electron theory of Lorentz.

It is now pretty generally recognised that Newton's "laws of motion," including his definition of "force," are not unalterable laws of thought, but merely arbitrary postulates assumed for the purpose of interpreting natural phenomena in the most simple and adequate manner. Unfortunately, nature is not very simple. "As the eye of the night-owl is to the light of the sun, so is our mind to the most common phenomena of nature," says Aristotle. And if since Newton's time we have made some progress in the knowledge of physics, it is but reasonable to conclude that the postulates which appeared most simple and adequate two hundred years ago cannot be regarded as such at the present time.

This does not mean, of course, that the mechanics of Newton has lost its value. The case is somewhat parallel to that of the postulates of geometry. Just as the abandonment of one or the other of the postulates of Euclidean geometry leads to a more general geometry which contains the old geometry as a particular, or limiting, case, so the abandonment or generalisation of some of the postulates of the older mechanics must lead to a more general mechanics. The creation of such a generalised mechanics is a task for the immediate future. It is perhaps too early to say at present what form this new non-Newtonian mechanics will ultimately assume. Generalisation is always possible in a variety of ways. In the present case, the object should be to arrive at a mechanics, on the one hand sufficiently general for the electron theory, on the other such as to include the Newtonian mechanics as a special case.

After the searching criticism to which Poincaré, especially in his St. Louis address,[1] in 1904, has subjected the foundations of mechanics and mathematical physics, almost the only one of the fundamental principles that appears to remain intact is the principle of least action. It seems, therefore, natural to take this principle as the starting point for a common foundation of mathematical physics and of a generalised mechanics, but with a broader definition of "action," or what amounts to the same, with a generalised conception of "mass" so as to make the latter a function of the velocity.

The Partition of Energy.[2]

The general theorem which I wish to discuss may be stated by saying that the kinetic energy of the body is so distributed among the degrees of freedom, by which the state of the body as a dynamical system is described, that an equal share is, on the average, allotted to each degree of freedom of each type of molecule.

The questions which have always been raised about this important theorem of the kinetic theory at once come to our minds. First, is the theorem true, or rather, does it state what would be true for an ideal system of particles moving freely within a containing vessel? second, is the proof of the theorem impeccable? third, is there any experimental evidence that it applies to real bodies?

[1] "Bulletin des sciences mathématiques" (2), 28, pp. 302–324; English translation in the *Bulletin of the American Mathematical Society*, vol. xiii., February, 1906.

[2] From the address of Prof. W. F. Magie, president of Section B, Physics.

I would remark about the first question that the theorem is so distinguished by its simplicity, and by its aspect as a sort of unifying principle in nature, that few men can set it fairly before their minds without at least desiring to believe it true. Most of those who have recognised that Maxwell's original demonstration was not flawless are still convinced of the truth of his conclusion, or at least believe his conclusion to be so probable as to make it worth while to try for a more accurate demonstration. Their state of mind is like that of Clausius and of Lord Kelvin, when they perceived that Carnot's theorem respecting the efficiency of a reversible engine could not be proved in the way in which Carnot tried to prove it.

With respect to the second question, it was very soon pointed out that Maxwell had made in his proof an assumption that could not be justified by immediate inspection, and which was itself in need of demonstration or of avoidance. The later demonstrations of Maxwell and Boltzmann have been likewise subjected to criticism, and can be shown to involve assumptions that will not be granted on inspection. The difficulties that arise in these proofs come from the necessity of applying in them the calculus of probabilities, and centre around the question of the legitimacy of the application of that calculus. It is commonly agreed that Maxwell and Boltzmann have assumed a condition of the system of moving particles, as a requisite for the application of the calculus of probabilities, which is contradicted by many systems of which we have certain knowledge, and cannot without proof be admitted as likely to obtain in other systems, about which less is known. In the method employed by Jeans the application of the calculus of probabilities is made in a different manner, and does not necessitate the introduction of the hypothesis of Maxwell and Boltzmann. It seems to me that, in this last form of the theory, the difficulties which have environed the subject have at last been mastered.

In respect to the third question, that concerning the experimental evidence for the truth of the theorem, it is well known that, in general, Boyle's law follows as a consequence of the general principles of the kinetic theory, that Gay-Lussac's law is an immediate consequence of a relation plausibly assumed between temperature and the kinetic energy of the molecule, that the motion of the radiometer and the laws of transpiration and many other properties of gases can be deduced from the general theory, and, in particular, that Avogadro's law follows from the simplest form of the theorem of equipartition. But further proof of this theorem in its general form is still needed. Such proof as we have will be discussed in this address.

Considering the bearing of the relations that have been adduced upon the general question of the equipartition of energy, it seems to me that their general consistency with that principle, especially the way in which the heat capacities of the organic compounds can be portioned out among the atoms by means of simple assumptions about their degrees of freedom, does afford some confirmation of the principle. Mere chance can hardly account for so large a number of successful coincidences.

The Sanitary Value of a Water Analysis.[1]

Though much valuable information can be obtained from the careful study of the nitrogen content of a water, the water analyst does not depend alone upon these factors in forming an opinion as to the source of the organic matter, and turns to other chemical as well as to bacterial data to substantiate or modify the opinion thus formed. From the chemical point of view the most important of these data is the combined chlorine that a water contains. This is due to the fact that though chloride of sodium occurs in rain-water, especially near the sea, and in small amounts is found in all soils, it is a characteristic constituent of sewage, the animal body expelling the same amount of salt as it absorbs.

A careful study of the amount of combined chlorine in normal waters, made by Prof. Thomas M. Drown, showed that in Massachusetts, where salt-bearing strata do not occur, the amount of chlorine in a surface water depended on its distance from the sea, and that for Massachusetts

[1] From the address of Prof. Leonhard P. Kinnicutt, president of Section C, Chemistry.

it was possible to establish normal chlorine, or, as they are commonly called, iso-chlor lines.

The work begun by Prof. Drown has been carried on by other investigators, and to-day the iso-chlor lines for all the New England States and New York and New Jersey have been determined. The result of this work is that the amount of chlorine occurring in the surface waters of the above named States gives most valuable information. Chlorine above the normal of the region shows pollution. It does not indicate whether the pollution is direct or indirect, but does show that sewage, from which the organic matter and the germs of disease may or may not have been removed by filtration through soil, has had access to the water. Chlorine above the normal is, therefore, always a suspicious sign which must be investigated. I know that it is claimed that in many of the western States, owing to geological conditions, very little information can be obtained from the determination of chlorine. I believe, however, more careful and thorough work is necessary to prove that such is the case, and that further investigation may show that though it is impossible to construct iso chlor lines running through the State, the normal chlorine of different localities in a State can often be determined.

Another factor that is often used in the attempt to decide whether or not a water contains an excessive amount of organic matter is the oxygen consumed. The oxygen consumed is not, however, a measure of the organic matter in a water, but only a measure of the amount of mineral reducing salts plus a certain amount of the organic matter, the amount depending on the method of determination used. It gives, in my opinion, very little information as to the character of the organic matter, and is only valuable when different surface waters are to be compared with each other, or when used in filtration experiments.

The same may be said as regards colour, turbidity, and the amount of mineral matter that a surface water contains, that, though of essential importance in deciding on the value of a normal water as a potable water, they give little information as to pollution.

In the early days of bacteriology it was claimed that the final criterion as to pollution of a water would be furnished by aid of that science, and though this hope has not been fulfilled, the information that can be gained by a bacterial analysis is often of the highest importance. It not only aids in the interpretation of the chemical data, but may of itself show, almost without question, that a given water is polluted, for though attempts to isolate special pathogenic germs have generally failed, even in waters known to contain these forms, characteristic sewage forms, like the colon bacillus, can be isolated if they occur in any number in a water. Occurrence of numerous characteristic sewage bacteria can point only to one thing, pollution, and if such forms are found there is no question that the water receives sewage drainage. Bacteriology, however, cannot determine, except very roughly, the amount of pollution or the present condition of the polluting matter, nor does it give but very little, if any, information as to past pollution. If the pollution is recent and of any considerable amount, a careful bacterial examination will show the fact, and probably better and more convincingly than any chemical analysis. If the pollution is more remote, more information can, as a rule, be drawn from chemical than from bacterial data. If the polluting matter has filtered through the soil before entering the water, bacterial work will not indicate the fact.

As a general statement, it may be said that a bacterial analysis, while giving information as regards recent and continuous pollution, gives no information as to the past history of a water, and in this respect differs from a sanitary chemical analysis.

To form a judgment as to the wholesomeness of a water, the data of a sanitary water analysis, the source of the water, whether surface, ground, or artesian, must be known; a survey, even of a surface water, though it may show whether or not the water is polluted, does not give information regarding the amount or condition of the polluting matter; with ground and artesian waters it often gives very little information, and an opinion regarding the character of such waters must, as a rule, depend on the sanitary analysis.

The Generic Concept in the Classification of the Flowering Plants.[1]

The difficulties of classifying plants in a really natural and logical way are somewhat increased by the involuntary and well-nigh necessary admission of a certain historic element into our systems. There is another source of this artificiality, besides the temptation to allow poor genera to stand, on the ground of long usage. The relation of a genus to its name is a matter which exerts no small influence in this regard. The attempt to determine which of several names is to be retained for a given genus constantly forces us to consider the historic basis on which the genus rests, and to attach its name to some species or group of species to which it was first applied, to determine, in other words, what was the type of the genus, and to maintain the genus in such a way that it may always be true to its type. While sympathising to a considerable extent with those botanists who desire to place our nomenclature upon a more secure basis by attaching the names to recognised types, I feel that the methods employed will have to be very cautiously applied, or they will tend greatly to increase the artificial element in our system. The historic type is not a natural thing; it is merely that particular form of plant life which was, often quite by accident, first discovered and, therefore, first received the name which it bears. Later discoveries often show that this first species of a genus is by no means of a typical, or, as one may say, central character. It is often quite peripheral, perhaps even an aberrant or outlying member of the group to which it belongs. However important the historic type may be in nomenclature, it is obvious that it is of no particular significance in classification, and any employment of the type method in the determination of proper names must not on any account be permitted to exercise any influence in classification. The word type itself is decidedly unfortunate as thus applied to what is often very far from being typical. In this as in some other phases of taxonomy it is of the greatest importance to keep it clearly in mind that nomenclature, although very necessary to classification, is a thing wholly apart from the classification itself. It is, furthermore, quite evident that nomenclature should be subservient to classification, and that the clearness and accuracy of classification should never be sacrificed in order to give beauty or symmetry to any system of nomenclature.

The limitation of genera has always in the past rested on individual judgment, and it must continue to do so in the future. Although the genera of the flowering plants have now been scientifically studied for about two centuries, there is at present in America, at least, a degree of diversity in their interpretation which is rather discouraging. It is disheartening because it is impossible to see in it any real progress toward a well rounded and satisfying system, which will win the confidence of the professional botanist, give uniform training to the student, and command the respect of our colleagues in other branches of science. From this, I think that it is perfectly clear that botanical systematists have certain imperative duties in regard to this subject. These duties are, in the first place, great caution in making changes, and, in the second place, a feeling of obligation, when these changes seem necessary, to state the reasons for them so clearly and forcibly that they will appeal to all thoughtful and discriminating workers in the same field. The burden of proof should always rest upon the writer suggesting the change.

What we need in botanical classification is a series of constants, a number of graded categories which can be generally endorsed and properly respected. Standards as definite as those of the physicist are, of course, quite unattainable in dealing with the variable and often intergrading groups of organic creation. But where absolute accuracy and uniformity are impossible, we should the more diligently seek to preserve such standards as exist. As has been pointed out, there are but few families of flowering plants which have not been comprehensively treated by monographers who, so far as their particular group was concerned, have been in a position to see pretty

[1] From the address o. Prof. B. L. Robinson, president of Section G, Botany.

clearly where it was best to draw generic lines. While it must be admitted that there are many minor differences in the generic concepts exhibited in the scholarly and monumental works to which I here refer, yet they establish a good usage, which on the whole has a considerable measure of uniformity, and goes far to establish the rank of such categories as genus, species, and variety.

Let me urge that, while we remit no effort to secure further light on this subject, there should be a general agreement to treat the accepted and traditional interpretation of large and important genera as sacred and binding until we can furnish definite and convincing evidence that change is needful, and that for the welfare and dignity of our science all should unite in opposing changes of the artificial sort, which consist merely in the shifting of ranks and modification of standards.

Investigations and Commercial Tests in Connection with the Work of an Engineering College.[1]

In any school it is necessary, in securing the best efficiency in instruction, that the professors shall be able to speak with authority on the subjects which they teach. In technical schools those who teach the practical engineering subjects cannot speak with authority unless they have had practical experience. Investigations and commercial tests may serve to give them this practical experience, and the question naturally arises, Is it a good policy for professors to conduct such work in connection with their regular college duties?

Let us consider the various ways in which a professor in an engineering school may acquire the practical experience which is necessary in his work.

First, he may be called to a professorship from the practical field.

Second, after teaching for a time and finding how necessary a practical experience is in his work, he may turn to the practical field, and then return to teaching.

Third, he may undertake practical work in connection with his college duties, and gain his experience in this way.

Each method possesses its own advantages and disadvantages. Starting with the first, it must be admitted that many of our best instructors have entered the teaching line after they have had experience in the practical field. Such a man has an advantage in being able to make use of this experience immediately, when he starts at his teaching work. There is a disadvantage, however, in the fact that should he have secured a mature experience in the practical field, he will necessarily be no longer a young man, and it may be hard for him to teach and properly to adapt himself to the theoretical part of his course.

The advantages of the second system of securing a practical experience, where the professor leaves the teaching field, takes up outside work, and then returns to teaching, are that during his practical career he will be very much alive to the points he should look into, and, furthermore, if he returns to teaching he will possess the advantage of having experience both as a teacher and as a practical engineer.

We will now take up the third method, where a professor obtains his practical experience by conducting outside work in connection with his college duties. The outside work undertaken by a professor should be that of a scientific or strictly engineering type.

The advantage to a college in having its professors do research and outside work is that what reflects to the credit of the professor will reflect to the credit of the college. Furthermore, the college will be looked to as a source from which an unbiased opinion can be obtained, and in maintaining this standard it will be fulfilling a high and useful mission. The results of the investigations may be made the subjects of scientific papers to be read before the various societies, and any reputation that a professor gains in this way will benefit his college.

The day is past when there can be a strict line drawn between the work of the consulting engineer and that of the professor who teaches in the same field. The ideal professor in a given line should be able to take up the work of the consulting engineer in that line, and the ideal consulting engineer should possess enough technical knowledge to fit him for being a professor. There should be no jealousy, but rather a bond of friendship in that the fundamentals which each should master are the same.

[1] From the address of Prof. D. S. Jacobus, president of Section D, Mechanical Science and Engineering.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The results of a census undertaken each year by the *Magazine* show that there are 2722 undergraduates actually in residence this term, as compared with 2621 in Hilary term, 1905. The increase is probably due to the Rhodes scholars and to the fact that a larger proportion of undergraduates now complete three years of residence than was the case a few years back. The three largest colleges are Christ Church, New College, and Balliol, with 211, 210, and 181 members in residence.

A long vacation course in geography will be held in Oxford between August 7 and 25, provided that sufficient names are sent to the Reader in Geography, Old Ashmolean Building, Oxford, by June 1. The course will include lectures and demonstrations in the School of Geography, and surveying and map-drawing in the field.

At a meeting of the Junior Scientific Club, held on Wednesday, February 14, at the museum, papers were read by Prof. Miers on "Spontaneous Crystallisation," and by Mr. C. G. E. Farmer on "The Use of Finely Divided Metals in Organic Chemistry."

CAMBRIDGE.—The regulations for the diploma in mining engineering were passed by the Senate last Thursday. Among the chief of these regulations is that the candidate may take such parts of the natural sciences tripos and of the special examination in mechanism and applied sciences as bear upon the subject of mining engineering, or a candidate may take honours in the mechanical sciences tripos. Details of the examination and the schedules in the art of mining and in metallurgy will be found in the *Cambridge University Reporter* for December 5, 1905.

The Smith's prizes for 1904 have been adjudged as follows, the names being in alphabetical order:—C. F. Russell, Pembroke, for his essay on "The Geometrical Interpretation of Apolar Binary Forms"; F. J. M. Stratton, Gonville and Caius College, for his essay on "A Problem in Tidal Evolution Suggested by the Motion of Saturn's Ninth Satellite."

Mr. J. W. Nicholson, of Trinity College, has been elected to the Isaac Newton studentship in astronomy and physical optics, of the value of 250*l*. for one year, for study and research in astronomy.

Mr. R. H. Rastall, late scholar of Christ's College, Harkness scholar in 1903, has been elected to a junior fellowship at Christ's College. Mr. Rastall has worked chiefly in the Geological Museum at Cambridge, and has written on the Blea Wyke beds of Yorkshire and on "The Buttermere and Ennerdale Granophyre" of Lakeland.

DR. C. H. LEES, lecturer in physics and assistant director of the physical laboratories of the University of Manchester, has been appointed professor of physics at the East London College.

THE King's Speech, read by His Majesty at the opening of Parliament on Monday, promised that, at the earliest possible moment, a Bill would be introduced "for amending the existing law with regard to education in England and Wales."

THE Lancashire County Education Committee has recommended the council to make a grant of 100*l*. a year to the fund for the establishment of a department in economic botany in the University of Liverpool. The cost of the proposed department has in consequence now been completely guaranteed.

THE Senate of the University of St. Andrews has resolved to confer the following honorary degrees, among others, at the graduation ceremonial on April 3:—LL.D., Dr. A. C. L. G. Gunther, F.R.S., in appreciation of his lifelong and distinguished labours in zoology, Prof. J. C. Wilson, Oxford, and Prof. A. H. Young, Manchester.

AN open competitive examination for not fewer than twelve situations as assistant examiner in the Patent Office will be held by the Civil Service Commissioners in April next. The examination will commence on April 23, and forms of application for admission to it are now ready for issue, and may be obtained on request addressed by letter to the secretary, Civil Service Commission, Burlington Gardens, London, W.

AT the annual conference of the Labour Representation Committee held on February 16 considerable discussion took place on the following resolution:—"That this conference condemns the educational policy of the Government as laid down in the Act of 1902, and demands the formulation of an educational programme based upon the principle of equal opportunities for all, such programme to aim at securing—(1) that immediate provision be made for giving at least one free meal per day to all school children; (2) that all grades of education shall be free and State maintained; (3) that all education shall be free, and that secondary and technological education be placed within the reach of every child by the granting of bursaries or maintenance scholarships to all children whose usefulness would be enhanced by such extended education; further, that adequate provision be made for children to continue at school until the age of sixteen years, or until such age as the university course begins; (4) that provision be made to continue the education of capable students through the university courses; (5) that the standard of capacity shall be judged by work previously accomplished, and not by competitive examination; (6) that the education in all State-supported schools shall be secular; (7) that all State-supported schools shall be under the control of and their affairs administered by the directly elected representatives of the people; (8) that each educational district shall be required to train the number of pupil teachers demanded by local needs, and for this purpose to establish training colleges, preferably in connection with universities or university colleges; (9) that the cost of the abovementioned reforms shall be borne by the National Exchequer out of revenue obtained through broadening the basis of taxation, and by the restoration and democratic administration of valuable misappropriated educational charities and endowments." "This conference, therefore, instructs the committee (or such body as may be appointed for the purpose) to draft a Bill embodying the principle of the said resolution, with a view to the Labour group introducing it early into Parliament." A division having been taken, the result was declared as follows:—817,000 votes for the resolution and 76,000 for its rejection. The resolution was therefore carried. In view of the growing importance of the labour interest, it is satisfactory and gratifying to find a large and representative body of labour delegates appreciating the fact that the future welfare of the country is closely bound up with the provision of a rational system of national education.

THE publication on February 19 of a correspondence between Mr. A. H. D. Acland, formerly Minister of Education, and Mr. Birrell, President of the Board of Education, is gratifying evidence that at last something is to be done in the direction of providing adequate Exchequer grants for English secondary education. Mr. Birrell, in reply to a series of suggestions made by Mr. Acland, announces that provision is to be made in the Estimates for this year for a considerable increase of the Exchequer grants (1) in aid of secondary schools; (2) to alleviate the burden now placed upon local authorities in respect of the education of teachers; and (3) to assist further the building of training colleges for teachers by the local authorities. How much higher education in this country has suffered from the inadequate education of boys in our secondary schools, which, through want of funds, are too often under- and inefficiently staffed and equipped, has been pointed out in these columns with patient persistence. It is earnestly to be hoped that the findings of the Royal Commission on Secondary Education of ten years ago will now be considered seriously, and a statesmanlike attempt made to secure for the pupils in whose hands our future success as a manufacturing nation lies, a rational and complete secondary education which will enable them to take proper advantage of higher technical instruction. The promise that local education authorities are to be helped—in a degree commensurate with modern needs—in the pressing work of supplying more training college accommodation is heartily to be welcomed. The proportion of fully trained teachers in our elementary schools is at present scandalously low; and this is due primarily to the fact that until quite recently the only training colleges were those built—with the aid of special State grants like that of 1835—by the National and the British and Foreign School Societies, and supported largely by Government grants on each teacher in training. Though in recent years the work of day training departments in connection with university colleges has improved the facilities for the training of teachers, much yet remains to be accomplished if English elementary education is to take advantage of modern educational enlightenment. Local education authorities, with their knowledge of local needs, will be in a position, when helped by the promised Treasury grants, to start the much needed provision of more colleges where teachers may become acquainted with the principles upon which successful teaching must be based. In carrying out this important work, the need of training for secondary school teachers must not be forgotten. Most masters in secondary schools begin their work knowing only what to teach, and nothing of how to teach.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 25.—"On the Effect of High Temperatures on Radium Emanation." By W. **Makower**. Communicated by Prof. Arthur Schuster, F.R.S.

(1) The activity of radium emanation in radio-active equilibrium with its products A, B, and C, is changed by heating above 1000° C.

(2) The effect increases with the temperature up to 1200° C., and possibly beyond this temperature.

(3) The effect increases with the time of heating for about the first hour, but subsequent heating is without effect.

PARIS.

Academy of Sciences, February 12.—M. H. Poincaré in the chair.—Some properties of the α rays emitted by radium and by bodies rendered active by radium: Henri **Becquerel**. Some experiments of Prof. Rutherford recently published have led the author to repeat some of his earlier work on the deviation of the radium rays. In the present paper full details are given of the strength of the magnetic field, and the dimensions and arrangement of the apparatus. As a result, M. Becquerel definitely rejects the interpretation deduced by him from his earlier experiments and the hypothesis of an increase in the radius of curvature along the trajectory, and accepts the explanation of Prof. Rutherford, all the measurements confirming the existence of a reduced velocity for the α rays when traversing a leaf of aluminium. There is no difference in the behaviour of α rays arising from radium salts or from bodies rendered active by the emanation.—The internal pressure of fluids and the equation of Clausius: E. H. **Amagat**.—Some lemmas relating to quasi-waves of shock: P. **Duhem**.—Observation of the eclipse of the moon of February 9, 1906, made at the Observatory of Paris: P. **Salet**. Note on the time of contact, with especial reference to the difference observed between the photographic and visual observations in different eclipses.—Observations of the Brooks comet (1906*a*) made at the Observatory of Algiers with the 31·8 cm. equatorial: MM. **Rambaud** and **Sy**. Observations on the apparent positions of the comet and the positions of the comparison stars were made on January 31 and February 2. On January 31 the comet had the appearance of a round nebulosity with an eccentric nucleus, with a lustre comparable with that of a star of the eleventh magnitude.—Observations of the sun made at the Observatory of Lyons with the 16 cm. Brunner equatorial during the third quarter of 1905: J. **Guillaume**. Fifty-six days were available for observations during the quarter, the results of which are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Integral functions: Ed. **Maillet**.—A hyperelliptic Hessian: Louis **Remy.**—The extinction of a solitary wave propagated along a horizontal elastic tube: A. **Boulanger.**—A comparison of the time of discharge in an X-ray tube and of a spark in series with the tube producing the rays: Bernard **Brunhes.** Remarks on a recent paper by M. André Broca, and directing attention to a paper published by the author in 1900 on the same subject.—The recombination of the ions in saline vapours: G. **Moreau.** The ions of salt vapours, both by their mobilities and by the values of the coefficient α, for temperatures between 170° C. and 0° C., are intermediate between the ions of ordinary gases and the large ions due to the oxidation of phosphorus. Their mass diminishes as the temperature rises, and in a flame, for the negative ion, they become comparable with kathodic particles, and, for the positive ion, with the atom of hydrogen.—Remarks on the combinations of the rare metals of the cerium group and on their sulphates: Camille **Matignon.** A reply to a claim for priority made by M. Otto Brill.—Calcium iodomercurates: A. **Duboin.** These salts are prepared by alternately adding calcium iodide and mercuric iodide to water, finishing with a slight excess of the calcium salt. The solution had a density of 2·89 at 16° C., and three crystalline compounds were isolated from the solution.—The existence of sulphides of phosphorus: H. **Giran.** Various mixtures of phosphorus and sulphur were heated in sealed tubes to 200° C., and the melting points taken after solidification. The results are given graphically. The four maximum points correspond exactly to the proportions of sulphur indicated by the sulphides P_4S_3, P_2S_3, P_2S_5, and PS_6.—The preparation and properties of strontium: MM. **Guntz** and **Rœderer.** Strontium amalgam is heated in a current of hydrogen until the whole of the mercury is expelled, strontium hydride remaining. This hydride, heated in a vacuum at 1000° C., is dissociated, the vapours of strontium being condensed on a cool tube. The metal thus produced contained 99·43 per cent. of strontium, and was utilised in redetermining some thermochemical data.—The action of some esters of some dibasic acids on the halogen-magnesium derivatives of the primary aromatic amines: F. **Bodroux.**—The constitution of the sulphates of chromium: Albert **Colson.**—The existence of bicarbonates in mineral waters, and on the supposed anomalies of their osmotic pressure: L. C. **Maillard** and Lucien **Graux.** For one specimen of mineral water it is shown that the cryoscopic results are not opposed to the idea of the existence of bicarbonates in mineral water.—A new mode of extraction of oil of anise: Ph. **Eberhardt.** The oil can be extracted from the leaves as well as the fruit.—The anti-coagulating power of the blood serum of the lower animals: J. **Sellier.** Serum extracted from some fishes and invertebrates has the power of preventing the coagulation of milk by rennet.—The annelids of the Red Sea: Ch. **Gravier.**—The salivary glands of the snail (*Helix pomata*): M. **Pacaut** and P. **Vigier.**—The mechanism of the pathological modality special to each organ in the course of a general disease: A. **Charrin.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 22.

ROYAL SOCIETY, at 4.30.—On the Coefficient of Viscous Traction and its Relation to that of Viscosity: Prof. F. T. Trouton, F.R.S.—Contributions to our Knowledge of the Poison Plants of Western Australia. Part I. Cygnine: E. A Mann and Dr. W. H. Ince.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Crane Motors and Controllers: C. W. Hill.

FRIDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 9.—The Internal Architecture of Metals: Prof. John O. Arnold.

PHYSICAL SOCIETY, at 5.—A Note on Talbot's Bands: J. Walker.—Secondary Röntgen Radiation: C. G. Barkla.—Records of the Difference of Potential between Railway Lines, and a Suggested Method for the Observation of Earth-Currents and Magnetic Variations: C. W. S. Crawley and F. B. O. Hawes.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Graphical Determination of the Deflection of Beams: C. H. Sumner.

SATURDAY, FEBRUARY 24.

THE ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford at 6.30.—The Mosses of Essex: a Contribution to the Flora of the County: F. J. Chittenden.—Mysterious Subsidence at Mucking, Essex. Miscellaneous Denehole Notes, 1906: T. V. Holmes.

MONDAY, FEBRUARY 26.

SOCIETY OF ARTS, at 8.—Modern Warships: Sir William White, K C B. F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Travels on the Boundaries of Bolivia and Peru: Baron Erland Nordenskjöld.

INSTITUTE OF ACTUARIES, at 5.—On a Form of Spurious Selection which may arise when Mortality Tables are Amalgamated: W. Palin Elderton.

TUESDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 5.—Food and Nutrition: Prof. W. Stirling.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Anthropological Notes from Lake Tanganyika: W. A. Cunnington.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Adjourned Discussion*: A Plea for Better Country Roads: G. R. Jebb.—Country Roads for Modern Traffic: J. E. Blackwall.

WEDNESDAY, FEBRUARY 28.

SOCIETY OF ARTS, at 8.—London Traffic: Captain G. S. C. Swinton

THURSDAY, MARCH 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Experimental Inquiry into the Factors which Determine the Growth and Activity of the Mammary Glands: Miss J. E. Lane-Claypon and Prof. E. H. Starling, F.R.S.—The Specificity of the Opsonic Substances in the Blood Serum: Dr. W. Bulloch and G. T. Western.—The Internal Anatomy of Stomoxys: Lieut. F. Tulloch.

CHEMICAL SOCIETY, at 8.30.—Studies of Dynamic Isomerism. Part IV. Stereoisomeric Halogen Derivatives of Camphor: T. M. Lowry.

ROYAL INSTITUTION, at 5.—The Physiology of Plants: F. Darwin, F.R.S.

LINNEAN SOCIETY, at 8.—On a New Type of Stem from the Coal-measures: Dr. D. H. Scott, F.R.S.—Notes on Some Species of Nereis in the District of the Thames Estuary: Dr. H. C. Sorby, F.R.S.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Coast Lines Protected by Chain Cable Groynes: R. G. Allanson-Winn.

FRIDAY, MARCH 2.

ROYAL INSTITUTION, at 9.—Hippocrates and the Newly Discovered Health Temple at Cos: Dr. R. Caton.

SATURDAY, MARCH 3.

ROYAL INSTITUTION, at 3.—The Corpuscular Theory of Matter: Prof. J. J. Thomson, F.R.S.

CONTENTS.

PAGE