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## Technical Institutions and the Board of Education.

THE Board of Education has issued a circular (1286) for the purpose of defining full-time teaching service within the meaning of the School Teachers (Superannuation) Act. The Board appears to find much difficulty in defining full-time teaching service—difficulty which would not be shared, we think, by the average layman.

It would seem to us that there are two classes of teachers—those who have chosen teaching as their profession and have taken up full-time appointments under an Education Authority, and those who are known as visiting teachers or part-time teachers, and attend at their educational institutions only in order to conduct the special courses for which they were appointed. Generally speaking, the latter individuals are members of some other profession and would not expect to be regarded as full-time teachers. We can believe that there may be a few border-line cases—but they would be relatively very few, and each case could be considered on its merits. But the Board of Education—or is it the Treasury?—cannot look at the matter in this broad light, and this circular is an attempt to define full-time teaching service. The circular indicates that the first essential for recognition of full-time teaching service should be a formal agreement between employer and teacher in which should be clearly set out the nature of the duties, whether they are wholly of a teaching character, the extent of the employer's claim upon the teacher's working hours, and the restrictions, if any, put upon the employment.

We should have thought that such an agreement would have been sufficient evidence of full-time teaching service, just as it would be sufficient evidence for any judge or jury. Indeed, it is even sufficient for the Board so far as head or assistant teachers on the ordinary staffs of elementary or secondary schools are concerned, but in the case of specialist teachers and of teachers in technical schools and colleges, many of which are of university rank, "it will be necessary to call . . . for information as to the actual teaching hours as evidence of their full-time employment." Teachers in technical schools and colleges have a genuine cause for complaint here—not only because their agreement cannot be regarded by the Board as sufficient evidence in itself, but also because of the nature of the additional evidence to be demanded.

Full-time teaching service consists essentially of two component parts: actual teaching before a class, and the subsidiary duties entailed by actual teaching. The proportional value of these components depends, most

obviously, upon the subject taught, upon the standard which is reached, upon the technicality of the subject, and upon the experimental preparation involved. Therefore it would be impossible for the Board to make any just assessment of the magnitude of the subsidiary duties entailed on a bare return of actual teaching hours. If the Board of Education is unable to accept an approved agreement as sufficient evidence of full-time service, then, in justice to the teachers of science and technology, it must have more information than would be given by a mere return of actual teaching hours.

The circular indicates that the specific preparation of lessons (as distinct from general study) would be regarded as a subsidiary duty entailed by actual teaching, and we would point out here that teachers of science and technology must spend a large amount of time in keeping in touch with modern developments in science, and with the even more rapid and more extensive developments of the applications of science to industry. The time absorbed to this end cannot be regarded fairly as general study of an independent kind; it cannot be considered as dissociated from the teaching service; and it cannot be described as non-essential.

The teacher of science and technology has a claim for very special consideration here, for, though we are prepared to admit that every teacher should and must spend time in general study and should keep in touch with modern developments, yet we cannot be expected to believe that the time which must be spent in keeping up with the development of, for example, Roman history, is comparable with that which must be spent in keeping in touch with the development of electrical engineering.

In this connexion we note with amazement that according to this circular (clause 7) research work will not be regarded as teaching service, and the time spent in research work would not be counted as teaching service for the purpose of the Superannuation Act. We can only hope that either our reading of the clause is wrong or that it has been badly phrased, and does not express the real intention of the Board. If the research work referred to is research work which a teacher is undertaking on behalf of some firm, and for which he is receiving remuneration, then it is quite reasonable to regard such work as private work and not as teaching service to the State. But if the clause means that all research work will be regarded as non-teaching service, then we must protest most emphatically in the interests of the State.

Is it not essential for teachers of science and technology to give a certain amount of attention to research work in order to keep in touch with modern developments? Are there not students doing research work in many of our technical institutions? Will the time spent by the teachers in these institutions in guiding and directing that work be regarded as of no service to the State? Surely that clause in the circular has been badly phrased: it is incredible that all research work in technical institutions should be banned, by order of the Board of Education! For many years the value of research by teachers has been impressed upon the governing bodies of our chief technical institutions, but if the Board holds that time spent upon such investigations, however stimulating the work may be to teacher or pupil, is to be excluded from the superannuation scheme as pensionable service, then the institutions will be thrown back to the state they were in twenty years ago.

We feel that this circular has been drawn up without sufficient consideration of what is involved in the teaching of scientific and technological subjects, and it would seem that there has not been sufficient regard for the special conditions of teachers of science and technology in our technical schools and colleges.

We are glad to note, however, that the circular has been sent out to local authorities, governing bodies, and others for their observations, and that the Board will not arrive at a final decision as to the application of the principles set out until these observations have been considered. We hope, therefore, to see very considerable amendment in the final form of the circular.

## Internal Secretion.

*Glands in Health and Disease.* By Dr. B. Harrow. Pp. xv+218. (New York: E. P. Dutton and Co., 1922.) n.p.

*Internal Secretion and the Ductless Glands.* By Prof. Swale Vincent. Second edition. Pp. xx+422. (London: E. Arnold and Co., 1922.) 25*s*. net.

THE two books before us have not the same object or scope, but they appear equally to fulfil the purpose intended. On the whole, they may be said, along with Sir E. Sharpey Schafer's "Endocrine Organs," to be the most useful books on the subject in the English language, apart from the encyclopædic "Endocrinology" edited by Llewellys Barker. While that of Dr. Harrow is of a somewhat popular nature, assuming comparatively little physiological knowledge on the part of the reader, Prof. Swale Vincent's book has the more ambitious aim of a scientific presentation of the facts definitely known on the subject. This latter has therefore rather the character of a work of reference, and will be found very useful in this way. It is naturally not so easy to read as Dr. Harrow's book, which presents an admirable, connected account of the

subject and may be thoroughly recommended to all who wish for a critical statement of the problems which are attracting so much attention at the present time. It is to be hoped that those of us who have been misled by the wild reports of marvellous results published in the Press will adopt Dr. Harrow's cautious attitude and assess such reports at their proper value. Prof. Harvey Cushing, as quoted by Dr. Harrow, remarks:

"Nothing will discredit the subject so effectively as pseudo-scientific reports which find their way into advertising leaflets, where, cleverly intermixed with abstracts from researches of actual value, the administration of pluriglandular compounds is promiscuously advocated for a multitude of symptoms, real and fictitious. The Lewis Carroll of to-day would have Alice nibble from a pituitary mushroom in her left hand and a lutein one in her right hand and presto! She is any height desired!"

The title of Dr. Harrow's book, and also to a lesser degree that of Prof. Vincent's, invites some criticism. The name "gland" implies to the physiologist many organs and tissues which have functions other than that of producing substances for the purpose of exerting a particular action on other organs or tissues when they pass into the blood current. Those which form saliva and also the lymphatic glands may be mentioned. It is true that we might define a gland in a new way and say that any organ that produces some substance not already contained in the blood is entitled to the name. It would conduce to accuracy, however, if the name "gland" were limited to those organs able to pour out a secretion which can be collected and examined—those of "external secretion" in fact. In this case, the ductless "glands" would have to be called "bodies," or some similar name, as is indeed frequently done in speaking of the "pituitary body" or the "supra-renal bodies." The name "secretion" itself as applied to the activity of the endocrine organs is also not very satisfactory.

It must be confessed that we do not possess a really good name for these substances which act as "chemical messengers," formed by special cells for the special purpose, if the expression may be allowed, of producing an effect on another organ or cell when carried to it by the blood. A short word with the meaning of "chemical messenger" is what is wanted. When Prof. Starling and the present reviewer were engaged in investigating the mechanism of pancreatic secretion, we sought in vain for a word of this kind and were finally obliged to be satisfied with "hormone," although we felt that it was not exactly what we wished. It has, however, come into general use, although its meaning as "setting into activity" has caused the introduction of a number of other names, which might perhaps have been avoided. It is to be remembered that a messenger is sent for a special purpose, although he must take the road or railway which is in existence. Thus one of our hormones in the blood passes by a number of different cells before arriving at that kind which is sensitive to it, just as a letter sent by post is only received at that house to which it is addressed. A definition on the lines suggested would exclude such a constituent of the blood as carbon dioxide, called by Gley a "par-hormone." Carbon dioxide would be produced by all active cells whether the respiratory centre happened to be sensitive to it or not. A train (the blood) carrying soldiers (carbon dioxide) to a port for foreign service (the outer air) might pick up men at various stations (organs of the body) through which it passed. At one station there might be on the platform a nursemaid (the respiratory centre) who greatly admired soldiers. She would be excited by the passage of the train, but it would scarcely be held that the soldiers were sent for that purpose. The development of the special sensibility of the respiratory centre is of course another question.

While each of the books before us is provided with a good index, Dr. Harrow alone gives a list of original works, which, however, does not profess to contain more than the most important ones. Considering that Prof. Vincent's book is especially valuable for reference, it seems unfortunate that he has omitted in this second edition the bibliography contained in the first. It may be putting too great a burden upon him, but it would have been of great service if he had given the titles of papers which seemed to him to contain definite new knowledge, rejecting those numerous ones which have no real value. Perhaps we might ask him to reprint in the next edition the original bibliography, adding to it papers which appeared up to 1915 and referring to *Physiological Abstracts* for the subsequent literature. Although many of the current text-books of physiology serve well for the use of junior students without references, it must not be forgotten that the more advanced of these books are often referred to by research workers and teachers, and information as to the place of more detailed description would greatly increase their value.

The great difficulty of exact research in the problems dealt with is impressed upon readers of either of the books before us. Sensational reports as to the transplantation of organs from one individual to another, or even from one species to a different one, are put in their proper place. It seems certain that individual characters are so highly marked, at all events in the higher mammals, that the only permanent grafting occurs when a tissue is taken from one part of an individual and planted in another part of the same individual. Occasional success has been obtained by L. Loeb between closely related persons, brothers for example.

Otherwise the graft always degenerates sooner or later. All the effect it has is the temporary addition of just that amount of the special hormone present in the cells of the graft when inserted. This appears to be the only basis of the much-talked-of transplantations of Prof. Voronoff.

That part of the subject about which the evidence is most conflicting is the interrelation of the various "ductless glands." Both books deal with this in a duly cautious manner. Prof. Vincent gives a valuable account of the morphology of the different organs and tissues. His views as to the nature of the Islets of Langerhans will perhaps not be generally accepted, but it must be admitted that he brings good evidence.

The only points in Dr. Harrow's book which invite criticism are (1) the undue importance ascribed to adrenaline and to the nervous system in the production of wound shock—we find no reference to the toxæmic aspect, which would seem to be more appropriate to the subject matter; and (2) the reference to the liver as "the seat of carbohydrate metabolism in the body," in connexion with diabetes. The views of Langfeld are quoted, but the reversibility of the action of the liver enzymes is not taken into consideration. It seems to the reviewer that this word "metabolism" is used far too frequently in a loose way and often when other expressions would convey the meaning much better. The "metabolism" of carbohydrates, for example, should refer to the complete series of chemical changes which take place from the time of their introduction to their final elimination as carbon dioxide and water. When measurements of the oxygen intake are made, what is really done is to determine the whole oxidative processes and should be called "oxidation," not "metabolism" as is common. Similarly, valuable measurements of output of heat have been made. It would be more useful to speak of such determinations as of heat production, not as of metabolism. One also hears sometimes of mere nitrogen estimations in urine as "metabolism experiments." However this may be, it is certainly misleading to suggest that the liver is the most important place of chemical changes in carbohydrates. The whole problem of diabetes is still in a very unsatisfactory state. May it not be that we have given our attention too much to changes in particular compounds, such as glucose or fat, while the fundamental defect is a general failure in oxidative capacity? Thus the pancreatic hormone might be an oxidation-promoter, possibly for glucose, since there is evidence that the combustion of fat and protein is inadequate except in the presence of and as part of a kind of coupled reaction with that of sugar. "Acidosis" rather than "ketosis" should not now be regarded as the cause of diabetic intoxication, as Prof. Vincent suggests.

The multitude of the physiological phenomena concerned, as well as their practical importance, may serve as some excuse for the length of this review. We may conclude with a list of those organs or tissues which appear to Prof. Vincent to have established their claim to be regarded as producing true hormones. These are the thyroid, pancreas, reproductive organs, adrenals, pituitary body, and the intestinal mucous membrane ("secretin"). The evidence as to the parathyroids (which seem to act otherwise), the thymus, kidney, and pineal body is conflicting. It is to be remembered that the chemical nature of two only of the hormones has been discovered. Even active extracts have not been prepared in all cases. Still more uncertainty exists as to the way in which hormones act. There is much yet to be discovered. W. M. BAYLISS.

## The Origin of Worlds.

*Origine et Formation des Mondes.* Par l'Abbé Th. Moreux. Pp. xii+401. (Paris: Gaston Doin, 1922.) n.p.

THE Abbé Moreux has essayed, in the volume under notice, the ambitious task of giving a complete explanation of the origin of all the orbs in the solar system. Works on cosmogony have this advantage that no one can positively assert that any particular system is wrong, since certainty is quite unattainable. Hence a reviewer is not called upon to pronounce a theory of cosmogony right or wrong, but merely to note how far it appears to fit in with known facts.

The author uses as his materials nebulæ and meteoric swarms; he attributes the dark lanes in the Milky Way and regions where stars are unusually sparse to meteoric clouds, and supposes the outbursts of Novæ afford examples of the collisions between nebulæ and meteoric clouds which he assumes to be the origin of systems. He uses the spiral nebula analogy in tracing the distribution of the matter scattered by the collision. At this point he notes the fact that the planetary orbit-planes are arranged alternately on opposite sides of the plane of maximum areas. He also conjectures that the two arms of the spiral were in slightly different planes, and that the planets were developed alternately from one or other of them. This idea seems somewhat fanciful; it is fairly obvious that the two most massive planets, Jupiter and Saturn, would have their orbit planes on opposite sides of that of maximum areas, while the same would probably hold for Uranus and Neptune. Another criticism is that his theory, like that of Laplace, makes Neptune much the oldest planet. It was pointed out by the late Prof. Lowell that

apparently the two outer planets were not much further advanced in development than Jupiter and Saturn, although their much smaller size would imply a shorter career and more rapid development; it therefore seems probable that the order of formation of the giant planets has been from the inside outwards, and not the reverse.

In the matter of the origin of the moon the author does not favour the idea of its separation from the earth by fission, holding that it grew from meteors captured in the outer portion of the extended nebulosity which represented the future earth. Throughout the book he postulates the action of resisting medium; many systems of cosmogony do the same.

A few errata may be noted. On p. 207 the author pours scorn on the suggestion that the comets of Tuttle and De Vico have any connexion with the planets Saturn and Neptune respectively; he overlooks the fact that while the inclinations of their orbits are 55° and 85° respectively, the inclinations of their major axes are much less, so that in each case a shift of the node by a few degrees would bring about intersection with the planetary orbit. In the tables of planetary elements he adopts for Venus the very doubtful rotation period of 68 hours, while he treats both the rotation time and the position of the axis of Uranus as unknown, whereas both are known within narrow limits.

It is of course unreasonable to expect a book on such a subject to settle definitely all the matters on which it treats. Viewing it as a setting forth of the problems presented by our system, with more or less plausible solutions, it makes interesting reading.

A. C. D. CROMMELIN.

## Reservoir and Other Dams.

*The Design and Construction of Dams: including Masonry, Earth, Rock-fill, Timber, and Steel Structures, also the Principal Types of Movable Dams.* By E. Wegmann. Seventh edition, revised and enlarged. Pp. xvii+555+plates A-Z+plates AA-VV+plates I-III. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 50*s.* net.

MR. WEGMANN'S treatise has been before the public for so long that we imagine its general features will be more or less familiar to all who are engaged in the domain of waterworks engineering. The modest volume of 106 pages which appeared thirty-four years ago has, however, developed considerably in the course of time. It is now a ponderous tome of some 600 quarto pages of text, with well over 100 full-page plates in addition. A volume of such weighty proportions cannot fail to impress the reader in point of size alone, and it undoubtedly represents a considerable amount of patient toil in its compilation. It is, in fact, not merely a text-book; it is a work of reference, containing diagrams and particulars of most of the notable dams which have been constructed in recent years. It is permissible to the critic to question the wisdom of combining the two objects in a single volume. To the student, a text-book of modest proportions is a desideratum; he needs something easy to handle and conveniently portable, in the pocket if need be. The work of reference, on the other hand, is only required on occasion and may rest in the bookcase for long intervals. This combination of text-book with an exhaustive, or nearly exhaustive, record of existing examples is open to the objection that it meets the convenience neither of the student nor of the expert. However, we do not wish unduly to press the point.

In the seventh edition Mr. Wegmann has made his treatise replete with information of a highly valuable character. He has included a full description of the Kensico dam, New York; particulars of the movable dams of the New York State Barge Canal; and a brief notice of the Camarasa dam in Spain. This last is stated to be the highest gravity dam in the world, but surely the Arrowrock dam is higher by 20 ft. Probably what is meant is that the depth of water against the Camarasa dam is not equalled elsewhere. Why is the Arrowrock dam not included in the table of high masonry dams? Another very high dam omitted is the Hetch-Hetchy dam. There is, perhaps, some excuse for this omission, as the dam is yet under construction. Still, its dimensions are known and it is an important undertaking. A new chapter on crest gates and siphon spillways has been added, with particulars of examples built both in America and elsewhere, some of them of considerable size.

The subject of dams, of course, is wider than the sphere of waterworks engineering, although this is, perhaps, the most important field of its application. Mr. Wegmann's treatise covers dams as adapted to river engineering operations, and cofferdams as used in foundation work. Briefly, the volume consists of four parts, the first of which deals with the design and construction of masonry dams; the second, with earthen, rock-fill, timber, and steel dams; the third, with movable dams, cofferdams, and overflow weirs; and the fourth with recent dams of all classes. There is an appendix containing the specifications for the New Croton dam with various supplementary notes, a lengthy bibliography which, unfortunately, is not alphabetically arranged (the writer traced some works with difficulty, and failed to find mention of Mr. Powell Davis's book on irrigation works, which contains a

good deal of information on dams), and a fairly full index.

Taken as a whole, the work undoubtedly maintains its high reputation as a standard authority on the subject of reservoir dam construction, and its wealth of diagrammatic profiles from existing examples will cause it to be of great value to the practising engineer, as well as to the student who is seeking to acquire a knowledge of first principles.

BRYSSON CUNNINGHAM.

## Science and Progress.

*Progress and Science: Essays in Criticism.* By Robert Shafer. Pp. xii+243. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 12*s.* net.

THIS volume is almost entirely critical, mainly of the doctrine that science has contributed to a more rapid "progress" of the human race as a whole, and that we may expect this progress to continue. Much of the criticism is acute and many other writers are cited—Prof. Bury, Mr. G. D. H. Cole, Mr. Tawney, and Miss Follett; but the main attack falls upon Mr. F. S. Marvin, whose books, "The Living Past" and "The Century of Hope," are largely quoted in the initial chapter, which gives its title to the whole; he is dismissed in the concluding sentence thus: "It follows that men such as Mr. Marvin are hardly doing us any good, are promoting rather beliefs and hopes which may in the end work an intolerable mischief in the world."

It is a challenge to optimism, or rather to meliorism, based on science, and would have more justification if the author could find any passage either in Mr. Marvin's writings, or in any sympathiser's, indicating a belief either that this progress was complete, or that it could be expected to continue without the strenuous efforts of mankind to carry it further and remedy its defects. This Mr. Shafer does not attempt to do. We are, therefore, reduced to asking him one or two quite simple and direct questions as to his judgment of facts.

1. Is it not a fact that the advance of science in the last three or four centuries has, on the whole, led to an enormous alleviation of human suffering and an increase in the capacity and the facilities for happiness?

2. Has not this advance been accompanied by a growth in the collective consciousness of mankind, quite unparalleled in history? And is not this growth in the sense of "humanity" due, partly to the knitting up of the world by the mechanical application of science, partly to the fact that science is in itself a social thing and that its growth involves the co-operation of multitudes of minds bent on the whole—poison gas and weapons of war notwithstanding—towards increasing human welfare?

3. If this is so, is it an evil or mischievous thing to try to realise these forces in the world and to feel that they are with us in our individual efforts to promote the same great ends?

It should be noticed that Mr. Shafer in his criticism of Mr. Marvin quotes exclusively from the two books mentioned above, which are rather popular summaries of great epochs of history, and does not refer to the more philosophic treatment of the same topics in the various volumes of the "Unity" series published by the Oxford University Press.

## Our Bookshelf.

*The Union of South Africa. Department of Mines and Industries. The Geology of the Country around Heidelberg; Geological Map of the Country around Heidelberg.* By Dr. A. W. Rogers. Pp. 84. (Pretoria: The Government Printing and Stationery Office.) 8*s.* 6*d.* net, including map.

THE publication of the official description of the geology of the Heidelberg district has been anticipated with much interest by South African geologists. The main features of the area have long been known on account of the economic importance of the Nigel Reef. Mainly owing to the pioneer work of Dr. Hatch, it was recognised more than twenty years ago that the Heidelberg district forms the south-eastern limb of the great pitching syncline, on the northern limb of which lies the Rand, and it may at once be said that the result of the detailed survey fully confirms the accuracy of Dr. Hatch's general conclusions. The gradual extension of mining towards the East Rand and the sinking of many bore-holes, some of great depth, have clearly shown that the Nigel Reef belongs to the Main Reef series of the Witwatersrand; it is also shown that the whole Witwatersrand system decreases regularly in thickness towards the south and east, from about 25,000 feet near Johannesburg to 15,000 feet at Heidelberg. This is quite in consonance with the theory of its formation as the delta of rivers coming from an old land to the north-west.

In this memoir the structure of the district is lucidly described. The most remarkable feature is the great Sugarbush fault, so called from its relation to the Zuikerboschrand. This is a new discovery of great importance. The fault is apparently nearly vertical, with a down-throw to the south; at one point in its course, where it brings the Ventersdorp Amygdaloid against the Hospital Hill Series, the throw must be at least 16,000 feet. It therefore ranks as one of the world's greatest dislocations. The fault is certainly of pre-Karroo date, but its relation to the Pretoria Series has not been made out. Probably, however, it was later in date than the deposition of the whole of the Transvaal system, and therefore possibly of early or middle Palæozoic age.

R. H. RASTALL.

*Patents for Inventions.* By J. Ewart Walker and R. Bruce Foster. Pp. xiii+377. (London: Sir I. Pitman and Sons, Ltd., 1922.) 21*s.* net.

THE authors of this book depart somewhat from the usual manner of treating the subject of patent law. After a brief introductory survey, they first deal with the manner of obtaining a patent, detailing the procedure in the Patent Office and in possible opposition proceedings. Their next concern is the establishment in the courts of the validity of the patent, consideration being given both to the general rules governing the interpretation of patents and to the grounds upon which the patent may be held invalid. Finally, the privileges and responsibilities associated with the possession of a valid patent are discussed, the chapters relating to this covering very fully the rights of the patentee in respect of infringements, royalties, licences, etc., and his liabilities as regards revocation and compulsory licences.

By presenting the subject in this sequence, the principles underlying patent law are linked up in a manner which can easily be followed. As, in addition, the treatment throughout is clear and concise and avoids undue stress upon legal technicalities, the book should commend itself not only to legal practitioners but also to business men, directors of industrial research, and others who are interested in the protection and commercial exploitation of inventions.

An appendix, which extends to a little over half the book, contains as its most valuable features the Patents and Designs Acts in a consolidated form, and a list of the leading cases to which reference has been made in the text. Of lesser value relatively are the reprints of the patents forms, the Patents Rules, and the war legislation, the inclusion of which accounts for the abnormal size of the appendix. These reprints, we think, might very reasonably have been dispensed with as adding unnecessarily to the cost of a very useful book. E. J.

*Technische Träume.* Von Hanns Günther (W. de Haas). Pp. 83. (Zurich: Rascher & Cie, 1922.) 50 marks.

THIS illustrated pamphlet issued free to subscribers to the journal *Natur und Technik* contains short accounts of the most important of the proposals which have been made from time to time either to use coal more efficiently in view of its complete exhaustion 1500 years hence, or to substitute for it some other source of power. Of schemes falling within the former category the author thinks Ramsay's plan for converting coal into water-gas *in situ* not likely to prove successful, and attaches more importance to the proposals to generate electric current thermo-electrically or by means of carbon cells. Apart from coal and petroleum, natural power has been derived from sunlight, from the wind, from steam in volcanic regions, from the tides, and from the waves of the sea. Sunlight power plants in tropical regions can, he considers, compete with coal at 10*s.* a ton, while at Landerello in Tuscany all domestic and power heating is supplied by steam from underground heat. The waves have not proved an economical source of power, but the tides are more promising where the necessary structural work is not too costly. The estimated costs of the Severn Scheme the author thinks too low.

*Filtration: An Elementary Treatise on Industrial Methods and Equipment for the Filtration of Liquids and Gases for those Concerned with Water Supply, Ventilation, and Public Health; Chemists, Mechanical Engineers, and Others.* By T. Roland Wollaston. (Pitman's Technical Primers.) Pp. x+102. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

THE very ambitious title of this small volume would naturally lead one to expect more than is contained in the book. The author has wasted a good deal of the space at his disposal by a rambling style and by irrelevant discussions. Thus, on p. 4 no less than thirteen lines are sacrificed to a reference to a paper in connexion with two very simple chemical equations which are to be found in every text-book. Much of the text deals with very elementary matters, which should be assumed to be known by the readers. In consequence, the remaining space is insufficient to render possible a clear description, in sufficient detail, of apparatus for technical filtration.

*The Tutorial Chemistry.* Part 2, *Metals and Physical Chemistry.* By Dr. G. H. Bailey. Edited by Dr. W. Briggs. 12th impression (4th edition). Pp. viii+494. (London: University Tutorial Press, Ltd., 1922.) 6*s.* 6*d.*

DR. BAILEY'S text-book, in its revised form, will continue to be useful to students. It gives a clear introductory course of physical chemistry and of the chemistry of the metals. A good feature is the inclusion of brief accounts of the so-called "rare metals," many of which are now technically important. Specific heats at low temperatures might have been mentioned, and we also miss any allusion to Werner's theory and the cyanide process for silver extraction. There are some criticisms which might be made. The definitions in connexion with the phase rule (§ 45) are not sufficiently precise. Stas's silver was not so pure as is implied (§ 281); the existence of $MnO_3$ is doubtful; stannous oxide is olive coloured, not black; and the atomic weight of nitrogen is not a whole number within the limits of experimental error (§ 508).

*Mentally Deficient Children: Their Treatment and Training.* By Dr. G. E. Shuttleworth and Dr. W. A. Potts. Fifth edition. Pp. xviii+320. (London: H. K. Lewis and Co., Ltd., 1922.) 10*s.* 6*d.* net.

THE fact that a fifth edition of this book has been required is sufficient evidence of its value. It gives in a very comprehensive form a quantity of useful information, legal and medical, concerning the mentally defective child. At the beginning of the book there is an interesting account of the early efforts of Séguin and other pioneers in this field. This is followed by chapters on the regulations in England and other countries, the types of mental defect, the treatment available, educational, industrial, and moral training. The appendices supply a list of institutions, both in England and America, where treatment is given, as well as the medical certificate forms under the Mental Deficiency Act, and a list of the Binet-Simon tests. There is also an excellent bibliography.

## Letters to the Editor.

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

### The Isotopes of Selenium and some other Elements.

THE first experiments with selenium some time ago were not successful. Very satisfactory mass-spectra have now been obtained by vaporising the element itself in the discharge tube. The interpretation of these is quite simple and definite, so that the results may be stated with every confidence. Selenium consists of six isotopes, giving lines at 74 (*f*), 76 (*c*), 77 (*e*), 78 (*b*), 80 (*a*), 82 (*d*). The line at 74 is extremely faint. The intensities of the lines are in the order indicated by the letters, and agree well enough with the chemical atomic weight 79·2. Measurement of the lines shows no detectable deviation from the whole number rule.

Application of the method to cadmium and tellurium has failed to give the mass lines of these elements. The employment of the more volatile $TeCl_3$ was also unsuccessful, but incidentally gave evidence of great value, which practically confirms two facts previously suspected, namely, that chlorine has no isotope of mass 39, and that aluminium is a simple element 27.

During some work requiring very prolonged exposures with a gas containing xenon, two new isotopes of that element were discovered at 124, 126, making nine in all. The extreme faintness of both lines indicates that the proportion of these light isotopes in the element is minute.

It will be noticed that the first of these is isobaric with tin, and that the seleniums 78, 80, 82 are isobares of krypton. All isobares so far discovered, including the radioactive ones, have *even* atomic weights.

F. W. ASTON.

Cavendish Laboratory, Cambridge, November 6.

### Bohr's Model of the Hydrogen Molecules and their Magnetic Susceptibility.

BOHR'S model of the molecules of hydrogen explains very satisfactorily the light dispersion of hydrogen,[1] and gives the same value for the moment of inertia as that deduced from the specific heat;[2] but it is generally believed that the model does not explain the diamagnetic property of the gas.[3] For, according to P. Langevin's theory,[4] the hydrogen molecules must have paramagnetic susceptibility, while as a matter of fact the gas is diamagnetic, as determined by Dr. T. Soné.[5] But, as this note will show, this conclusion is not correct.

It is well known that, besides three degrees of freedom for translation, hydrogen molecules possess two degrees of rotational freedom. According to Bohr's model, this rotational motion must, from the point of view of symmetry, take place about an axis perpendicular to the magnetic axis of the molecules—that is, an axis perpendicular to the line joining two positive nuclei. This rotational motion is uniform and increases with the rise of temperature. Hence the magnetic effect of each molecule due to the revolving electrons vanishes on account of the rotational motion. In this case, therefore, Langevin's theory of paramagnetism is not applicable. Obviously his theory can be applied only when the gas molecules have no degree of rotational freedom, or when they revolve only about their magnetic axes.

If a strong field acts on a uniformly revolving magnet in its plane of revolution (Fig. 1), the rotation begins to become slightly accelerated in the half-revolution in the direction of the field and retarded in the other half, this causing a diamagnetic effect.[6] In the case of the molecules of hydrogen the moment of inertia about the axis of rotation is, however, very large on account of the positive nuclei being apart from each other; hence, during rotation, these two revolving nuclei behave like a large flywheel, and before the revolution of the molecules is sensibly accelerated it is newly excited by thermal impacts. Hence we may assume that this rotation is not sensibly affected by the action of a strong magnetic field, and therefore, in the mean, remains uniform throughout. The hydrogen gas is then diamagnetic, and its susceptibility can be calculated by Langevin's theory of diamagnetism.[7]

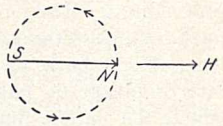

FIG. 1.

Assuming Bohr's new model of the hydrogen molecules (in which the electrons have elliptic orbits), we have for the major axis of the orbit

$$a = \frac{h^2}{4\pi^2 me^2}\left\{\frac{2}{(1+\kappa^2)^{\frac{3}{2}}} - \frac{1}{4}\right\}(n+n')^2,$$

$$\kappa = \frac{1}{\sqrt{3}}, \qquad 1-\epsilon^2 = \frac{n^2}{(n+n')^2},$$

where $h$ is Planck's universal constant, $m$ the mass of the electrons, and $e$ their charge; $\epsilon$ is the eccentricity of the orbit, $n$ and $n'$ are the azimuth and radial quantum numbers.

In the case of $n+n'=1$, the possible orbit is $n=1$, $n'=0$, which reduces to a circle, the radius of which is

$$a = 0{\cdot}507 \times 10^{-8},$$

$$\frac{h^2}{4\pi^2 me^2} \text{ being } 0{\cdot}532 \times 10^{-8}.$$

The magnetic susceptibility of the gas per gram-molecule is given by

$$\chi = -\frac{nm}{12}\left(\frac{e}{m}\right)^2 \Sigma a^2,$$

where $n$ is the total number of electrons and $\Sigma$ is to be taken for different orbits. Applying this formula to the above case, we have

$$\chi = -0{\cdot}712 \times 10^{-6}.$$

In the case where $n+n'=2$, $n=n'=1$ corresponds to the elliptic orbit. Here $\epsilon^2=3/4$, and the equivalent radius of the circle is

$$a = 1{\cdot}433 \times 10^{-8} \text{ cm.},$$
$$\chi = -5{\cdot}70 \times 10^{-6}.$$

The diamagnetic susceptibility $\chi = 3{\cdot}96 \times 10^{-6}$ observed by Dr. T. Soné lies between these two. In actual cases a certain fraction of the whole number of molecules may have the first orbit ($n=1$, $n'=0$), and the other fraction the second orbit ($n=n'=1$), etc. As the orbit becomes greater there is a greater chance that it will collapse into a smaller orbit;

[1] Debye, Münchener Akademie (1915), 1.
[2] Reiche, *Ann. der Phys.*, **58** (1919), 682.
[3] J. Kunz, *Phys. Rev.*, **12** (1918), 59.
[4] P. Langevin, *Ann. de Chem. et de Phys.*, **8** (1905), 70.
[5] Sci. Rep. **8** (1919), 115.
[6] K. Honda and J. Okubo, Sci. Rep. **5** (1916), 325.
[7] P. Langevin, *l.c.*

hence the number of molecules with an orbit $(n, n')$ at any instant rapidly decreases with the increase of $n$ and $n'$. If we assume that the hydrogen gas contains only the first and second kinds of molecules, viz., 35 and 65 per cent. respectively, then the calculated value exactly coincides with that observed.

KÔTARÔ HONDA.

Research Institute for Iron, Steel,
and other Metals,
Imperial University, Sendai, Japan,
September 22.

## Gravity Observations in India.

THE importance of the bearing of a change in the force of gravity, if such could be established, on all problems connected with the physics of the earth, especially those of the origin of mountains, continents, and oceans, is sufficient justification for directing attention to certain peculiarities in the determinations which have been made at Dehra Dun.

When observations of gravity in India were resumed in 1904, with a group of four identical half-seconds pendulums of v. Sterneck's pattern, the value of gravity at Dehra Dun was determined, by comparison with Potsdam, as 979·063 dynes. The earlier observations of Basevi had given a value equivalent to 978·962 dynes, so there was an apparent increase of 0·101 dyne in the interval between the two sets of observations.

A fuller examination of the evidence has shown that no such conclusion can be drawn from the comparison of these two sets of observations. Basevi's final value at Dehra Dun was derived from an elaborate series of observations, made in a room specially adapted for experimenting on the effect of changes of temperature, and in this the legs of the stand were supported on brick pillars. At the time it was unknown and unsuspected that this would seriously vitiate the results, and we have also on record the value obtained from a preliminary observation, conducted under conditions similar to those in his other stations, where the stand rested directly on a concrete floor at ground-level; this preliminary observation gave a value discordant from the final ones, but differing from the 1904 value by about the same amount as is found in other of his stations which have been re-observed. The position was, therefore, that there was no proof of any change of the force of gravity at Dehra Dun, but equally there was no disproof of such change having taken place; all that could be said was that, if any change had taken place, it must have been of a much smaller order of magnitude than one-tenth of a dyne.

In the course of the new series of observations further evidence came to light. The pendulums, swung regularly every year at the commencement and close of each field season, showed a gradual decrease in the period of vibration till, in November 1909, the mean period had decreased by 0·0000043 seconds, making the apparent value of gravity 979·079 dynes. Since then the time of vibration showed a gradual increase till in April 1913 it had reached a value only 0·0000012 seconds less than in 1904. It has been suggested[1] that the increase after 1909 was due to a gradual wearing of the agate edges; the suggestion is a possible one, but it leaves unexplained the diminution between 1904 and 1909, which was evidently due to some cause which affected all four of the pendulums in about equal degree. There was no change in the routine of observation[2] which could account for it, and the alternatives seem to be a gradual molecular change in the material of the pendulums, leading to change in length, or a real change in the value of the force of gravity at Dehra Dun. As all four pendulums were made at the same time, of the same material, and, so far as possible, of the same form and dimensions, the former is not impossible, but the latter would equally affect all four simultaneously and alike. The situation therefore remained as in 1904, that, so far as the Indian observations are concerned, there was neither proof nor disproof of any change in the force of gravity having taken place.

In addition to the observations of the Survey of India there have been some other determinations of gravity in India. In 1905 Hecker, at Jalpaiguri, obtained a value which was 0·002 dyne in excess, and in 1906 Alessio, at Colaba, a value of 0·004 dyne in defect, of the Survey of India values, being in substantial agreement with the value determined at Dehra Dun in January-February 1904. In 1913 another determination was made at Dehra Dun, by Prof. Alessio, with an apparatus consisting of eight pendulums prepared for the Filippi expedition to Central Asia, and the value obtained, which has only recently been announced,[3] was 979·079 dynes, or 0·016 dyne in excess of the standard accepted value used by the Survey of India, as determined in 1904. The position therefore now is that, while independent direct comparisons made in the two years following the commencement of the new series of observations in India showed substantial agreement, a similar determination made nine years later showed a material difference, and this opens out the possibility that part, at least, of the changes noticed at Dehra Dun may have been due to a real change in the force of gravity at that place.

The difficulty of accepting such interpretation is less at Dehra Dun than at many other stations, for that place lies on the fringe of the Himalayas, the elevation of which has been one of the latest incidents in the geological history of the earth, and it also lies in a region where the surface deformation, established after the earthquake of April 4, 1905, shows that changes are still taking place.

It is to be hoped that when gravity observations are resumed in India the matter will be looked into; in part the doubt left by these observations might be cleared up by the re-observation of some of the Peninsular stations, where gravity was determined at the outset of the series and about 1909. For example, Colaba (1904), Mysore (1908), and Jubbulpore (1910) seem convenient and suitable; a fresh determination at these stations would show whether there had been a change in the force of gravity as compared with the reference station of Dehra Dun.

R. D. OLDHAM.

[1] H. J. Couchman, Prof. Pap., Survey of India, No. 15, p. 2.
[2] Records, Survey of India, vol. 2, 1913, p. 33.

## The Miraculous Draught of Fishes.

To the several names of the Sea of Galilee, Prof. Gudger, in his very interesting letter (NATURE, October 28, p. 572) has thrice added "Lake of Tiberius," evidently by mistake for "Lake of Tiberias." Also he omits any reference to the important paper by Prof. Théod. Barrois, "Contr. à l'étude de quelques lacs de Syrie" (in *Rev. Biol. du Nord de la France*, tome vi., 1894), which usefully summarises what is known of the fauna of the lake in modern times from Belon in 1553 to his own date in 1894. The lake, it appears, contains twenty-two species of fish, some small fishes and some large ones in vast abundance. As of old, it is subject to sudden squalls, dangerous to navigation. Some of its inflowing waters for their

[3] *Rivista Marittima*, March 1922, Supplement, p. 73.

healing properties have, says Prof. Barrois, from the most remote antiquity, attracted patients suffering from eczema, arthritis of every kind, and other afflictions. But, with regard to Prof. Gudger's ingenious explanation of the miraculous draught of fishes, coupled with Lortet's description of the behaviour of grebes over a shoal of large Chromids and Canon Tristram's account of their dorsal fins as seen at the surface, surely the wonder is that experienced fishermen like St. Peter should have needed outside assistance, let alone superhuman aid, as is implied in the narrative of St. John's Gospel.

T. R. R. S.

Tunbridge Wells, October 30.

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IN the passage from Lortet's work on the Lake of Tiberias, quoted in Prof. Gudger's interesting letter in NATURE of October 28, p. 572, the scientific title of the crested grebe is given as *Podiceps cristatus*. This misrendering of the true name of the genus Podicipes may be traced, I think, to Yarrell, for it appears in his "History of British Birds," published in 1845. Yarrell was not a classical scholar; but it is strange that the late Lord Lilford should have slipped into the same error in his splendid "Coloured Figures of British Birds." The difference in form is important, because Podiceps, if it means anything, means "rump-headed"; whereas in coining the word Podicipes, meaning "rump-footed," Linnæus indicated the posterior position of the feet so characteristic of the genus.

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire.

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PROF. E. W. GUDGER'S letter on this subject in NATURE of October 28, p. 573, is interesting from the natural history point of view, but it misses the most suggestive point in the narrative. That point is the number—one hundred and fifty and three. What is the meaning of this very definite figure? It will scarcely be contended that the number is merely the simple statement of a historic fact—that the fishes caught did actually number one hundred and fifty and three, neither more nor less! The naïve literalism of such an explanation is totally blind to the true significance of the story.

Obviously, the story is a parable. The lake of Gennesaret is the world. The fishes are the souls of men. The net that is not broken is the Church. And the number? That is a problem, but an explanation I heard given in a sermon by my father, the late Rev. R. B. Drummond, of Edinburgh, seems to meet the case. Where he found the solution I do not know. It was not original.

The Jews, as is well known, attached a mysterious significance to numbers, and if they met a definite number like this, they would not pass it by unheeding, but would try to discover its meaning. Well now, this number is what is called the perfection of the number 17; that is to say, it is the number arrived at by adding all the consecutive numbers from 1 to 17 inclusive. And the number 17 itself is the sum of the two sacred numbers 7 and 10. These again (here I am a little vague as to why) stand respectively for the Jews and the Gentiles. Hence the story means that the net of the Church is able, without breaking, to gather together not only, as some contended, Jews and those who became Jews, but all sorts and conditions of men of every race and tribe.

W. B. DRUMMOND.

Baldovan Institution, by Dundee.
November 1.

PROF. GUDGER'S communication under this heading in NATURE for October 28, p. 572, has brought back to me a vivid recollection of a fishing incident in the north-west of Ireland. About a dozen years ago I spent a week-end at Ballina, County Mayo, and as the express to Dublin did not leave until after mid-day, I devoted Monday forenoon to a ramble along the banks of the Moy river. Observing several men, with a boat and draw-net, making a succession of fruitless attempts to land fish, I crossed the river and made my way to them. It was true—they had toiled and had caught nothing. They were putting out to make another attempt, and I offered them five shillings for the next haul. They declined. The net was hauled in, and there was not a scrap of anything in it. They put off again, and I repeated my offer, which was rejected, and the net came in empty, as before. With all their futile endeavours the men were not in the least put out. Calmly the boat and net were again got ready, and I was told it would be no use offering to buy the haul. When the net was landed it was found to have brought in one little fish—a sprat in size! Apparently this was looked upon as a good sign—a command to try again, for, still undaunted, the men persevered—they rowed off cheerfully, let out the net, then returned to shore and hauled at the net, but evidently it was harder work than on any previous occasion. When the operation was completed, hundreds—the men said eleven hundred—salmon had been landed! A school from the sea had come up on the rising tide.

HY. HARRIES.

October 28.

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### On the Reality of Nerve Energy.

I HAVE only to-day seen Dr. Adrian's letter of September 30 in which he states with great clearness the present-day physical explanation of the nature and transmission of the nerve impulse.

It seems to me that it is the relation of this nerve impulse to nerve energy that stands in need of elucidation. My present concern is not so much to recommend the more extensive use of the term nerve energy as to make sure that when physiological or medical writers use it, we shall have some more accurate notion of what they mean by it. Evidently, from what Dr. Adrian says, sometimes they mean mental energy. Surely mental energy is not what is meant in the following paragraph, "In defæcation, when all the nerve energy of the cord is directed into one channel . . ." (Verdon, "Angina Pectoris," Brighton, 1920, p. 357). The late Sir William Osler wrote: "An organisation which is defective in what, for want of a better term, we must call nerve force . . ." ("Principles of Medicine," 1895, p. 1032).

Prof. Halliburton, in reviewing von Monakow's "Die Lokalisation im Grosshirn" (*Physiol Abst.*, Nov. and Dec. 1918), thus expressed himself, "The introduction of a change in the quantity of nervous energy (Hughling's Jackson) passing over a given system of Conduction paths . . ." In his "Text-book of Physiology" (London, Churchill, 1912, p. 1211), Prof. Starling wrote: "During the second stage (of asphyxia) there is a discharge of nerve energy which spreads throughout the whole central nervous system, beginning in the Bulbar Centres . . ." In none of these quotations is it a synonym for mental energy, unless, perhaps, we except Osler's use of it.

(To recognise "mental energy" as a real existence in the sense of being a *vera causa* of neural processes is, I believe, necessary, but it involves grave difficulties both in psychology and metaphysics.)

The authors just quoted are surely not indulging

in metaphors; they evidently have something quite definite before them which they believe is conveyed to their readers. Is it what other writers, *e.g.* Sir Frederick Mott, would call innervation? Apparently so, for he writes in "The Brain and the Voice in Speech and Song" (*Harper's*, 1910) of "innervation currents." Now currents must be real, must be a flowing of something.

Clinicians—neurologists—believe in nerve energy, but apparently they do not derive their belief from their physiological teachers, for, according to McDougall, "the professional physiologists refer to it (nerve energy) contemptuously as a survival from the Dark Ages." Without doubt, something here is in need of being cleared up.

The intelligent layman thinks there *is* such a thing as "nerve energy," physicians use the term constantly, some professional physiologists use it when they find it convenient, and yet Dr. Adrian assures us that "as a physiological concept, 'nerve energy' has little to recommend it." If that is so, it is unfortunate the term is so popular. Dr. Adrian, however, concedes that "If the term 'nerve energy' is to be retained, it might be used to mean the total potential energy in the neurone available for use in the transmission of impulses."

This definition is so broad that it would cover (as it should) such cases of innervation as cerebellar control of other nerve centres, as well as unconscious cerebral inhibition of certain lower centres, neither of which could be called mental energy.

This is all that is wanted as a beginning of the clearing of the air. In this sense, nerve energy is real. I had only suggested it might be measured in order, if possible, to satisfy the demand that as a form of energy it should be measured.

It now remains for some physiologist to discuss the reality of nerve energy by defining the concept, relating it to nerve impulses and to innervation-processes, and placing the term in his index. Then the neurologist and psychopathologist would know whether he was using the term nerve energy in the same sense as that in which other men of science use it. In time, something more definite than at present would filter through to the laity.

D. FRASER HARRIS.

Dalhousie University, Halifax, N.S.,
October 11.

### Habits of *Echinus esculentus*.

IN the October issue of the Journal of the Marine Biological Association, Miss Trewavas records the occurrence of *Echinus esculentus* between tide-marks on the Cornish coast and makes a request for information "of the occurrence or absence of this sea-urchin between tide-marks at other parts of the British coast."

In this district *E. esculentus* occurs abundantly between tide-marks in spring and early summer, on rocky coasts; a few may be found at almost any other season. About February or early March a shoreward migration seems to set in, so that in suitable weather conditions some hundreds may be collected at springs between April and June. Then their abundance decreases until about November, from when until January it is at a minimum. This inshore vernal maximum is coincident with the spawning season; ripe individuals being found from February to August with a maximum occurring in early May. A similar shoreward spawning migration occurs in other, chiefly Boreal, species—*Solaster papposus, S. endeca, Henricia sanguinolenta, Archidoris tuberculata, Jorunna Johnstoni, Aeolidia papillosa, Leander squilla, Spirontocaris pusiola,* and doubtless various other species.

The presence of *E. esculentus* between tide-marks is strongly influenced by various conditions—*e.g.* (1) in April 1921 a spell of sharp frosts caused numerous urchins which had invaded the intertidal zone to retire to deeper water, where they were visible in abundance in 1-2 fms.; (2) during the hot spell of May and June 1921 they were unusually scarce between tide-marks; (3) in April 1922 a spell of heavy weather either washed away or caused a temporary seaward movement of urchins from the intertidal area, and further, although they had also been abundant in 1-2 fms., none were to be seen there, all having apparently retired into the shelter of crevices and boulders. There is some evidence that males approach the shore ahead of the females. While inshore, urchins feed very largely on barnacles.

On an average the life of *E. esculentus*, as an urchin, begins about midsummer: the first months are spent in the Laminarian zone browsing freely on such limy food as Membranipora; by the end of the calendar year some are well over 2 cms. in diameter and at the close of their I.-year period about 4 cms., the more advanced having spawned about May at an approximate age of 10-12 months. The II.-year group appear to range between 4-7 cms., the III.-year group 7-9 cms., and the IV.-year group 9-11 cms. Largely owing to the prolonged spawning period there is no discontinuity between the year groups, which merge into one another. The adults feed on Polyzoa, Laminaria—particularly if encrusted with Membranipora,—balanids, etc. In October urchins are found with large gonads rich in fats; an occasional one may have a few immature ova. The yearly cycle would seem to be:

July–November—Growth and fattening of gonads—Laminarian zone offshore.

December–March—Maturation of gonads—Laminarian zone offshore.

April–June—Spawning—largely inshore.

RICHARD ELMHIRST.

Marine Biological Station,
Millport.

### Perseid Meteors in July 1592.

MAY I bring it briefly to the notice of readers of NATURE that there is apparently a reference in the history of Akbar, the Emperor of India, to a brilliant display of Perseid meteors in the Panjab about the end of July 1592. The passage occurs in the account of the 37th year of the reign, and just before the description of Akbar's expedition to Cashmere.

Akbar and his son Daniel had left Lahore and crossed the Rāvī, and were encamped at a garden called the Rāmbārī. On the 27th day of Tīr O.S., which might correspond to about July 28, 1592, three hundred little stars or pieces of stars (*sitāracha*) were seen traversing the heavens from west to east. The Persian text does not say whether this was in the day or in the night, but presumably it was the night or at least the evening, for the meteors would not be visible during the day.

Akbar and his son were so alarmed at this appearance, which took place three days after their departure from Lahore, and while they were still encamped at Rāmbārī, that they at once consulted the astrologers who were with them in the camp and by their advice broke up their camp and returned to Lahore. Nor did they resume their march till about a fortnight later and after they had ascertained a more auspicious day for a start.

Perhaps the phenomenon was not seen in England or even in Europe. The night may have been foggy, or the transit of the meteors may have taken place in the daytime there.

It does not seem impossible that Shakespeare may have heard of the display from sailors and other travellers in the east when he wrote about the close of the sixteenth century of certain stars shooting madly from their spheres. H. BEVERIDGE.

53 Campden House Road, W.8,
October 26.

### Skin Effect in Solenoids.

SKIN effect in long, single layer solenoids wound with solid round wire and used at very high frequencies has been treated by Sommerfeld,[1] Lenz,[2] and Abraham, L. Bloch, and E. Bloch.[3] (The frequency is supposed so high that the Rayleigh approximation applies.)

The last of these disagrees with the first, giving the ratio of the resistance of a closely wound solenoid to the resistance of the wire of the solenoid when stretched out straight and used at the same frequency as equal to 3·73, while Abraham, L. Bloch, and E. Bloch obtained 3·46. The writer calculated the same ratio by a different method and obtained $23{\cdot}4 \pm 0{\cdot}02$. Going through the calculation of Sommerfeld and correcting for an error in the graphical evaluation of the area under Sommerfeld's curve, the same result (3·41) is obtained by Sommerfeld's method. For loosely wound solenoids the calculations of Abraham, L. Bloch, and E. Bloch, Lenz, and the writer are in fair agreement.

On reading this letter Prof. Sommerfeld has informed the writer that he agrees with this conclusion.

G. BREIT.

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Harvard University, U.S.A.

### Colour Vision and Syntony.

AFTER reading the letter of Dr. Edridge Green (NATURE, October 14, p. 513) it occurred to me that the following method, involving no head movement, of observing the movement of positive retinal "after images" might be of interest. If, in a dark room, the eyes being in a state of "dark adaptation" and one covered, a dry petrol lighter of the spring release type be flashed, a fan-shaped pattern of brilliant streamers will be seen. This pattern is followed by a similar "after image." The "after image" immediately begins to contract. This contraction continues till the after image appears as a rather thick irregular line of smaller area and greater brilliancy than the original pattern. The rapidity of the change, and the final form varies for different parts of the retina. Two points are of interest, the contraction of the image, and the increase of brilliancy.

H. S. RYLAND.

London, S.E.,
Oct. 16.

### Mosaic Disease in Plants.

THERE has been considerable speculation recently upon the cause of the so-called 'virus diseases," which occur in both animals and plants, such as typhus and Rocky Mountain fever in man, and "mosaic" disease in plants. These diseases are supposed to be due to the presence of some ultra-microscopic filter-passing organism. Many small bodies, some of a granular nature, have been described in connexion with these disorders, such as Rickettsia, Negri bodies, etc. As regards the mosaic disease of plants, L. O. Kunkel, a worker in Hawaii, last year demonstrated the presence of a peculiar body of amœboid appearance in the diseased cells of maize affected with mosaic.

The purpose of this communication is to place on record the discovery of apparently similar bodies in the tissue of potato plants affected with mosaic, a disease which, so far as the potato is concerned, has become of considerable economic importance. No attempt is made at present to define the nature of this body, but it is hoped that further work may throw more light on the subject. All that can be said is that there is invariably present in the cells of mosaic potato tissue, in close association with the nucleus, an abnormal body which is definitely connected with the disease. Preparations showing these bodies were demonstrated at a recent meeting of the Association of Economic Biologists in London.

KENNETH M. SMITH.

The Victoria University of Manchester.

### Einstein's Paradox.

IN his review of Bergson's new book (NATURE, October 14) Prof. Wildon Carr refers to "Einstein's paradox," which he quotes in inverted commas as follows :—"Suppose a traveller to be enclosed in a cannon-ball and projected from the earth with a velocity amounting to a twenty-thousandth of the velocity of light; suppose him to meet a star and be returned to earth; he will find when he leaves the cannon-ball that if he has been absent two years, the world in his absence has aged two hundred years." It so happens that a paradox of this identical kind was proposed to Einstein himself by M. Painlevé at the Paris conferences in April of this year. Unless I have greatly misunderstood Einstein's reply, as recorded by M. Nordmann in the *Revue des Deux Mondes* of May 1, this particular paradox, arising from the imaginary departure and return of an observer travelling with great speed from a given point and back again, was shown to be one not legitimately derivable from the restricted theory—the theoretical construction is not one to which the transformation formulæ can properly be applied (pp. 146-152).

The humble student of relativity is therefore in the position of a schoolboy who finds that what he learns from one master to-day is contradicted by another to-morrow. Bergson and Nordmann both speak with Einstein's voice; but whereas the former apparently puts the paradox before us categorically as an inescapable Einsteinian fact, the other represents it as a non-Einsteinian fiction. Which of these two views are we to accept? They cannot both be true. Einstein, as quoted by M. Nordmann, advanced good reasons for putting the paradox out of court; but as Bergson was present at some at least of the conferences it appears that these reasons did not seem to him to be convincing.

There is a certain indefiniteness of phrase about the paradox as quoted above which gives rise to doubt. The only observer mentioned is the traveller in the cannon-ball; and it is quite overlooked that he would naturally expect the difference between his time and earth time to be in exactly the opposite direction—he would expect earth time to have advanced by only one-hundredth of his own time.

[1] A. Sommerfeld, "Über den Wechselstromwiderstand von Spulen," *Ann. d. Phys.*, 329, p. 609, 1907.
[2] W. Lenz, "Über die Kapazität der Spulen und deren Widerstand und Selbstinduktion bei Wechselstrom," *Ann. d. Phys.*, 342, p. 923, 1912.
[3] H. Abraham, L. Bloch et E. Bloch, "Radio-télégraphie militaire," 1919, E.C.M.R. Report No. 4629.

If the traveller happened to be a relativist, his faith in the transformation formulæ would receive a rude shock when, instead of the seven and a half days he had calculated, he found on returning that the earth had aged no less than two hundred years.

There is also an obvious slip as regards the speed necessary to produce so large a difference in computed time (assuming the paradox to stand good). An observer travelling out and back with a velocity of one twenty-thousandth the velocity of light, or 9·3 miles per second, would only expect a difference of *one-twelfth of a second* in either direction between his own time and earth time after two years.[1] This is perhaps fortunate for us, as the earth travels with twice this velocity, or 18·5 miles per second in its orbital course. The cannon-ball would indeed have to be projected with a velocity of *within* one twenty-thousandth of the velocity of light, *i.e.*, $v=c(1-1/20{,}000)$ or with the incredible speed of about 185,990 miles per second, to produce the result stated.[2]

This, however, which is plainly only a *lapsus calami*, is of small importance. The difficulty is created, not by the magnitude of the paradox, but by its existence, and the contradiction it opposes to common sense. If true, it throws the whole relativity doctrine into the lap of metaphysics, from which, if we are to believe M. Nordmann, Einstein was determined to rescue it. "La théorie d'Einstein est née de problèmes posés par l'*expérience*. Elle est née des faits, et son auteur insiste avec beaucoup de vigueur sur ce point. . . . Elle est tout le contraire d'un système métaphysique" (p. 134, *loc. cit.*). Obviously this paradox, in any of its forms, can never be subjected to the test of experiment; and as it is a fundamental principle with Einstein that nothing must enter into his theory (and therefore that nothing must interfere with his theory) that cannot be so tested, is not the difficulty thereby automatically ruled out of consideration? These are deep waters, into which a sciolist like myself has to venture carefully, even when it is done of necessity, by way of question, in search of information from competent authority.

H. C. BROWNE.

Dublin, October 26.

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THERE is, as Mr. Browne points out, a *lapsus calami* in my quotation. The supposed velocity of the cannon-ball is, not a twenty-thousandth of, but less by about a twenty-thousandth than, the velocity of light. It is an often-quoted paradox, which I heard for the first time from M. Langevin in his address to the Philosophical Congress of Bologna in 1911, and the discussion of it occupies a large part of M. Bergson's book. With regard to the paradox itself, it is, as Mr. Browne very well points out, not a paradox for the relativist but an illustration of the consequence of rejecting the principle of relativity. In exactly the same way Zeno's paradoxes were not paradoxes for Zeno but arguments for his doctrine that nothing moves. The principle of relativity is that it is possible to pass to a completely different frame of reference without breach of continuity, provided that the space-time coefficients vary to maintain the ratio constant. The paradox shows the form which the breach of continuity will assume if with common-sense we suppose the change of the system of reference not to be compensated by a variation in the space-time co-ordinates. There are, in fact, two alternatives. I may conceive my traveller retaining the dimensions of his old system in his new system, then he will become a kind of ephemeral insect or microbe in his new environment, for his proportions will be incommensurate with his old proportions; or, I may conceive him automatically shrinking or expanding in his dimensions proportionately to the change in his environment, then, however much the system changes, he can never become aware of it. This is what I referred to in my article as the relativity of magnitudes. The paradox disappears in the principle of relativity; it arises because common-sense is accustomed to the view that space and time are constant and invariable.

H. WILDON CARR.

November 1.

[1] Taking $c=1$, and $v=1/20{,}000$,

$$t=t'\div\sqrt{1-1/400{,}000{,}000}=t'(1+1/800{,}000{,}000+\text{a negligible}),$$

when $t'=2$ years, $t=2$ years $+\frac{63{,}072{,}000}{800{,}000{,}000}$ seconds, or $t-t'$ is less than 1/12 second.

[2] $c=1$, $v=1-1/20{,}000$. $1-v^2=\frac{1}{10{,}000}$—a negligible, or $\sqrt{1-v^2}=\frac{1}{100}$. Therefore $t=100t'$.

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### Waterspouts.

CORROBORATING the letter of Dr. G. D. Hale Carpenter in NATURE of September 23, p. 414, reference may be made to a note in *Monthly Weather Review*, 43, p. 550-551, 1915, where a funnel or pendant seen near Cape San Lucas, Lower California, is described and sketched; the sheath or sleeve seen by Dr. Hale Carpenter was very striking. The phenomenon was under observation a considerable time.

Also, the following from my note-book on an observation made in Manila, P.I.:

"*1919 V. 24 d. 6 h. 15 m.* P.M.—Under a thunderstorm developing in N., from my window I saw a small tornado funnel stretching downward in N.W., obliquely toward W. or S.W. It did not reach halfway to earth; the sun was so low that a flood of yellow light poured horizontally under the cloud, and the funnel was brilliantly lighted. The figure and description given in my note, *Monthly Weather Review*, November 1915, apply excellently, except that the brighter illumination brought out the hollow core better. The distance was greater, so that I could not very well make out the lattice pattern."

This one showed the sleeve or sheath very well. Another, mentioned in the same note in the *Monthly Weather Review*, a gauzy but large waterspout, extending clear to the water, and causing there a great powder-puff of spray, did not show the sleeve at all. (This was near San Salvador, in the Bahamas; the position given by latitude and longitude is quite wrong, inserted by some other hand.)

WILLARD J. FISHER.

Cambridge, Mass., October 16.

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### Tables of the Incomplete Gamma-Function.

I SHOULD be greatly obliged if you could allow me a little of your valuable space to state that Dr. J. F. Tocher has kindly pointed out an error in my Introduction to the above Tables. In a table on page xx the wrong argument has been inserted to the correct value of the function.

An errata slip has now been issued, and will be inserted in all future volumes sold. This slip will be supplied by the Sales Office, H.M. Stationery Office, Princes Street, Westminster, to all past purchasers of the work, and is arranged so that owners of the Tables can paste them over the offending matter.

I can only apologise sincerely to purchasers of the book for this inadvertency.

KARL PEARSON.

Department of Applied Statistics,
University of London, University College, W.C.1.

## The Nitrogen Industry.

By Prof. C. H. DESCH.

THE discussion on the nitrogen industry, organised by Section B (Chemistry) of the British Association at the Hull meeting, proved to be a great success in spite of certain obvious difficulties in the way of such a discussion at the present time. There are many processes in the field for the fixation of nitrogen, and commercial rivalries make it impossible to secure completely frank and unbiassed accounts of the merits of the various systems. Much information of great scientific value has, for commercial reasons, to remain unpublished. The Section was therefore fortunate in obtaining a general survey of the subject from Dr. J. A. Harker, whose experience in this field during and since the war was exceptionally great, his practical acquaintance with most of the competing processes enabling him to take an impartial view of many controversial matters. His paper makes it easier for chemical readers to judge of the value of statements appearing in the technical periodicals and in the popular Press. According to Dr. Harker, there is little to be added in the way of statistical material to the Report of the Nitrogen Products Committee published some eighteen months ago, while the fluctuations in the German exchange make it quite unprofitable to discuss German conditions of production or the possibility of dumping, topics which would otherwise have been attractive to the author of such a paper. The nitrogen question has attracted so much public attention that it has even found its way into school examination papers, although profound ignorance on the subject prevailed five or six years ago, not only among the general public, but also in the circle of high officials directly concerned with questions of national importance.

The oldest process for the synthesis of nitrogen compounds from atmospheric nitrogen is that which employs the electric arc. The great plants in Norway, of immense size and working with the greatest success, are avowedly derived from the laboratory apparatus of the late Lord Rayleigh, and Prof. Birkeland stated that his decision to establish the process as an industrial one was based on the famous presidential address to the British Association by Sir William Crookes. Lord Rayleigh's experiments included the measurement of the relation between the energy consumed and the nitrogen fixed, and it is a striking fact that even now less than two per cent. of the energy of the average arc furnace is absorbed as chemical energy in the initial oxidation of the nitrogen. The modern plants are of enormous size, the two plants at Rjukan, for example, employing a total of 200,000 kilowatts, generated at an astonishingly low cost by means of water power. Several modified arc processes have been tried experimentally, including the Kilburn Scott three-electrode furnace. The use of enriched air has been tried on a large scale by a company having works in Switzerland and Germany, a closed circuit being used, and the nitrogen peroxide removed by cooling instead of absorption. This operation is not free from danger, and serious explosions have taken place. The arc furnace plants erected in France during the war have been closed, the power plants being required for their original purpose, the electrification of railways.

Of the many processes for the production of synthetic ammonia, the original Haber process, the most familiar of all, has been successfully worked by the Badische Co. at Oppau, and at the even larger works recently completed at Merseburg in Saxony. The pressure in this process is 200 atmospheres, which is not now regarded as high, and the gases move slowly through reaction vessels 40 feet long and 3 feet in external diameter, the walls being 6 inches thick. The gases are pre-heated and circulated. The process worked out at University College, London, by the Nitrogen Products Committee uses higher gas velocities, and was planned to yield about 5 kgm. of ammonia per hour for each litre of space filled with catalyst, instead of 400 gm. as in the Haber system. The first American plant at Sheffield, Alabama, used activated sodamide as the catalyst, but it is not surprising, in view of the action of water vapour on this substance, that it proved a failure; the later modified plant of the Solvay Process Co., now making liquid ammonia for the refrigerating industry, has avoided the defects.

The Claude process uses very high pressures of 900-1000 atmospheres, and the issuing stream contains as much as 25 per cent. of ammonia. Circulation is replaced by multiple stage working, and the reaction vessels, made by a Sheffield steel firm from a special heat-resisting material, are surprisingly small. Hydrogen is to be produced by an improved process from coke oven gas. Electrolytic hydrogen is used on several plants, notably at Terni in Italy, and it seems likely that where water power is cheap, hydrogen can be economically prepared by this means, provided that the form of the cell can be improved.

Cyanamide, regarded by some as obsolete, remains the cheapest form of combined nitrogen, but in spite of this, many of the war works using this process have been closed. The largest plant is that of the American government at Mussel Shoals, the future of which is still uncertain. The German cyanamide plants are being increased in size. A disadvantage of this compound for agricultural purposes is that it is liable to change into dicyandiamide, but attempts are being made to convert it into other more valuable compounds. One American company is converting it into a mixed fertiliser, ammonium phosphate, which is useful but at present too costly. In Switzerland the calcium cyanamide has been converted to free cyanamide by carbonic acid, and then into urea. Mixed with monocalcium phosphate, a product known as phosphazote is obtained, and this substance is used for vines, the cost not being high. Mixed salts containing ammonium nitrate have suffered in popularity through the Oppau explosion, but the use of powerful blasting cartridges, which caused that explosion, is indefensible.

The cyanide process, the oldest of all nitrogen fixation processes, is in use in America for making the acid for plant fumigation, and researches are in progress with the object of cheapening the manufacture.

In concluding his paper, Dr. Harker directed atten-

tion to the large increase in the German capacity to produce synthetic nitrogen compounds, and the erection of new plants in that country. At the end of this year Germany will be independent of all importation of nitrates, while the large munition works in this country are being dismantled. The subject, therefore, has political importance as well as scientific and commercial interest.

Mr. J. H. West's paper dealt with the manufacture of the nitrogen and hydrogen required for synthetic ammonia processes. Three volumes of hydrogen being required for one of nitrogen, and the former being the more expensive gas, the cost of the process depends mainly on that of the hydrogen. The electrolytic process is convenient, and yields pure hydrogen, but the capital cost of the plant is high, and the method is only practicable where cheap hydro-electric power is available. Coke oven gas may be used, the method employed being that of liquefying all the gases present except hydrogen, but in this case the small quantity of carbon monoxide which always remains mixed with it must be removed by chemical washing or by conversion into methane, the gas being a poison to the catalyst in the subsequent ammonia synthesis. Water gas may be used, a reaction with steam being brought about in presence of a catalyst: $CO+H_2O=CO_2+H_2$. In a modified process, due to the author and A. Jacques, the coal is treated by a process of complete gasification, and the gaseous products treated in the same apparatus to yield carbon dioxide and hydrogen with a catalyst. Nitrogen is made by the liquid air process, or by mixing air and hydrogen in such proportions that on passing over a suitable catalyst the oxygen is converted to water, and a mixture of nitrogen and hydrogen in the required proportions remains. In the Haber process, water gas and producer gas are mixed in such proportions that a correct mixture is left after removal of the carbon monoxide.

Both this paper, and the succeeding one by Mr. C. J. Goodwin, were presented in the absence of their authors, so that they suffered in the discussion. Mr. Goodwin described the Häusser process for the production of nitric acid by exploding nitrogen and oxygen with a fuel gas in a bomb. Although the plant has hitherto been on an experimental scale, it is expected that the new bombs of 1200-1500 litres capacity will give commercial yields, and the use of stainless steel has overcome much of the corrosion difficulty. The absorption towers have been greatly reduced in size by employing nickel-chromium steel or silicon-iron for the vessels, under a pressure of 2·5-4 atmospheres. The suggestion has been made that a special gas engine or Humphrey pump might be used in place of a bomb, in order to utilise the heat energy of the fuel more economically, but it remains to be seen whether such a change would prove advantageous on the whole. The main advantage of the process is its compactness, the size of the plant being small, especially when gases of high calorific value are used.

Dr. E. B. Maxted's contribution concerned the question whether nitrogen fixation, based on water power, could be economically undertaken in this country. Under present conditions, there are several sites in these islands where it should be possible to produce hydro-electric energy for 4*l*.-5*l*. per kilowatt-year, the greater part of this sum representing interest on the capital cost. This would allow of the production of electrolytic hydrogen at a cost of 1*s*. 7*d*. per 1000 cubic feet, which does not compare unfavourably with the cost of hydrogen from fuel. Greater economy would be effected if uses for large supplies of oxygen in the chemical industries could be found. Comparing together the ammonia and cyanamide processes, it appears that a given amount of power, say 10,000 kilowatts, being available, either process would result in the fixation of about the same quantity of nitrogen, but the ammonia process would yield large quantities of oxygen as a by-product, while the cyanamide process would require the bringing of anthracite and lime to the site. There would be some compensating conditions, such as the greater simplicity of the cyanamide process, and the necessity of fixing ammonia by means of an acid.

Mr. E. Kilburn Scott denied the contention that the arc process is uneconomical. It has been stated that in Norway nitric acid could be made profitably where electric energy costs 10*l*. per kilowatt-year, while the Scottish schemes can provide the same quantity for 4*l*. The arc process is the only one capable of utilising off-peak power, and where large generating stations are set up it is quite economical. Moreover, calcium nitrate is the best of all artificial fertilisers. Little else emerged in the discussion. It is clear that processes which promised well during the exceptional conditions of the war have to be re-examined very carefully in regard to their practicability under ordinary conditions of competition, and it has yet to be demonstrated that synthetic processes can be established successfully where power has to be obtained from the combustion of coal. Whatever may prove to be the future of these processes, Dr. Harker's review of the present position of the question will be of value, as an addition to the important memoirs already published from official sources.

## The Thermal Basis of Gas Supply.

By Prof. JOHN W. COBB.

THE amount of attention which has been given in the Press during the past few months to the new basis of charge for gas introduced by the Gas Regulation Act of 1920, is at first sight somewhat surprising and unexpected. To the scientific mind there seems to be so little in it that calls for mental strain in its comprehension, or for criticism in its introduction.

Gas is now to be sold at so much per therm, and the therm is simply 100,000 British Thermal Units—*i.e.* a convenient multiple of what is the most widely known and generally accepted unit of heat. A

decision having once been taken to charge for gas on a thermal basis, the choice of such a unit was natural if not inevitable. It is true that the justice of making the potential heat units in the gas the sole measure of its usefulness is not to be established completely by *a priori* considerations, although most of us would probably be inclined to look kindly upon the notion from the beginning. There are factors other than potential heat content which might help to determine the value of gas in use, and should, therefore, be considered, such as the temperature attainable on combustion. If these factors were of sufficient importance the assumption that thermal units alone could be rightly taken as determining price would be invalid and a different basis for charging necessary.

Such matters as these were, however, discussed at length in conferences called by Sir George Beilby for the purpose, before the Fuel Research Board made the recommendations to the Board of Trade on which the Act was based. At these conferences the experience and the judgment of gas users and makers were freely drawn upon, and the results of experimental work bearing directly upon the points at issue, made by the Joint Research Committee of the University of Leeds and the Institution of Gas Engineers, were considered. The result was an acceptance by all parties of the principle establishing a thermal basis for the sale of gas. It was accepted that the legislative control of the gas industry, necessary because it is a public service with certain exclusive rights, must be made more elastic in some fundamental respects if the gas industry was to be able to take advantage of technical developments presented to it, and to realise fuel and monetary economies, so obviously desirable at the present time for the public good and its own interests.

The magnitude of that industry and the national importance of improvements effected in it may easily escape notice. The gas industry does not dominate any particular town or locality in the same way that steel dominates Sheffield or Middlesborough, or cotton some of the Lancashire towns, but in estimating the importance of the industry it should be remembered that every city and town and many a village throughout the country has its gasworks, carbonising a total of eighteen million tons of coal per annum, and incidentally employing a capital of some 150 million pounds.

The greater elasticity of control to which reference has been made above included a permission to each company or authority to supply gas of the calorific value which it could produce most economically, although the calorific value being declared a close adherence to the standard was to be secured by systematic outside inspection and testing, in which the recording gas calorimeter was to play a prominent part. On this system one town may be supplying gas of 550 British Thermal Units per cubic foot, and another a 450 gas. Comparison of charges cannot be made fairly on the price per 1000 cu. ft. alone, but requires a correction for calorific value. Charging by the therm, *i.e.* by the potential heat units carried by the gas, simplified the matter by introducing a common denominator.

To Sir George Beilby and others, including the writer, there seemed to be no difficulty in such a change or objection to it from the consumer's point of view. In justice to the gas industry it may be said that when the matter was under discussion its representatives declared themselves as being apprehensive of the way in which this strange new mode of making out a gas bill would be viewed by some consumers, and, through the ministrations of a certain section of the Press, this apprehension seems to have been justified for the time being.

An explanatory pamphlet bearing "The Therm"[1] as its title has just been issued by the Department of Scientific and Industrial Research (to which the Fuel Research Board is attached) in which the reports of the Fuel Research Board on "Gas Standards" have been reprinted. It is issued at a very low price, presumably with the hope of securing many readers and of placing the public in a less confused state of mind on a question in which a large section has a very direct interest.

There is something to be said for this hope. The only fear is that these reports, although well and clearly written, are somewhat too technical in content and language for the layman. Moreover, although this does not affect the main issue, one disadvantage arises from the fact that although the operative Act is based upon the recommendations of the Fuel Research Board as detailed in the pamphlet, there are some points of difference between the two which might have been indicated.

But it is surely plain enough, answering the question usually asked, that no increase in a gas bill can be rightly attributed to the use of the therm as the basis of charge. If a consumer has burned 2000 cu. ft. of gas with a calorific value of 500 British Thermal Units per cu. ft. he has used 10 therms, and it is a matter of indifference whether he is charged 4*s.* 2*d.* per 1000 cu. ft. or 10*d.* per therm; the same volume and calorific value determine the sum in each case and he pays 100*d.*

It is true that according to the Act, when a gas-supplying company or authority comes under the new scheme an increase in price may be authorised by the Board of Trade "in order to meet unavoidable increases since the 30th day of June 1914 in the costs and charges of, and incidental to, the production and supply of gas by the undertakers," but that is another matter, and has nothing to do with the use of the therm as the unit of measurement.

Moreover, although it is possible such increase of price may be authorised as essential, in some cases and for the time being, to the stability of a service which must be maintained in the public interest, it is widely recognised inside and outside the gas industry that the full development of public gas supply, with all the undoubted benefits it can confer upon the community, can be attained only through the medium of a cheaper gas. In the opinion of the writer it is also true that, in spite of misleading indications of the moment, the Gas Act of 1920 with its thermal basis of charge is well calculated to stimulate a continuous and general movement in that direction which will become more apparent in the future.

[1] The Therm. Reports of the Fuel Research Board on Gas Standards. (London: Stationery Office, 1922.) 3*d.* net.

## Obituary.

### PROF. A. CRUM BROWN, F.R.S.

ALEXANDER CRUM BROWN was born at Edinburgh on March 26, 1838. His father was Dr. John Brown, minister of Broughton Place United Presbyterian Church; his mother was a sister of Walter Crum, a chemist of distinction. Educated at the Royal High School and at the University of Edinburgh, he graduated as M.A. in 1858 and as M.D. in 1861. In the following year he was awarded the D.Sc. degree of London, and thereafter studied in Germany under Bunsen and Kolbe. Returning to Scotland in 1863, he began his career in Edinburgh as an extra-mural lecturer in chemistry. For six years he taught small classes of medical students and busied himself with research. On the election of Prof. Lyon Playfair in 1869 to represent the University in Parliament, Crum Brown was appointed to succeed him in the chair of chemistry. The department placed under his charge was at first purely medical, but during his tenure it gradually changed its character, and at his retirement in 1908 had become one of the chief departments in the Faculty of Science.

Crum Brown was a man of extraordinary mental activity. The mention of a new subject sent his mind darting and exploring in all directions. In a few moments some pithy saying, some apt suggestion, or perhaps some awkwardly pointed question would be the outcome, showing his instantaneous grasp of the problem and his insight into its implications. That he was a pioneer far in advance of his contemporaries may be seen in the thesis which he presented at the age of twenty-three for the degree of Doctor of Medicine. It was entitled "On the Theory of Chemical Combination," and displayed such originality of thought as earned it a most discouraging reception, so that the author was deterred from publishing it at the time, and only printed it for circulation among his friends eighteen years later. Even to-day this thesis of 1861 bears a modern aspect, polarity and interatomic forces being at the basis of the presentation, and graphic formulæ being freely used. A pioneering research on the function of the semicircular canals in regard to the sense of balance and rotation, and another (in conjunction with Fraser) on the relationship between physiological activity and chemical constitution, illustrate his fertility of mind. Essentially of a speculative and philosophical turn, he yet invented many practical devices and supervised many practical researches. His name will always be associated with the rule for position isomers in benzene compounds and with the electrosynthesis of dibasic acids. He became a fellow of the Royal Society in 1879, and was an honorary graduate of all the Scottish Universities. During the years 1892 and 1893 he was president of the Chemical Society.

Apart from his chemistry, Crum Brown was of the widest general culture, and his mastery of languages assumed in Edinburgh circles almost legendary form. His business ability was utilised by his University, his church, and by the Royal Society of Edinburgh, of which he acted as secretary for a quarter of a century. In social gatherings he shone by reason of his wit and his gifts as a raconteur.

Two years after his retirement from University duties, his life was shadowed by the loss of his wife, a daughter of the Rev. James Porter, of Drumlee, Co. Down. Gradually failing bodily health confined him to the house for the past six years, but his mental ability remained unimpaired. His friends could always enjoy the refreshment of a talk with him—a talk sure to abound with quaintly apt stories and interesting reminiscences. After a few weeks' illness he died peacefully on October 28, the last representative of an academic period of singular brilliance.

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### PROF. J. P. KUENEN.

THE unexpected death of Dr. Johannes Petrus Kuenen on September 25, having taken away from the University of Leyden in the full vigour of life a beloved professor, who only a few days before was invested with the dignity of Rector Magnificus, means a heavy blow to his many friends and in particular to myself. Kuenen returned to Leyden sixteen years ago, and since that time I shared with him the laboratory where he was one of my first pupils. He was born in 1866 and matriculated in 1884 in Leyden, where his father, the celebrated critic of the Old Testament, was then professor. By a life of idealism according to a tradition handed down from father to son he fulfilled the expectations which he then awakened.

As early as 1889 Kuenen became assistant in my laboratory. In 1892 he took his degree on a gold medal prize paper, and in 1893 he lectured as a privat docent. His brilliant experimental researches opened to him a career in Great Britain. After having worked for a time in Ramsay's laboratory, he was appointed professor in Dundee. In a touching letter Sir James Walker tells me how he was struck by the tall and handsome young Dutchman, the first meeting being the beginning of a friendship for life. When we read in Leyden that Kuenen was from the first a success in Dundee, both with his students and his colleagues, that he contrived to do in very adverse circumstances a considerable amount of research work, and that Sir James Walker admired the simple way in which Kuenen overcame experimental difficulties, we see that his friends both at Dundee and Leyden have the same vivid recollection of him. And when Sir James Walker reminds us of Kuenen's genial manner, of his quiet humour in conversation, and of his singing Schubert's songs, it is as if we hear Kuenen here in the laboratory, and with deep mourning we recall the ennobling influence of his presence and the happiness he spread around him everywhere he went by his kind and sunny heart.

Having declined different calls from Holland he accepted that from Leyden in 1906, where he took upon himself the teaching of one of the courses to which Lorentz had consecrated a good deal of his precious powers. Welcomed here with the greatest joy, he immediately exerted a great influence on our scientific life. He earned the profound gratitude of his pupils and general admiration for his love for science, his deep learning and insight, modesty, and unselfishness. To his unlimited helpfulness we have all been

highly indebted, and myself more than any one else. He gave me all that a younger partner can give to the older one. He took an enthusiastic part in the development of the Leyden laboratory, where he was to take over my part of the work. The plans for the extension of the laboratory in which he had all the time worked in a very disadvantageous location, were all made in conjunction with him. It is a great pity that he has been taken away before the beautiful new buildings for his department could be opened. We had both assisted in the preliminary dedication by putting, according to local use, the flag on the roof.

His many-sidedness made him spread widely the benefits of science and of its culture. He wrote, *e.g.*, an extensive and most interesting history of the development of physics in Holland during the last 150 years.

The main part of Kuenen's work lies in thermodynamics. He wrote many papers on it and also lucid and comprehensive books treating the equation of state and the equilibrium of liquid and gaseous phases of mixtures. By his masterly repetition of Galitzine's experiments he much aided science, proving that they could be explained by the influence of small admixtures.

The great achievement of Kuenen was his fundamental work on gaseous mixtures. He was the first to fill out experimentally for a complete series of mixtures of two gaseous substances in different proportions, a surface diagram that can be considered as the analogue of Andrews' line diagram for a single substance. The genius of van der Waals, then depressed by deep mourning, took a new flight when he was asked to work out in connexion with Kuenen's measurements his theory of binary mixtures given before only in sketch. Kuenen discovered then retrograde condensation, and from van der Waals' more extended theory deduced a complete explanation of this process. I still hold in vivid remembrance how Kuenen, putting in action his magnetic stirrer, the simple but fundamental contrivance by which he succeeded in eliminating retardation, had the satisfaction of demonstrating to van der Waals the retrograde condensation, and of seeing van der Waals looking in deep reflection at the beautiful phenomenon, which at once put his theory beyond any doubt. An admirable interaction of Kuenen's experiments and van der Waals' deductions followed.

Kuenen's discovery of mixtures with minimum critical temperatures and maximum vapour pressures led to many important discussions on the properties of the transversal plait on the free energy surface for the mixtures. A happy extension of his research, partly with Robson, was the study of different pairs of substances, which are not miscible in all proportions in the liquid state. It brought experimental material for the investigation of the longitudinal plait in connexion with the transverse one, where the theory of plaits of Korteweg had to be combined with van der Waals' theory, forming an imposing whole, that showed the way in what seemed once a labyrinth. A posthumous work of Kuenen with Verschoyle and van Urk continuing the work with Prof. Clark on the retrograde condensation of mixtures of oxygen and nitrogen makes the last as well as the first of his papers belong to his great life-work. Kuenen leaves incorporated in science a diversity of images systematising in the light of theory the full life of concrete facts in a wide domain and constituting a lasting monument to his genius. H. KAMERLINGH ONNES.

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DR. ALBERT A. STURLEY, instructor in physics at Yale University, and formerly professor of physics in the University of King's College, Windsor, Nova Scotia, died in New Haven, Connecticut, U.S.A., on October 22, at the age of thirty-five years.

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## Current Topics and Events.

H.M. THE KING has approved of the following awards this year by the president and council of the Royal Society: A Royal medal to Mr. C. T. R. Wilson, for his researches on condensation nuclei and atmospheric electricity; and a Royal medal to Mr. J. Barcroft, for his researches in physiology, and especially for his work in connexion with respiration. The following awards have also been made by the president and council: The Copley medal to Sir Ernest Rutherford, for his researches in radioactivity and atomic structure; the Rumford medal to Prof. Pieter Zeeman, for his researches in optics; the Davy medal to Prof. J. F. Thorpe, for his researches in synthetic organic chemistry; the Darwin medal to Prof. R. C. Punnett, for his researches in the science of genetics; the Buchanan medal to Sir David Bruce, for his researches and discoveries in tropical medicine; the Sylvester medal to Prof. T. Levi-Civita, for his researches in geometry and mechanics; and the Hughes medal to Dr. F. W. Aston, for his discovery of isotopes of a large number of the elements by the method of positive rays.

THE Royal Swedish Academy of Sciences, Stockholm, has awarded the Nobel prizes for physics and chemistry for 1921 and 1922 as follows: Physics, 1921, Prof. Albert Einstein, Berlin, for his theory of relativity and general work in physics; 1922, Prof. Niels Bohr, Copenhagen, for his researches on the structure of atoms and radiation. Chemistry, 1921, Prof. F. Soddy, Oxford, for his contributions to the knowledge of the chemistry of the radioactive elements and the nature of isotopes; 1922, Dr. F. W. Aston, Cambridge, for his investigations of elements and isotopes with the mass-spectrograph. The Nobel prize for medicine is reserved for next year, and that for peace will be announced on December 10, the anniversary of the death of Alfred Nobel, when the prizes will be presented by the King of Sweden.

THE well-known periodical, *Curtis's Botanical Magazine*, which appeared regularly from its foundation in 1787 until the end of 1920, has now fortunately reappeared under new auspices. The first part of Volume 148 has just been published by Messrs. H. F.

and G. Witherby, for the Royal Horticultural Society, the new proprietors of this valuable publication, and the Society has been so fortunate as to secure Dr. O. Stapf, late Keeper of the Herbarium and Library of the Royal Botanic Gardens, Kew, as editor. The long connexion between Kew and the magazine will thus, we hope, be maintained in the future as in the past, and in fact the legend on the cover which states, "Hand-coloured figures with descriptions and observations on the Botany, History, and Culture of new and rare Plants from the Royal Botanic Gardens, Kew, and other Botanical Establishments," gives good assurance that this will be the case. Indeed it is difficult to imagine that a work of this kind, to be of real value, could be prepared without the close connexion with Kew being fully maintained. This part, the first of the new venture, is one on which the new proprietors as well as the editor and publishers deserve to be highly congratulated. The plates are beautifully drawn and are both accurate and artistic, while the colouring leaves very little to be desired. There is the same fidelity to botanical detail with which readers of the older volumes are familiar and which makes the plates of so much value. The drawings in this part are the work of three different artists, and we think it is not undue praise to say that they are worthy of the magazine in its best days. The beauty and fidelity of such plates as those of *Stapelia tsomoensis*, a very difficult subject; *Bulbophyllum triste*, a delicate and very remarkable orchid from India, and *Symphytum grandiflorum*, leave nothing to be desired. An ample description both in Latin and English accompanies each plate, and there is much additional matter of an interesting and very useful nature. The English descriptions might possibly be somewhat abbreviated and also some of the general discussion, but it is all of value and shows how much care and trouble the editor must have spent to produce the letterpress, which is a mine of useful information. A volume for the year 1921 to preserve the continuity of the magazine is being prepared by private enterprise.

THROUGH the courtesy of Admiral of the Fleet Sir Henry B. Jackson, chairman of the Radio Research Board under the Department of Scientific and Industrial Research, we are able to publish this week an article on "The Origin of Atmospherics" by Mr. R. A. Watson Watt, who is in charge of the Board's Research Station at Aldershot. The interesting results described will no doubt receive close attention from the scientific public. The members of the Radio Research Board and of its Sub-Committee on Atmospherics who are responsible for the investigations carried out at the Aldershot Station are as follows: *Radio Research Board.*—Admiral Sir Henry B. Jackson (chairman), Captain C. E. Kennedy-Purvis, Lieut.-Col. A. G. T. Cusins, Wing-Commander J. B. Bowen, Mr. E. H. Shaughnessy, Sir Ernest Rutherford, Sir J. E. Petavel, Prof. G. W. O. Howe, Mr. O. F. Brown, and Mr. L. C. Bromley (secretary). *Sub-Committee B on Atmospherics.*—Colonel H. G. Lyons (chairman), Prof. S. Chapman, Major H. P. T. Lefroy, Mr. A. A. Campbell Swinton, Mr. R. A. Watson Watt, Mr. G. I. Taylor, Mr. C. T. R. Wilson, Mr. H. Morris Airey, Dr. G. C. Simpson, and Mr. O. F. Brown (secretary).

AT a general meeting of the Royal Scottish Geographical Society, held on November 7, the Society's gold medal was awarded to Prof. J. W. Gregory, University of Glasgow, in recognition of the scientific importance of results obtained by him through explorations in Spitsbergen, Australia, East Africa, and South-west China.

THE Thomas Hawksley lecture of the Institution of Mechanical Engineers will be delivered at 6 o'clock on Friday, December 1, by Dr. T. E. Stanton, who will take as his subject, "Some Recent Researches on Lubrication."

MR. R. T. A. INNES, the Union Astronomer at Johannesburg, who is at present in Paris and will be in England in a few weeks' time, has had the degree of doctor of science, *honoris causa*, conferred upon him by the University of Leyden.

THE following new appointments in the Peabody Museum of Natural History have recently been announced by Yale University: to be director, Dr. R. S. Lull, professor of vertebrate palæontology; to be curator of mineralogy, Dr. W. E. Ford, professor of mineralogy, in succession to Prof. E. S. Dana, who has held the curatorship since 1874.

IN connexion with the Liverpool section of the Society of Chemical Industry a Hurter Memorial Lecture will be delivered at 8 o'clock on Wednesday, November 22, in the Chemistry Lecture Theatre of the University, Liverpool, by Mr. W. Macnab. The subject will be "Some Achievements of Chemical Industry during the War, in this Country and in France."

THE council of the Institution of Civil Engineers has made the following awards in respect of papers printed without discussion in the Proceedings for the session 1921–1922: A George Stephenson gold medal to Dr. B. C. Laws (London); Telford premiums to Prof. L. Bairstow (London), Dr. A. J. Sutton Pippard (London), Mr. E. A. Cullen (Brisbane), Mr. H. H. Dare (Roseville, N.S.W.), and Mr. F. W. Stephen (Aberdeen). And for papers read before meetings of students in London and the provinces: A Miller prize and the James Forrest medal to Mr. F. H. Bullock (Cardiff); and Miller prizes to Mr. J. G. Mitchell (London), Mr. A. G. M'Donald (London), and Mr. Harry Wolf (Manchester).

THE twenty-fifth annual Traill-Taylor memorial lecture was delivered by Dr. Reginald S. Clay at the house of the Royal Photographic Society on October 10, and is printed in full with numerous illustrations in the November number of the Society's Journal. The subject was "The Photographic Lens from the Historical Point of View," and the discourse is probably the most complete, if not the most extensive treatment of the subject now available. The lecturer referred to "two great inventions"—first, the anastigmats of Schroeder, Rudolf, and von

Hoegh, and second, the Cooke lens of Harold Dennis Taylor, and remarked that only time can show which of these has been of greatest value, and upon which, if either, the objective of the future will be based. He adds, "I do not think the great step which the Cooke lens marks is as well appreciated here as on the Continent . . . the Zeiss Unar and Tessar were based on the same principle as the Cooke lens. . . . Harting has also made several lenses which are modified Cookes."

THE Optical Society of America held its seventh annual meeting and exhibition of optical instruments at the Bureau of Standards, Washington, on October 25-28. Special sessions were arranged for the consideration of radiation, atmospheric optics, physiological optics, photometry, optical pyrometry and photography, and the whole process of manufacturing optical glass was available for inspection during the meeting. Reports of committees which have been considering the combination of the Journal of the Society with the Instrument Makers' Journal and the possibility of publishing a translation of Helmboltz's "Physiologische Optik" were received. Informal accounts of the present position of the work of the committees on nomenclature and standards of polarimetry, reflectometry, spectroradiometry, refractometry, visual sensitometry, optical glass and instruments, wave-lengths, illumination and photometry, photography, pyrometry, and spectrophotometry were also given. Visitors not members of the Optical Society were allowed at both meetings and exhibitions of apparatus.

THE annual report of the Chief Medical Officer of the Ministry of Health for the year 1921, recently issued, is entitled, "On the State of the Public Health." The death-rate for that year was 12·1 per 1000 persons living, the lowest on record; the birth-rate 22·4, a decline of 3·1 on the previous year. The infant mortality was 83 per 1000 births, a very low figure, though slightly higher than that of 1920. Of 1000 deaths from all causes, cancer accounted for 100, bronchitis for 73, pneumonia for 76, heart diseases for 117, and nervous diseases for 105. As regards infective diseases, no cases of plague, cholera, or typhus fever occurred, and influenza remained at a very low ebb during the greater part of the year, but 336 cases of smallpox were recorded. Only 12 new indigenous cases of malaria were detected, as compared with 36 in the previous year and 103 in 1919. Encephalitis lethargica increased, 1470 cases being recorded, as compared with 844 cases in 1920. Tuberculosis is decreasing, the number of cases notified being the lowest recorded. Much information is given on schemes for maternity and child welfare, on the prevention of venereal diseases, on the care and after-care of tuberculous cases, on the relation of food to health and disease, and on the medical and sanitary administration of the country.

IN *Scribner's Magazine* for November, Dr. George E. Hale describes the buildings now being erected in Washington for the National Academy of Sciences and the National Research Council. The architect is Bertram Grosvenor Goodhue of New York, and the sculptural decoration has been entrusted to Lee Lawrie. The complete plan is a hollow square with a frontage of 260 feet, the centre of which will be occupied by a domed hall surrounded by seven top-lit exhibition rooms. For the present only this central area and the front block are being erected. The two upper floors of the front block will contain the offices of the Academy and the Research Council; the entrance hall on the ground floor will be flanked by a library, lecture-rooms, and conference rooms. The central hall, though primarily intended for exhibits, will be capable of transformation into a lecture-room or meeting-room. The novelty of the scheme lies in the utilisation of the central space for a museum of discovery. Those natural phenomena which for the time being provide the chief fields of investigation, the apparatus for studying them, and the means by which fundamental discoveries in pure science are applied for the public welfare will all be demonstrated in a permanent but ever-changing exhibition, kept constantly up-to-date, and covering the whole range of the physical and biological sciences. At the same time the provision of a convenient and dignified headquarters for the National Academy and the Research Council will greatly assist those two bodies in their tasks of advising the Government and organising the scientific work and resources of the United States. The building will doubtless justify the title of Dr. Hale's article as "A National Focus of Science and Research."

THE annual report of the Lancaster Astronomical and Scientific Association has recently been received. The rules and regulations of the Association are such as could with advantage be imitated and followed by many other similar institutions up and down the country. It is apparently conducted entirely by honorary officials, and the motto borne by the Association is clearly the whole spirit of the work—"If we succeed in giving the love of learning, the learning itself is sure to follow"—Lord Avebury. The Association has a total of 281 members. Lectures are given monthly and they are of a scientific and educational character. Meteorology forms an important feature of the report. Monthly and weekly results from readings taken at the Greg Observatory are sent to the Meteorological Office and are used in the official publications. Mean values for each month throughout the year 1921 are given in the report for barometer as well as the extreme readings, the duration of bright sunshine and the number of sunless days. Monthly rainfall statistics are tabulated, and during 1921 the total measurement was 41·25 in., which fell on 194 days. Lancaster escaped the drought from which so many other places suffered, and the showers during the summer kept the ground from being dried up. The mean air temperature for the year was 50°·2 F., which is warmer than either of the two preceding years.

THE recently issued report of the museums of the Brooklyn Institute (N.Y.) for 1921 shows that the children are well catered for, not only in the delightful

Children's Museum, but also at the Central Museum. Here it is the higher grade schools that receive chief attention, and an attempt is made to correlate the demonstrations with their curriculum. Besides the classes at the Museum, full use was made of the collection of lantern slides, more than 2800 being sent out on loan. The department of ethnology continues to furnish suggestive material to the American clothing and allied industries; four rooms have been constructed and equipped for the increasing number of artists and manufacturers consulting these collections.

ONE way in which the Smithsonian Institution pursues "the increase of knowledge" is by exploration and field-work. A richly-illustrated pamphlet describing the work so accomplished during 1921 has been issued as Publication 2669. The prevailing high costs restricted the number of expeditions, but fourteen of the more important ranged from China to Chile and brought back large collections to the United States National Museum. Our own museums do their share of exploration, but the great advantage possessed by the museum at Washington is that it seems able to detail its own staff for this purpose. This is to the benefit of both the individuals and the eventual study of the collections. Dr. C. D. Walcott continued his exploration of pre-Devonian strata in the Canadian Rockies. Dr. Bassler collected fossils in Tennessee for study and for exhibition. Mr. Gilmore collected fossil vertebrates in New Mexico, and Mr. Gidley did the same in Arizona, California, and Nebraska. Dr. Hitchcock collected and studied grasses and bamboos in the Philippines, Japan, and China. Dr. Bartsch visited the Tortugas and the Bahamas in connexion with his breeding experiments on the mollusc Cerion. Dr. Aldrich was sent to Alaska to collect insects. Seven other expeditions were devoted to archæological field-work in the United States and Dominica, and on them also many members of the staff were engaged. The health and enthusiasm gained by this contact with Nature in the open air must be a great help to the workers during the rest of the year.

THE Geological Survey of South Africa has earned the thanks of a wide circle by publishing, as Memoir No. 18, "A Bibliography of South African Geology to the end of 1920" (Pretoria, 1922, price 10*s.* 6*d.*). Mr. A. L. Hall has undertaken what must have been an arduous task, and Miss M. Wilman has generously supplied him with the data collected by her since the publication of her "Catalogue of Printed Books, Papers, etc.," in 1905. The result is a clearly printed list, classified by authors, of 5794 entries, and covering even remarks put forward in the discussions that are so usefully printed in the Proceedings of the Geological Society of South Africa. The only slips that we have noticed are in one or two initials of authors, and here and there the omission of the place of publication or of a date. "Liège," which is used throughout, is of course a repetition of a common error. The whole question of a uniform system of abbreviations has still to be considered. "Jl." for Journal and "Ro." for Royal are unusual and unnecessary. "G.S., U.S.A." is misleading for a publication that has nothing to do with the senior Union across the Atlantic, and "Minn." means Minnesota and should not be used for Minneapolis. There should be no comma, though this has been systematically inserted, after the first "S" in "G.S.S.A." However, the complete list of serials quoted at the outset helps us over these small difficulties, and Mr. Hall's energy has cleared away a thousand greater ones from the path of the student of South African geology.

WITH the enormous increase in the production of petroleum and the widely different uses to which the commercial products are put, the various international congresses which met prior to the war, realising the importance of standard methods of testing, attempted to deal with the question internationally, but little practical success was achieved. With such products so many of the tests are empirical, depending, like the flash point and so-called viscosity, on the form of apparatus and conditions of testing, that standardisation is absolutely essential if the tests are to have real value. It remained for the greatest producing country, the United States of America, through that valuable body the American Society for Testing Materials, to accomplish successfully the work of standardisation of methods, and defining as accurately as possible the desired characters of the various products. In this country, which although not a producing country is one of the largest consumers and controls many important oil fields, the Institution of Petroleum Technologists decided last year that standardisation must be taken in hand, and at a meeting of the Institution on October 10 Dr. A. E. Dunstan gave a summary of the progress which had been made. Hearty support and assistance was given by all the Government Departments concerned with the use of oil products, and by the British oil companies, and co-operation with the British Engineering Standards Association, a body representing a most important section of users, has been arranged to deal with specifications. The work of standardisation has been divided between the six following sub-committees: naturally occurring bituminous substances (crude oils, etc.); distillates up to kerosene; kerosenes and intermediates; lubricants; liquid fuels; asphaltum and artificial residues. It is anticipated that the methods recommended will be issued early next year.

REFERRING to the article on "The Sense of Smell in Birds" in NATURE of June 17, Dr. B. S. Neuhausen, of Johns Hopkins University, Baltimore, writes to direct attention to a paper by Dr. H. H. Beck on "The Occult Senses in Birds" (*Auk*, 1920, xxxvii, 55). In this communication Dr. Beck gave an example of the great food-finding powers of carrion-eating birds. At a hunt, one frosty morning in Pennsylvania, a dog went mad and had to be shot: the body was thrown into a limestone sinkhole close at hand, where it was speedily located by turkey vultures, the nearest haunt of which was eight miles

away. One may readily agree with the author that a freshly killed dog would give off little odour at a temperature below freezing-point, and one must accept his opinion that the body was practically invisible in the hole; but there seems to be no conclusive evidence that the incident of the killing could not have been both seen and heard by the vultures. Dr. Beck's theory is that none of the ordinary senses suffices to explain events like this, and that some "occult sense," by which he means a sense not within the scope of our own subjective experience, must be invoked. He would have us believe that birds possess a special "homing sense" and a special "food-finding sense," while a "mate-finding sense" is mentioned as a third possibility. It seems more than doubtful, however, whether naming new senses adds anything to our knowledge of the subject. The idea of a sense has little meaning if divorced from the idea of a sense-mechanism, and a "food-finding sense" implies that food (a comprehensive term in the case of birds) is capable of acting as a direct and simple physiological stimulus through some unknown channel of perception which is independent of such more obvious properties of the food as its appearance and odour. Granted that birds have powers of perception transcending our subjective experience, it is surely more reasonable to attribute these to greater acuteness of the known senses than to imagine new senses for which no physiological basis can be suggested.

## Our Astronomical Column.

FIREBALL ON OCTOBER 31.—In daylight on the early evening of Tuesday, October 31, at 5.10, an unusually brilliant meteor was observed from various places in the south of England, including Neath, Hereford, Bournemouth, Goring, Witney, and on the eastern boundary of South Wales. The accounts of its appearance, while they all testify to the startling lustre of the object, are yet imperfect and inexact in describing the course it traversed. There were only a few of the brighter stars visible at the time. On the basis of the available data it is impossible to compute a perfectly satisfactory real path for the meteor, but it appears probable that the radiant point was at 194° +33°, and that during its luminous flight the meteor was over the region from Brecon to Wiltshire, the height declining from 65 to 29 miles. Further observations would be valuable.

SOLAR PHYSICS OBSERVATORY, CAMBRIDGE.—The ninth annual report of the Director of the Solar Physics Observatory has recently been issued; in it is described briefly the work done during the year April 1921 to March 1922. The observations of two novæ, Nova Aquitæ III. and Nova Cygni III. (1920), have been under discussion; those of the former are expected to appear in Parts 2 and 3 of vol. 4 of the annals, while the latter have been communicated to the Royal Astronomical Society (Mon. Not. R.A.S. vol. 82, p. 44). The well-known variable $\beta$ Lyræ has been investigated, and 64 spectrograms taken at Cambridge in 1921 and 96 taken in 1907 at the Allegheny Observatory are being reduced. It is stated that the indications of the results are that the system of $\beta$ Lyræ contains probably at least four components in relative motion. Three lines of work relate to the investigation of the circulation of the atmosphere of the sun. The first is a detailed discussion of the shapes of the clustered masses of flocculi, recently referred to in this column, showing that these masses are inclined at certain angles to the solar equator. The second is a study of the proper motions of the sunspots and the movements of zones of prominence activity; while the third is the determination of the solar rotation by the spectroscopic method, also recently described. The observations and experiments in the department of meteorological physics have been continued. It is interesting to note that the mounting of the three-foot reflector will be completed since the staging has now been finished.

THE METEORS OF THE PONS-WINNECKE COMET.—Mr. G. Shain, of Pulkovo Observatory, discusses this meteor swarm in *Astr. Nach.*, No. 5190, noting that the agreement of the radiant with that calculated from the cometary orbit indicates a common tangent to the two orbits, but identity is only shown if they are found to have the same secular perturbations. It will be remembered that it was in this manner that Prof. J. C. Adams showed that the period of the Leonids must be about 33 years. Since the meteors seen in June 1916 were 10 months behind the comet, their perturbations by Jupiter in the ensuing revolution were different; the meteors made their nearest approach to Jupiter (distance 0·719) in mid-May 1918. The following are the calculated perturbations between May 1917 and May 1919: $\Delta\Omega$ − 65′·9, $\Delta i$ +41′·5, $\Delta\pi$ +59′·5, $\Delta\mu$ − 13″·5, $\Delta\phi$ − 45′·5, and $\Delta q$ +·047. The date of the chief display went back from June 28, 1916, to June 27, 1921, in good agreement with the above change of the node. The comet itself went still nearer to Jupiter than the meteors and suffered larger perturbations. Mr. Shain considers that the indications are all in favour of connexion between the comet and meteors, and notes that a similar shower was seen in early July 1867, 1868, 1869, 1872 by several observers.

KALOCSA OBSERVATIONS OF PROMINENCES.—The Rev. B. G. Swindells, S.J., gives a useful summary in the *Observatory* for October of the work on prominences by Father J. Fenzi at Kalocsa from 1886 to 1917. The curve of prominence activity is synchronous with that for the spots, but the distribution is different. At minimum the chief prominence-development is in latitude 50°. There are none at the poles and few at the equator. The prominence-zone extends towards the poles as maximum approaches and, for a short time at maximum, the poles are the seat of greatest prominence-activity. But a state of quiescence soon returns at the poles, not to be disturbed for nearly 11 years. It is as though two waves of activity start from lat. 50°, one filling the equatorial gap, the other approaching the poles from all sides, so that there is a great heaping-up there, which soon collapses again. While these changes are different from those of the spots, they accord with the changes in the coronal rays, so that the latter appear to be closely connected with the prominences. In some eclipses coronal arches have been seen surrounding prominences, which is a further argument for connexion. It is not difficult to imagine that the more finely divided matter expelled in a prominence-eruption should rise to a great height under such influences as light pressure and electrical repulsion.

## Research Items.

THE MAORI MODE OF DRILLING.—In the last issue of the *N.Z. Journal of Science and Technology*, Mr. Eldon Best, of the Dominion Museum, contributes an article on the methods of drilling used by the Maoris. The type of drill formerly used by them was the cord drill, which was used in ancient days in India and is still employed in making the sacred fire. The pump drill and bow drill were unknown to the Maori in pre-European times. The European form of pump drill was introduced by the early European settlers. Had the Maori known the pump drill in former times, it would have been the free-bar drill used by the nations of the western Pacific. The pierced-bar form was not known in that region in ancient times, but was introduced by early European visitors and residents. Mr. Best gives three photographs showing the present use of the drill for piercing blocks of stone.

RELATION OF TRANSPIRATION TO DRY WEIGHT IN TOBACCO PLANTS.—Many experiments have been made to determine the relation between the rate of transpiration in a plant during its growth and the dry weight and ash content of the resulting plant. Lawes made some experiments on the subject as early as 1849. In a recent paper Mr. N. B. Mendiola (*Philippine Journ. of Sci.*, vol. 20, No. 6) describes series of experiments with tobacco plants grown in water culture, to determine the effect of a dry or humid atmosphere and of light or shade. He concludes that there is no absolute correlation between the percentage of ash, the relative rate of transpiration of the plant during its growth, and the total dry matter produced.

PHOSPHORESCENT LIGHT OF FIREFLIES.—Ever since the classic experiments of Langley, the light of the firefly has attracted attention on account of its presumed high efficiency and the hope that we may ultimately be able to produce synthetically substances yielding useful phosphorescent light. Some experiments by Dr. H. E. Ives, summarised in the Journal of the Franklin Institute, show that the brightness of the firefly is about 0·014 lumens per sq. cm. This may appear so low as to be of little practical value in comparison with the brightness of a typical white sky (about 1 lumen per sq. cm.) and it is, of course, far below the brightness of most artificial illuminants. Yet if we could obtain such a steady brightness synthetically, and cover fairly extensive surfaces with the phosphorescent substance, it would be possible to obtain a serviceable illumination. The examination of the distribution of energy in the spectrum of the firefly is attended by great difficulty owing to the feeble nature of the light. Dr. Ives employed two methods, photography with panchromatic plates and "extinction of phosphorescence," and deduced that the radiation is confined between 0·5 and 0·6 $\mu$, which is the region of the visible spectrum where perception of light by the eye is most acute. His estimate of luminous efficiency is based partly on reasoning involving assumptions of the total energy of a glow-worm in relation to its weight, and is therefore somewhat dubious. But he conjectures that about 80 per cent. of the total radiated energy appears as visible light.

A NEW TEXTILE FIBRE.—The October issue of *Conquest* completes the third year of its publication, and throughout this period it has consistently carried out its purpose of setting forth the progress of science so far as it concerns our daily life. In this issue Mr. A. S. Moore directs attention to the possibilities of the new textile fibre "arghan," which Sir H. Wickham noticed in native use in South America and introduced four years ago into the Federated Malay States, where the authorities granted 30,000 acres for its cultivation. It is a plant of the pine-apple type, and its leaves split readily into fibres 5 or 6 ft. in length, which resemble silk and exceed the best hemp and flax in strength. It resists the action of sea water, and will be invaluable for nets and ship cordage; it spins and bleaches well and retains all dyes, and makes a firm cloth when woven either alone or in combination with cotton or flax.

INDEXING SCIENTIFIC LITERATURE.—We have received from the National Research Council of the United States the reprint of a paper by Mr. Gordon S. Fulcher on "The Indexing of Scientific Articles" which deserves notice. Mr. Fulcher does not appear to be well posted in the literature of his subject, for he places in one category the "International Catalogue of Scientific Literature," and the indexes of the H. W. Wilson Co., which are prepared on entirely different principles. For example under the scheme of "The International Catalogue" a paper on the flora of Formosa would appear under its author's name, the geographical area of its flora, and under the new genera or species described. Similarly a paper of anthropological interest would be classed under its period, locality, and subject matter. Mr. Fulcher's scheme is practically on those lines; but he goes one step further by advocating the elimination of the author and title of the paper and substituting a series of notes, dealing with the salient features of each paper, which are subsequently arranged for printing in alphabetical order. Our objections to Mr. Fulcher's system are as follows: It is "in the nature of real things to be inexhaustible in content," hence if bibliographical unities are disregarded the extent of analysis must be arbitrary, and uniformity of work and phraseology rendered very difficult. To bring it within the range of practice such a scheme must be a classification of original matter arranged under agreed subdivisions. Under Mr. Fulcher's scheme the same subject appears under two or more sub-heads, *e.g.* Nebulæ: origin-planetary, etc. Nebulæ: planetary-origin, etc. Neither, however, of the above methods are adapted to the indexing of scientific papers. The elimination of the author's name divests the paper of its proper authority; while the substitution of the analytical note for the author's title destroys the unity and purpose of the article. A minutely-classified file of excerpts from the scientific journals prepared by some central authority would undoubtedly prove of great national service, but an index prepared on Mr. Fulcher's lines would probably be seldom consulted.

COLOUR FILTERS IN MICROSCOPY.—Messrs. Kodak have just issued the sixth edition of their booklet on photomicrography. It has been revised so that it now deals with cut films instead of plates, bringing it into line with Messrs. Kodak's practice of making films only on account of the many advantages that they offer. It includes for the first time details of a set of Rheinberg's filters for differential colour illumination in microscopy. Although this method of illumination was introduced by Mr. Rheinberg some 25 years ago, Mr. Rheinberg says that this is the first time that the discs and rings have been made commercially in a suitable form and in suitable colours. The book gives within its 40 pages a great deal of information on the adjustment of the apparatus, the use and properties of colour filters of all kinds, exposure factors, and so on.

# The Origin of Atmospherics.[1]

By R. A. WATSON WATT.

THAT abnormal outbursts of atmospherics—the "$x$ storms" of the radio-telegraphist—were associated with convective weather was indicated by the work of the British Association Committee on Radio-telegraphic Investigations in 1914–15. That actual thunderstorms could be located by direction-finding on atmospherics was established early in a Meteorological Office investigation begun in 1915. But it has not yet been shown whether the fully developed thunderstorm is the only, a main, or merely a subsidiary source of atmospherics.

A critical examination of the data obtained in the Meteorological Office investigation referred to promises to throw some light on the question, and it has been thought desirable to give a preliminary indication of the evidence which is emerging.

The coastal direction-finding stations of the Admiralty co-operated in the investigation by reporting the apparent direction from which atmospherics were arriving whenever such a direction was observed, and when pressure of traffic permitted an observation.

Some twelve stations took part in this scheme, which began in March 1916. The examination of the results has been made for two years, April 1916 to May 1918. During this period there were approximately 1000 occasions on which three or more stations observed a direction of arrival of atmospherics within the same hour. On plotting these approximately simultaneous observations on a gnomonic chart, it is found that on almost exactly half of the occasions the three or more bearings gave an intersection in a point of a limited area, indicating a source of atmospherics at a point so determined. Actually the distribution of these intersections, according to the number of participating stations, is as follows :

| | |
|---|---|
| Six stations giving bearings meeting in a point (within the limits of accuracy of observation) | 2 |
| Five stations giving bearings meeting in a point (within the limits of accuracy of observation) | 15 |
| Four stations giving bearings meeting in a point (within the limits of accuracy of observation) | 68 |
| Three stations giving bearings meeting exactly in a point | 231 |
| Three stations giving bearings meeting in a point after adjustment within the limits of accuracy, assumed ± 5 degrees | 110 |
| Three stations giving bearings failing to meet in a point but delimiting a small area as source | 62 |
| Total number of locations | 488 |

The geographical distribution of these apparent sources of atmospherics is :

| | | | |
|---|---|---|---|
| England and Wales | 58 | Central Europe and Balkans | 12 |
| Scotland | 18 | Mediterranean and N. Africa | 44 |
| Ireland | 45 | Iceland and Atlantic | 9 |
| English Channel | 59 | Belgium | 7 |
| Bay of Biscay | 37 | Holland | 7 |
| France | 144 | Switzerland | 6 |
| Spain | 23 | | |
| Italy | 19 | | |

The comparison of these locations with meteorological data is a somewhat extensive investigation and is still in progress. In 288 cases, however, the immediately available data seemed to provide an adequate basis for discussion. In a relatively small number of cases only were thunderstorms found to have occurred in the region located as a source of atmospherics, and near the time of observation. Since the thunderstorm is a known source of atmospherics, it is not proposed to detail here these cases, particularly as it is necessary to search more closely for records of thunderstorms, which are notoriously sporadic phenomena, liable to slip unobserved through the open mesh of the network of observing stations.

Comparison was also made with the map in the British Daily Weather Report, which shows the area over which rain has fallen during the 24 hours, 7 A.M. to 7 A.M. In 239 out of the 288 cases, the apparent source of atmospherics was definitely associated with the rainfall area for the corresponding 24 hours. In 105 cases the source was on the advancing edge of the rain area, in 75 within that area, and in 59 cases it was on the rear edge. Of the remaining 49 locations, 30 were found to fall in places where thunderstorm or squall phenomena had been reported about the same time.

Thus in only 19 of the 288 cases, *i.e.* in 6½ per cent., has no meteorological relation with the source of atmospherics yet been traced, while it is also noteworthy that 10 of these 19 fell in the least trustworthy class of location, the three bearings delineating an area not negligibly small.

One is therefore faced with the alternative conclusions that—

(1) Rainfall, without the occurrence of a fully developed thunderstorm, is an important source of atmospherics.

(2) The climate of south-west Europe is so wet, that there is an extremely high probability of rain in a random 24 hours at a random point.

To test the validity of conclusion (2) the maps for the same two-year periods were used. Four individuals (two without knowledge of the nature of the test) were asked to carry out a blind spotting game by placing a random dot on each chart, without seeing its detail. Again, many of these dots were beyond the range of adequate data, but 335 out of 732 could be compared with data. The results show that the chances are nearly even for or against rain, the distribution of the random points being :

| | |
|---|---|
| In rain area | 73 |
| On advancing edge | 46 |
| On rear edge | 62 |
| Total associated with rainfall | 181 |
| Total definitely not so associated | 154 |

It appears, therefore, to be established conclusively that a very high proportion of sharply defined sources of atmospherics are to be found in areas in which rain is falling, and particularly on the advancing edge of such areas, more than 90 per cent. in the present series being in rain areas, and 36 per cent. on the forward edge of the 24 hours' rain area. It is perhaps a permissible inference that, were one able to deal with the instantaneous advancing edge instead of the edge of the area for the day, the latter figure would be increased.

The results of this investigation fall into line with modern views of the mechanism of rainfall and thunderstorm phenomena. The separation and accumulation of charges caused by ascending currents may be readily believed to be more pronounced on

[1] Published by permission of the Radio Research Board of the Department of Scientific and Industrial Research.

the forward edge of a rain area, and to stop short of actual thunderstorm formation, while still being sufficiently marked for the necessary readjustment of charge to originate electro-magnetic waves. The difficulty of picturing readjustments propagating radiation of such energy content as to produce audible atmospherics at distances of more than 1000 kilometres, without producing visible lightning or audible thunder at ground stations near the source, is considerable, but not so great as the difficulty of picturing sufficient "full scale" lightning discharges, or other known phenomena, to account for the reception of atmospherics at an annual average rate of more than one per second at a station in these latitudes.

The writer desires to acknowledge his indebtedness to the Meteorological Office and to the Radio Research Board, for providing the facilities for carrying out this work, and for granting permission to publish the results.

## X-Ray Electrons.

AMONG the items of the programme of section A of the British Association at Hull this year, there was one of outstanding interest consisting of the description of some very beautiful experiments which apparently constitute still another triumph for the quantum theory and the atomic theory of Bohr. Both M. le Duc de Broglie and Prof. R. Whiddington, who described the experiments, have recently been working on the same subject, namely, the properties of the electrons ejected from metallic atoms by the incidence of X-rays; and their results are in general agreement. The method of procedure has been to allow a beam of characteristic X-rays of known frequency, for example from a tungsten anticathode, to fall upon a prepared metallic surface, say of silver. The electrons which, as a consequence, emerge from the silver do not all possess, as Barkla at first supposed, equal amounts of energy. They thus have different velocities, and, by the well-known method of the application of a suitable magnetic field, the original mixed bundle of electrons can be differentially deflected, and spread out into a "magnetic spectrum." A focussing device is employed whereby the electrons of the same speed are concentrated upon the same part of the photographic plate, so that each line in the spectrum corresponds to a group of electrons having a definite velocity. There is a certain amount of general fogging of the plate, but the comparatively sharp lines superimposed are unmistakable. Several actual plates were shown both by M. de Broglie and Prof. Whiddington.

The interpretation of these spectra, which are of somewhat simple appearance, proves to be most important in relation to current theories of quanta and atomic structure. In the first place, the phenomenon obeys the general law of photo-electric effects, in that the velocity, and therefore the energy, of the electrons expelled depends only on the frequency, and not on the intensity, of the exciting X-radiation.

Of still greater importance is the bearing of the experimental results on Bohr's theory of atomic constitution. As is well known, this theory involves that the electrons, in number $N$, which surround the nucleus of an atom of atomic number $N$, are distributed in a certain number of regions, or layers, each characterised by the work which it is necessary to expend in order to remove an electron from the region under consideration, and bring it to the exterior of the atom. If we denote by the letters $K$, $L$, $M$, etc., the levels of these regions, we can attribute to them energies of extraction $W_K$, $W_L$, $W_M$, etc. The fundamental principle underlying the production of the magnetic spectra above mentioned will be made clear by quoting from M. de Broglie's remarks:

"What appears to happen is that if radiation of frequency $\nu$ strikes one of these electrons, situated, for example, in the region $K$, it communicates energy equal to $h\nu$ in order to extract the electron from the atom; it is clear that the corpuscle, once removed from the atomic edifice, will possess a resultant energy equal to $h\nu - W_K$."

In this, of course, $h$ is Planck's constant, and the resultant energy of the electron, which proves to have the value specified, is that which is measured experimentally by means of the magnetic deflection. For truly monochromatic X-radiation, the magnetic spectrum would thus consist of a few lines, corresponding to the various different regions in the atom from which electrons may be ejected, *i.e.* to the various possible values of $W$. Unless $h\nu$ is greater than $W$ the radiation is incapable of extracting electrons from the atomic region in question. This proves to be true experimentally; unless an anticathode is used for which the frequency of the characteristic radiation is sufficiently large in relation to at least some of the energies of electron extraction for the irradiated metal, no magnetic spectrum appears. With a Coolidge tube as the source of X-rays it has not been possible to make $h\nu$ large enough to extract the more deep-seated electrons in metallic atoms of high atomic number; but the employment of $\gamma$-rays, with their much greater frequency, has enabled Ellis to extend the process to these regions, and to prove in this case also the validity of the general relation.

The lines in the magnetic spectra are usually composite. This arises from the fact that the X-rays used are seldom monochromatic, the characteristic radiation from the anticathode having several components. Again quoting M. de Broglie:

"Each line of the spectrum of the incident X-rays re-echoes on each level of the illuminated atom in such a way that we obtain at once an analysis both of the spectral lines of the illuminating beam and of the Bohr levels of the illuminated atom."

The method, as M. de Broglie pointed out, serves for measuring, without the intervention of a crystal, the frequency and wave-length of X-radiation. It thus furnishes a means of checking the magnitudes of the crystal spacings which form the basis of X-ray analysis.

The papers of M. de Broglie and Prof. Whiddington evoked great interest in the Section. There was some discussion, particularly with reference to the general fogging of the magnetic spectrum plates, which seemed to point to some of the ejected electrons having all sorts of emergent velocities. Prof. Lindeman suggested the possibility of having to assume that in the atom there were numerous electron levels, instead of the comparatively small number assumed by Bohr. Sir Ernest Rutherford, however, was satisfied that no such explanation was needed, for the reason that the fogging was inevitable, owing partly to the general radiation from the anticathode, and partly to the fact that some of the ejected electrons would lose random amounts of energy from various causes along their paths to the photographic plate.

A. O. RANKINE.

## Correlation of the Social Sciences.

A CONFERENCE was held at Oxford on October 7-9, under the auspices of the Sociological Society, with the view of securing proper correlation between the various sciences contributory to the science of sociology. Dr. A. J. Carlyle, of University College, Oxford, acted as local secretary, and other Oxford men, such as Prof. J. L. Myres and Dr. R. R. Marett, helped in the work of organisation. The Warden of New College gave the opening address. History, geography, biology, psychology, philosophy, anthropology, economics, and political science—all these subjects were considered, the reading of a paper on each being followed by a discussion.

Mr. J. S. Marvin emphasised the need for a constant return of the sociologist to history; in history we saw sociological principles in action. He pointed the difference between the two methods by showing how the biography of a great man like Napoleon, say, could be material for history or for sociology, according to the way in which it was treated. Sir Halford Mackinder (in contradistinction to some of the other speakers) made very modest claims for geography, merely pointing out that it was a limiting factor in sociological matters. Mr. J. S. Huxley attempted to show the principles which are common to human and non-human biology. He stressed the biological differences between man and other organisms as against the resemblances, and rebutted the claims of those who seek to make the struggle for existence the most important biological principle. Further, he pointed out that the general direction observable in organic evolution provided an objective criterion for ideas of progress in social science. Prof. Myres was emphatic on the need for a biological basis for any true science of sociology.

Dr. Marett read a very stimulating paper on anthropology, laying stress on the fact that anthropologists were now coming more and more to adopt what might be called sociological methods, in that they were investigating whole cultures instead of isolated actions or beliefs. He made it clear that the only essential distinction between anthropology and sociology to-day is that the former investigated primitive peoples, while the latter is concerned with the greater complexity of civilisation.

Prof. Spearman made large claims on behalf of psychology, and drew a vivid (if somewhat unpleasing) picture of a future state of society in which the ability of every boy and girl would be gauged, and their occupations found for them by the application of mental tests. This would bring about a state of affairs in which the just claims of democracy would be realised, together with the merits of aristocracy.

Prof. Leonard Hobhouse, in an attempt to lead the conference back to fundamentals, insisted that the primary difference between science and philosophy was that the latter introduced the idea of values—a statement which provoked an interesting discussion.

Prof. W. J. Roberts, in discussing economics, pointed out that a broad treatment of the subject was necessary, particularly in order to prevent the common mistake of students of regarding the existing state of affairs as approximately ideal. Historical and sociological aspects of the science should be stressed.

Finally, Dr. Carlyle, in a characteristically amusing and vigorous address, dealt with political science.

The conference was obviously a success, in that it stimulated thought and discussion, and was profitable to those who took part in it. But the subjects treated were so large, the modes of treatment so varied, that many were doubtful whether much advance had been made by its close along the path of correlation.

Mr. Graham Wallas, in opening one of the debates in his most refreshing manner, made a suggestion which may prove fruitful. He pointed out that those who presented papers were given much too free a hand—that they could say what they liked, and that, as a matter of fact, this was usually not what the sociologists wanted to know. He suggested that sociologists should draw up *questionnaires* asking for answers on certain definite points from the anthropologists, the psychologists, the biologists, and the rest.

It is clear that sociology can become a most important science, and that its field is one left severely alone by other sciences. But it has to accept the data of a great many special sciences, to take them on trust, and then to correlate them in a particular way. It is to be hoped that the Sociological Society will adopt some such plan as that of Mr. Wallas, pinning the experts down to answering certain problems on which it must have light. This might be done at next year's conference; and the year after another might be held to deal with the purely sociological task of synthesising and employing these data.

## The Effect of Deformation on the Ar 1 Change in Steels.

THERE is considerable evidence as to the existence of lag in the crystallisation of pearlite, particularly in hypoeutectoid steels. Cooling curves show it in the observed temperature of the change, which depends on the rate of cooling. Microscopical observations testify to it in that the presence of carbide nuclei within the austenite (gamma iron) areas leads to crystallisation of globular pearlite at a temperature considerably higher than that at which growth occurs in the absence of such nuclei. Moreover, the growth of lamellar pearlite when once started does not occur simultaneously throughout the specimens. The change proceeds gradually, and there is no difficulty in quenching a specimen so that it contains areas both of pearlite (transformed) and martensite (partially transformed) intermixed.

In taking cooling curves, the specimen is usually allowed to cool undisturbed, and Mr. J. H. Whiteley has conducted an investigation to test whether the temperature of the change could be raised and the rate of pearlite growth increased by deforming steels in this metastable zone. Recently A. F. Hallimond, in discussing the question of delayed crystallisation, remarked that for super-saturated solid solutions, violent mechanical working may be the analogue of agitation. In Mr. Whiteley's experiments, described before a recent meeting of the Iron and Steel Institute, two methods of deformation were used, namely, hammering and bending. Tests were carried out in a small, electrically heated, vertical furnace, resting on a block of steel. A bar of hard chromium steel was used as an anvil, separated from the steel block by a thick pad of asbestos. Temperatures at the surface were measured. A rod of manganese steel selected because it is non-magnetic was used to transmit the hammer blows to the specimen on the anvil. In

carrying out the deformation by hammering, two small specimens, each weighing about one gram, were used. The temperature was raised to 900° C. and then lowered in about ten minutes to 695° C. After fifteen minutes the manganese steel rod was carefully placed on one of them, and a smart blow given with a hammer. To neutralise the effect of any slight difference in temperature between the end of the rod and the pieces, the rod was also placed on the other, but no blow was given. The positions of the two pieces were then interchanged. After an interval of ten minutes, the temperature still being 695° C., the above procedure was repeated in varying order about six times, and after a further five minutes the specimens were quenched in water. The deformations produced were comparatively small, not exceeding $\frac{1}{40}$ of an inch. Repeated experiments all agreed in showing that the lag at Ar 1 was diminished by this slight deformation. The author shows two photomicrographs. In one of these (the hammered specimen) fully half the austenite areas have been converted into pearlite. In the other (an unhammered piece) only one such area has undergone a change.

The same apparatus was used in the deformation by bending experiments. A V-shaped notch, $\frac{1}{8}$ of an inch deep, was cut in the top of the anvil, and the end of the manganese steel rod was shaped like a chisel. The metal used was a mild steel strip $\frac{1}{2}$ in. × $\frac{3}{16}$ in. × $\frac{1}{16}$. This was placed across the notch, heated to 900° C. and cooled to 695° C. After fifteen minutes the rod was placed upon it so that the end was in line with the notch, and two or three light blows were given with the hammer. In this way the strip was bent to an angle of about 60°. After a further five minutes at 695° C. the strip was taken out and quenched. This experiment was made repeatedly, always with the same result. At the bend, as shown in the author's photomicrograph, pearlite was always present, but in the limbs where the metal had not been distorted, the structure consisted almost entirely of ferrite and martensite. A similar but less pronounced effect was produced when strips were bent while being maintained at a temperature of 700° C.

The author states in conclusion that although lag was reduced, it was not completely eliminated by the methods of deformation used, since, in a previous investigation with the same steel, globular pearlite was found to grow between 705° and 708° C. when carbide nuclei were present in the austenite. Both hammering and bending tests, however, agree in showing that the lag at Ar 1 can be appreciably diminished through deformation.

## Medical Education.

THE professional course has grown so full in the training of a medical student that it has become increasingly difficult to cover the ground and secure qualification in a reasonable time. Some years ago this fact raised in an acute form the position of the preliminary examinations in the pure sciences. If these examinations were abolished, or placed outside the professional course, obviously a gain in time would result for abler students. The best account of the matter is to be found in the appendix to the fifth report of the Royal Commission on University Education in London—especially under the evidence of Sir H. Morris, Mr. Flexner, and others. The practice in other countries in regard to the preliminary sciences is also clearly described.

The new regulations of the General Medical Council in regard to student registration presumably indicate the conclusions of that body on the problem. The preliminary sciences are retained, but two of them are placed outside the professional course; at the same time the age of student registration is raised to seventeen years. The examinations in chemistry and physics must be passed *before* registration but *after* the examination in general education. Biology may not be taken until after registration.

The examinations in these preliminary sciences must be conducted or recognised by one of the existing licensing bodies. It remains to be seen what provision the licensing bodies will make for these pre-registration examinations. The Conjoint Board has not yet issued its regulations. Student registration is, of course, at present not legally obligatory, but the older licensing bodies, such as the Universities of Oxford and Cambridge, usually conform so far as possible to the requirements of the General Medical Council. It is at present unlikely that either Oxford or Cambridge will alter its current practice. Each will continue to conduct its present preliminary examinations and postpone student registration until after they have been passed.

These examinations can all of them now be taken under certain conditions before residence is begun. This comparatively recent concession on the part of these universities leaves their candidates practically unaffected by the new General Medical Council regulations. Boys going to these universities will postpone registration until after passing the preliminary examinations instead of, as at present, registering when they have passed the general education examination. It is not unlikely, however, that both Oxford and Cambridge may extend recognition to biology in their own Higher Certificate examinations—they will inevitably do so some day. This would prevent a hardship which may occur at present to a boy who can only proceed to the university if he wins a scholarship. The university scholarships are open up to nineteen years of age. If a boy waits for these and is unsuccessful, he would have obtained his qualification more quickly by leaving school at seventeen years of age and proceeding straight to a hospital. If he is allowed a certificate for all the preliminary sciences on the Higher Certificate examination, such a boy would lose less time.

## The Chilian Earthquake.

FROM the first accounts which have reached this country, it is evident that one of the world's greatest earthquakes occurred shortly before midnight on November 10-11 off the coast of Chile. As in all such earthquakes, the duration of the shock was considerable—nearly three minutes at Valparaiso and four minutes at Caldera—but it should be remembered that such estimates may include some of the immediately succeeding after-shocks. There can be no doubt, however, as to the great extent of the disturbed area. Along the coast, the shock was felt from Antofagasta to Valdivia, a distance of 1100 miles. It was felt across the continent at Buenos Ayres, where it was strong enough to stop clocks. As this city is about 900 miles from Coquimbo (which appears to be near the epicentre), the disturbed area must contain more than 2½ million square miles. The shock is also said to have been felt at Hilo, in Hawaii, but, without further and much stronger evidence, the statement may be discredited. The district over

which houses were damaged was also large, though perhaps not unusually large. The zone most affected was that between Coquimbo and Chanaral, the latter place being nearly 100 miles north of Coquimbo, but houses were also slightly damaged at Valparaiso, which lies about 240 miles to the south.

In this earthquake, as in so many others on the western coast of America, it is difficult in the early accounts to separate the effects of the shock from those produced by the sea-waves and by the fires that followed the earthquake. The sea-waves were observed along the coast from at least Antofagasta on the north to Talcahuano (near Concepcion) on the south, a distance of nearly a thousand miles. They were large enough to wash away boats at Hilo in Hawaii. All the submarine cables along the coast appear to be broken, but the statement that soundings taken between Copiapo and Caldera gave a depth of 86 fathoms, instead of 2800 fathoms as marked on the chart, must of course be erroneous. The earthquake resembles its predecessors in its submarine origin some distance from the coast.

## University and Educational Intelligence.

BIRMINGHAM.—The following appointments have been made by the Council: Mr. A. W. Nash, lecturer in oil mining; Dr. E. Ashley Cooper, lecturer in public health chemistry; and Mr. D. R. Nanji, assistant lecturer and demonstrator in the department of brewing and the biochemistry of fermentation.

CAMBRIDGE.—Mr. G. C. Steward has been elected to a fellowship at Gonville and Caius College, and Mr. G. Udny Yule, Mr. J. E. P. Wagstaff, and Mr. W. M. H. Greaves to fellowships at St. John's College.

LONDON.—The Senate invites applications for a new University Chair of Anatomy tenable at St. Bartholomew's Hospital Medical College, which has not hitherto had a professor of the subject attached to it. The present University professors of anatomy are as follows: Prof. E. Barclay-Smith, King's College; Prof. J. E. S. Frazer, St. Mary's; Prof. T. B. Johnston, Guy's; Prof. F. G. Parsons, St. Thomas's; Prof. G. Elliot Smith, University College; Prof. W. Wright, London; and Prof. T. Yeates, Middlesex. The full title of the holder of the chair at St. Bartholomew's will be "Professor of Anatomy in the University of London." The appointment will date from September 1, 1923, and will be subject to the statutes and regulations of the University and to the regulations of St. Bartholomew's Hospital Medical College. The professor will be expected to devote his whole time to the duties of the chair, except that he may be permitted to hold examinerships in anatomy, and will be able to devote time to research. The salary of the chair will be 1000*l.* per annum. Arrangements for assistance and for departmental expenditure are made by the Medical College of St. Bartholomew's Hospital in consultation with the professor. Applications for the chair (12 copies) must be received not later than first post on April 16, 1923, by the Academic Registrar, University of London, South Kensington, London, S.W.7, from whom further particulars may be obtained.

ST. ANDREWS.—Mr. Rudyard Kipling has been elected Rector in succession to Sir James M. Barrie.

SHEFFIELD.—Mr. R. Stoneley, assistant lecturer in mathematics, has been appointed curator of the University Observatory.

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PROF. ALFRED TENNYSON DELURY, head of the department of mathematics, University of Toronto, was in June last appointed Dean of the Faculty of Arts of that University. Sir Robert Falconer, president of the University, called a meeting of the Council of the Faculty of Arts and announced that, while the appointment of a Dean was by statute in his hands, he would like to receive nominations from the Council for an appointment to this important post. Nominations were accordingly made and balloting was carried on by mail.

THE first meeting of the Court of Governors of the University College of the South-West of England, Exeter, was held on October 27. The new governing body takes over the former Royal Albert Memorial College, Exeter, with its hostels and other property, and also enters into possession of the site and mansion-house given by Mr. W. H. Reed for the purposes of the new college buildings. The new University College which, on the recommendation of the University Grants Committee, has been placed upon the Treasury list of Universities and University Colleges as from August 1, 1922, is regarded as the first step towards the establishment of a University in the South-West of England. H.R.H. the Prince of Wales and Duke of Cornwall is president of the college, and sent a message of greeting and good wishes on the occasion of the first meeting of the court. The court elected Sir Henry Lopes, Bart., as deputy-president of the college: and one of the vice-presidents is Sir Arthur Quiller-Couch. The deputy-president made a statement to the court as to the present position and prospects of the college, emphasising his view that the governing principle of college policy should be the attainment, as soon as possible, of a status which would free the college from a purely external degree system, and indicating the possibilities of co-operation to this end among the various higher educational institutions in the south-western countries. A very substantial increase in the number of full-time degree students in attendance at the college was reported.

ON the occasion of the transfer of the Imperial Department of Agriculture from Barbados to Trinidad, following upon its amalgamation with the West Indian Agricultural College, Sir Francis Watts, principal of the College and Commissioner of Agriculture, received a letter from the Acting Governor of Barbados in which the latter stated that the department's work "has been a landmark in the history of the West Indian Colonies." He continued, "I beg also to be allowed to express the cordial gratitude of the Government of Barbados for the valuable and ready assistance which the Imperial Department has rendered the local Government on numerous occasions . . . may I also assure you of the warm good wishes of the Barbados Government for the success and prosperity of the Agricultural College in which the Department will now be merged, and of our confident hope that the establishment of the College will prove to be a great step forward in the development of scientific tropical agriculture not only in the West Indies but also in a wider field."

THE Royal Technical College, Glasgow, publishes for the session 1922–23, in a calendar comprising 356 closely printed pages, a vast amount of information relating not only to the courses of instruction it offers, the conditions under which the diplomas and degrees for which it prepares are obtainable, and the scholarships tenable in it, but also to the appointments now held by its past students. The list of past students and their appointments, including nearly a thousand names, affords convincing evidence of the practical value of the instruction given, and should be of great interest alike to past, present, and prospective students.

## Calendar of Industrial Pioneers.

**November 19, 1883. Sir William Siemens died.**—One of four brothers who were all closely associated with the application of science and the management of great industrial concerns, Siemens was born in Lenthe, Hanover, on April 4, 1823. He settled in England in 1844 and in 1859 became a naturalised British citizen. His name is connected with the introduction of the regenerative furnace for steel-making and the enunciation of the principle of the modern dynamo. He designed the cable ship *Faraday*, and was president of various technical institutions.

**November 20, 1713. Thomas Tompion died.**—The father of English watch-making, Tompion began his apprenticeship in London in 1664 and by 1675 had gained a foremost place among his fellow mechanicians. He supplied the first clocks to the Greenwich Observatory, and under Hooke's direction made one of the first English watches with a balance spring. His work made English watches the finest in the world. He is buried in the nave of Westminster Abbey, in the same grave as his famous pupil and successor, George Graham.

**November 20, 1898. Sir John Fowler died.**—A great railway engineer, and jointly responsible with Baker for the design of the Forth Bridge, Fowler's early work was done in the Sheffield district, while he afterwards became engineer to the Metropolitan Railway.

**November 21, 1555. Georg Agricola died.**—Agricola has been called the Bessemer of his age. He was born in Saxony in 1494, studied medicine at Leipzig and in Italy, and practised in Bohemia. Subsequently he abandoned his profession, became absorbed at Chemnitz in the study of metals and mining, and was given a pension by the Duke of Saxony. He collected specimens of ores, studied their chemical characters, and described them accurately. His work, "De re Metallica," is considered the most important technical book of the sixteenth century.

**November 21, 1863. Samuel Hall died.**—A native of Basford, Nottingham, Hall made a considerable fortune by his invention of a method of gassing lace and net. In 1836 he took out a patent for a surface condenser for ships which embodied most of the features of condensers as in general use to-day.

**November 23, 1902. Sir William Chandler Roberts-Austen died.**—The successor of Graham as chemist to the Mint, Roberts-Austen did much valuable work on the study of alloys, and was regarded as an authority on all that appertains to coinage. He delivered many important lectures, and in 1899–1900 served as President of the Iron and Steel Institute.

**November 24, 1916. Sir Hiram Stevens Maxim died.**—One of the greatest inventors of the nineteenth century and a pioneer worker on the flying machine, Maxim, like Edison and Swan, assisted to introduce the electric light, and then, turning his attention to the construction of an automatic gun, brought out his Maxim gun, which ever since has played so important a part in all warfare. He was also the first to combine nitroglycerine and true gun-cotton in a smokeless powder.

**November 25, 1893. Johann Bauschinger.**—A distinguished investigator of the strength of materials and the founder of the International Association for Testing Materials, Bauschinger was born in Nuremberg in 1834, and for twenty-five years was professor of mechanics and graphic statics at the Technical High School at Munich. E. C. S.

## Societies and Academies.

LONDON.

**Royal Society,** November 9.—Sir Charles Sherrington, president, in the chair.—H. E. **Armstrong**: Studies on enzyme action. XXIII. Homo- and hetero-lytic enzymes.—A. V. **Hill** and W. E. L. **Brown**: The oxygen-dissociation curve of blood and its thermodynamical basis. An attempt has been made to test the validity of the hypotheses (i) that the reaction of hæmoglobin with oxygen is represented by the equation $(Hb)_n + nO_2 \rightleftharpoons (HbO_2)_n$, where Hb represents the simplest possible molecule of hæmoglobin (containing one atom of iron), and $n$ the average degree of polymerisation of the molecule in the presence of the salts in blood: and (ii) that the dissociation curves of oxyhæmoglobin under various conditions can be deduced by simple application of the Laws of Mass Action. The heat of reaction $q$ of one gm. mol. of hæmoglobin $(Hb)_n$, with oxygen has been determined by the application of the van't Hoff isochore to the effect of temperature on the dissociation curve of blood, while the heat of reaction Q of one gm. mol. of oxygen with hæmoglobin has been measured directly in a calorimeter. The value of $q/Q$ is practically equal to $n$ determined in other ways, affording strong confirmation of hypothesis (1). The apparent heat of reaction of oxygen with blood may be very considerably reduced by the driving off of carbon dioxide by the more acid oxyhæmoglobin formed. A direct measurement of the heat of combination of carbon dioxide with blood confirms the theory that carbon dioxide combines with blood by taking base from the ionised hæmoglobin salt to form bicarbonate, leaving the non-ionised hæmoglobin acid. The heat of combination of carbon monoxide with hæmoglobin in blood is about 50 per cent. greater than that of oxygen: this proves that temperature affects the equilibrium of oxygen and carbon monoxide with blood.—H. **Hartridge** and F. J. W. **Roughton**: The velocity with which carbon monoxide displaces oxygen from its combination with hæmoglobin. Pt. I. When light falls on a solution containing oxyhæmoglobin and carbon monoxide hæmoglobin, the incoming light energy changes the position of equilibrium, tending to cause a reduction in the amount of the latter with a corresponding increase of the former. In the dark the original position of equilibrium is gradually recovered, the rate of return depending on the velocity constants of the reactions. By determining the percentage saturation of the hæmoglobin with carbon monoxide gas at intervals after the light has been turned off, the velocity constants can be calculated. This is done by causing the fluid to flow through two glass tubes in series; in the first it is exposed to a powerful light, while in the second it is kept in the dark, so that the original position of equilibrium is gradually regained. The percentage saturation with carbon monoxide gas of the solution at different parts of the "dark" tube was determined with the reversion spectroscope. At 15° C. the two velocity constants had mean values of 0·0067 and 0·55 respectively. At 34·5° C. the value of $K_2$ was 2·66, which gives a temperature coefficient for this velocity constant of 2·3 for a 10° C. rise of temperature,—approximately that given by many ordinary chemical reactions. Pt. II. The method of measuring the velocity of the reaction $CO + O_2Hb \rightleftharpoons COHb + O_2$ consists in ascertaining, by means of an electrically controlled stop-watch, the time taken for the equilibrium to shift from an unstable position to a stable one, the change being ascertained by

measurements on the absorption bands by means of the reversion spectroscope. The system was changed to an unstable position by (1) subjecting the solution to the action of a powerful beam of light, and by (2) suddenly obstructing the light rays. Thus chance fluctuations in the catalysing light source, and in the flow of the liquid under observation were avoided, but it was difficult to make accurate estimations on absorption bands moving from one position in the spectrum to another. Observations of the equilibrium constant were made by method (1) at 1° C. and laboratory temperature, and by method (2) at laboratory temperature and 34° C. At laboratory temperature, method (1) gave 0·51 and 0·59, and method (2) 0·44 and 0·40. The temperature coefficient per 10° C. calculated from values obtained by method (1) was 2·3, while method (2) gave 2·5 and 2·7.—L. T. **Hogben**: Studies on internal secretion. I. The effect of pituitary (anterior lobe) injection upon normal and thyroid-ectomised axolotls. While pituitary feeding has no influence on the metamorphosis of medium-sized or sexually mature axolotl larvæ of *Amblystoma tigrinum*, injection of anterior lobe extracts into axolotls of the same ages and dimensions was followed by the assumption of the adult characteristics, with rapidity comparable to metamorphosis induced by thyroid administration, and beginning about two to three weeks after the initial injection. Anterior lobe extracts also induce metamorphosis in thyroidless larvæ. Spontaneous metamorphosis does not generally occur, as Marie de Chauvin stated, in larvæ of six to nine months when placed in shallow water with opportunities for emerging.—L. T. **Hogben** and F. R. **Winton**: The pigmentary effector system. II. Apart from caffeine, the only reagents found to induce melanophore contraction were those known to excite peripheral sympathetic nerve-endings, namely, adrenalin, tyramine, ergotoxine, and cocaine. Apart from pituitary extract, the only reagents found to bring about melanophore expansion were apocodeine and nicotine, in quantities sufficient to paralyse all sympathetic nerve-endings. No unequivocal direct evidence is advanced that nervous control of pigment responses in Amphibia has been found. Synchronous colour changes of Amphibia in response to normal environmental stimuli are possibly determined mainly by endocrine influences.—A. **Fleming** and V. D. **Allison**: Further observations on a bacteriolytic element found in tissues and secretions. Strains of *M. lysodeikticus* resistant to lysozyme action can readily be developed. The resistance is not specific, *i.e.* strains made resistant to one tissue or secretion are equally resistant to all tissues, whether derived from man, the lower animals, or from vegetables, showing that the lysozyme affecting *M. lysodeikticus* is the same whatever tissue it is derived from. After solution of a large number of *M. lysodeikticus* there is an increase in the lytic power of the fluid, which affects wholly or mainly the homologous microbe. Different tissues and secretions vary in their capacity to dissolve different bacteria, and some tissue extracts have a marked lytic action on many of the well-known pathogenic bacteria.

## PARIS.

**Academy of Sciences**, October 23.—M. Albin Haller in the chair.—Ch. **Barrois**, P. **Bertrand**, and P. **Pruvost**: Observations on the coal measures of the Moselle.—W. **Kilian**: The stages of the retreat of alpine glaciers and the origin of Lake Lauvitel (Oisans).—A. **Angelesco**: A functional property of conics.—E. **Merlin**: Some properties of networks.—M. **Desaint**: The general representations of analytical functions.—P. J. **Myrberg**: The singularities of automorphic functions.—Frithiof **Nevanlinna**: The relations which exist between the distribution of the zeros and the poles of a monogen function and the increase of its modulus.—Alf. **Guldberg**: A theorem of M. Markoff.—Constant **Lurquin**: The criterium of Tchebycheff.—MM. **Constantin, Joessel**, and **Daloz**: A boat which moves against the wind using the wind itself as motive power. The motor is an air turbine of 9 metres diameter connected with a screw propeller by gearing. No drawings or details are given, but it is stated that a small 6-ton fishing-boat fitted with the motor has given successful results on trial.—L. de **Broglie** and A. **Dauvillier**: The spectral system of the X-rays. The proposed system is based on the principle of rigorous alternation of regular and irregular doublets (Wentzel), following the views of Smekal and of Rubinovicz. The table given includes some lines predicted from the theory but not yet observed.—M. **Vuillaume** and A. **Boutaric**: The photometry of sources of light constituted by black bodies at different temperatures.—R. **Mesny**: The generation of polyphase oscillations of high frequency by electronic tubes.—André **Charriou**: The separation of ferric oxide and alumina from magnesia by the method of nitrates.—M. **Picon**: The action of sodammonium on hexamethylenetetramine, tetramethyldiaminomethane, and ethylideneethylimine. Sodammonium, in liquid ammonia, is without action on hexamethylenetetramine at the ordinary temperature. The imine $CH_3 . CH : N . C_2H_5$, derived from acetaldehyde and ethylamine, is attacked by sodammonium giving diethyldiaminobutane.—Pereira **de Sousa**: The basic rocks of the nepheline syenite massif of the "Serra de Monchique."—Paul **Lemoine** and A. **Pinard**: The mode of contact of the chalk and pisolithic limestone at Meulan-Gaillon (Seine-et-Oise). The limestone has filled irregular pockets in the chalk, and a section of one such pocket is given.—Mlle. F. **Brepson**: The rôle of the phenomena of solifluxion in the model of the region of Saulieu (Morvan). The formation of ponds and lakes in this district cannot be explained as being due to the erosion of streams, nor is there any evidence of glacial action, and it is suggested that earth slides may have been the cause of this formation. The products of granite disintegration imbibe water freely and have a tendency to slip down the steep slopes, forming ridges known as *rideaux*. Examples of these phenomena in the neighbourhood of Saulieu are given, and this is considered to afford an explanation of the large number of small lakes in the district.—J. **Lacoste**: New radiogoniometric observations of atmospherics. An application of wireless telegraphy to the prediction of storms.—René **Souèges**: The embryogeny of the Carophyllaceæ. The first stages in the development of the embryo of *Sagina procumbens*.—Marcel **Mirande**: The relation existing between the relative acidity of the tissues and the presence of anthocyanine in the scales of lily bulbs exposed to light.—André **Guillaume**: Study of the limits of vegetation in the north and east of France. A study of the conditions limiting certain plants to certain areas. Meteorological, geological, physical, and palæontological influences are discussed, the effect of climate being the most important.—Med. **Gard**: The withering of young walnut trees in 1922. In the spring of this year there were heavy losses in young walnut trees. This does not appear to have been due to disease, as was at first suspected, but is attributed by the author to autumnal frosts.—G. **Vernet**: The rôle of calcium chloride in the coagulation of the latex of *Hevea Brasiliensis*. The addition of solutions of calcium

chloride to the latex of Hevea increases the rapidity of the coagulation and also the total weight of rubber obtained. The causes of these results are discussed.—Émile F. **Terroine** and H. **Barthélemy**: Avitaminosis and inanition. Two views of the action of vitamins have been put forward, one regarding these substances as indispensable for nutrition, the other as affecting the secreting power of glands and the diastatic properties of the digestive juices. According to the latter view, the nerve troubles and death resulting from feeding on polished rice are due to starvation caused by the inability of the intestine to assimilate the food. The authors use as a test for death by starvation the percentage of fats and lipoid substances in the animal, and find that in cases of avitaminosis neither the nerve troubles nor death can be wholly attributable to inanition.—M. **Marage**: Phonation and telephonic audition. The author's results are in agreement with those of Fletcher, although the methods employed are absolutely different.—A. **Policard**: The working of the adipose tissue. Researches on the nuchal gland of rodents.—M. **Vila**: Separation of the globulins of horse serum. The globulins are removed from the diluted serum by treatment with three volumes of cooled acetone, and these can be separated into fractions by treatment with dilute hydrochloric acid.—Y. **Manouelian** and Jules **Viala**: A case of hydrophobia in a lioness.—René **Zivy**: An unpublished method of preparing vaccine. Sterilisation is produced by repeated freezing at −18° C. and thawing. Pneumococcus was the most readily sterilised (two freezings), while enterococcus, the most resistant, required six.—Marcel **Leger** and A. **Baury**: Healthy carriers of the plague bacillus. A proof that negroes in Senegal, quite free from any clinical signs of plague, carried the Yersin bacillus and could act as plague carriers.

SHEFFIELD.

**Society of Glass Technology** (York Meeting), October 18.—Prof. W. E. S. Turner, president, in the chair.—J. A. **Knowles**: Processes and methods of medieval glass painting. Medieval window glass differs from modern glass in that whereas the ancient material was a potassium-calcium-silicate, modern glass is a soda-lime glass. The northern school of glass-painting situated at York in the middle ages obtained glass from the northern Continental glass-making districts of Hesse and other Rhenish provinces. The London school drew it from Lorraine, Burgundy, and Normandy. The uncoloured glass used in the north was much whiter than that employed in the south, probably due to the use of English-made white glass from the works at Chiddingfold. The present-day glass maker can produce colours with a certainty and in a far greater range of tints than the medieval craftsmen could. With the exception of the red or "ruby" glass, the medieval coloured glasses were those which were most easily produced. Being made from native oxides which contained other metals as impurities, the resulting colours were not pure or always harmonised. The colours such as red, blue, and green were contained in the glass itself, but details such as the face, folds of drapery, and ornamental work were painted on with a brown vitrifiable pigment, formed of a metallic oxide such as red oxide of iron or black oxide of copper, mixed with a soft glass known as "flux." In the kiln the flux melted before the glass itself, and attached the black oxide to the surface.—H. J. **Powell**: Modern developments in the making of stained and painted glass. The substance of much medieval window glass decays though many pieces of ancient Roman glass are sound. Some medieval glass has become partly or wholly opaque, and crumbles to powder. The most defective glass belongs to the fourteenth century. All the forms of decay originate from the excessive proportion of alkali in the glass mixture which causes the glass to be hygroscopic.

WASHINGTON, D.C.

**National Academy of Sciences** (Proc., Vol. 8, No. 10, October 1922).—H. **Blumberg**: New properties of all real functions. Descriptive and metric properties of planar sets and real single-valued functions of two real variables, with some generalisations, are discussed.—C. N. **Moore**: Generalised limits in general analysis. A proof is given of a generalisation of a theorem in the theory of divergent series.—Martha **Bunting**: Preliminary note on Tetramitus, a stage in the life cycle of a coprozoic amœba. Coprozoic amœbæ in cæcal material from a rat were cultivated on an artificial medium. Amœbæ containing at least one large contractile vacuole emerge from cysts, commonly spherical, the walls of which apparently dissolve. Prior to division, the amœba becomes homogeneously refractive ("gel" state). After division, individuals may become amœbæ or develop flagellæ. The flagellate form is thought to be identical with *Tetramitus nostratus* Perty; it reproduces by longitudinal fission after passing through a "gel" state. Eventually the amœboid form is reassumed. Reproduction of both forms appears to be indefinite but the amœbæ finally encyst.—Raymond **Pearl** and T. J. **Le Blanc**: Further note on the age index of a population. The numerical index of the age distribution of a population previously proposed by Pearl has been used successfully employing six to eight age groups covering the life span. Statistics from the 1915 census of Iowa show that it is also trustworthy, using only three age groups; there is high correlation between the values of the index for coarse and fine age groupings.—A. A. **Noyes** and H. A. **Wilson**: Thermal ionisation of gaseous elements at high temperatures; a confirmation of the Saha theory. It has been shown that the conductivity of flames into which salt solutions are sprayed is (*a*) independent of the acidic constituent of the salt; and (*b*) changes with the concentration of the salt in accordance with the equilibrium constant obtained when the substance, its ions and electrons, as represented by the equation $M = M^+ + E^-$, are regarded as perfect gases. Substantially, the whole conductivity is due to the electrons present. From (*b*) relative values for the ionisation constants of five alkali elements are calculated; the series is closely parallel to that obtained from thermodynamical equations utilising ionisation potentials as employed by Saha.—E. H. **Hall**: An electron theory of electric conduction in metals. It is assumed that an ion is formed from a metal atom by loss of an electron from the outer shell, leaving a pit in the ion which renders it unsymmetrical. An imposed electric field turns the ions so that the pits move as a positive charge would do, giving the effect of an electric current. Ohm's law can be justified, and an explanation is offered of the variation of metallic resistance with temperature. Rise of temperature probably directly increases resistance rapidly, while the increased number of ions produced tends to reduce it. C. **Barus**: Static deflection, logarithmic decrement and first semi-period of the vacuum gravitation needle. These three quantities are similar time functions with a period of one day; they are largest in the morning and least at night. Static deflection and logarithmic decrement appear to be nearly proportional, while the latter and the first semi-period also form a definite curve.

## Official Publications Received.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 7, No. 1: Notes on some Mesozoic Plants from Japan, Korea, and China, in the Collection of the Institute of Geology and Palæontology of the Tôhoku Imperial University. I. By H. Yabe. Pp. 28+4 plates. (Tokyo and Sendai: Maruzen Co. Ltd.)

Department of Agriculture. Report of the Director of Agriculture for 1921. Pp. 58. (Peradeniya, Ceylon.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico: Anno de 1915. Pp. viii+137. (Rio de Janeiro.)

The South-Eastern Naturalist: Being the Twenty-seventh Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Twenty-seventh Annual Congress, held at Southampton, 1922. Edited by Edward A. Martin. Pp. lxiii +73. (London: 285 Holmesdale Road, S.E.25.) 5*s.* net.

## Diary of Societies.

*SATURDAY*, NOVEMBER 18.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11.—Prof. A. Castellani: Mycology in Tropical Medicine.—Miss G. Gilchrist: Bark Canker Disease of Apple (*Myxosporium corticolum*).—Miss E. S. Moore: The Physiology of *Fusarium cæruleum*.—R. J. Tabor: A new fungal disease of Cacao and Coffee.—Dr. M. C. Rayner: The Mycorrhizal Fungus in relation to *Calluna* Cuttings.

*MONDAY*, NOVEMBER 20.

INSTITUTE OF ACTUARIES (at Royal Society of Arts), at 5.—W. P. Phelps: Presidential Inaugural Address.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Capt. G. I. Finch: The Equipment for High Climbing.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. J. Pearce, and others: Discussion on Electric Light Wiring.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—H. R. Hockley: Works Management.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—L. M. Tye: Illuminating Engineering in relation to Architecture.

INSTITUTE OF BREWING, at 8.—W. A. Riley: Elimination of Waste.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Club), at 8.—O. F. C. Bromfield: The Merchant Traders' View on Government Control of Trade in connexion with the Safeguarding of Industries Act and the Dyestuffs (Import Regulation) Act.

*TUESDAY*, NOVEMBER 21.

ROYAL GEOGRAPHICAL SOCIETY AND THE ALPINE CLUB (at Central Hall, Westminster), at 3.—Capt. J. B. L. Noel: First Exhibition of the Mount Everest Expedition Kinematograph Film.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Lord Emmott: The Relations of Capital and Labour. (Inaugural Address.)

ZOOLOGICAL SOCIETY OF LONDON, at 5.30—The Secretary: Report on the Additions to the Society's Menagerie during the month of October, 1922.—I. G. S. Montagu: A further Collection of Mammals from the Inner Hebrides.—F. R. Wells: The Morphology and Development of the Chondocranium of the larval *Clupea harengus*.—R. I. Pocock: The External Characters of the Beaver (Castoridæ) and some squirrels (Sciuridæ).—A. Loveridge: Notes on East African Birds (chiefly nesting-habits and stomach-contents) collected 1915–1919.—E. A. Stensiö: Notes on certain Crossopterygians.—Dr. E. Ghosh: The Animal of *Scaphula* Benson, with the Description of a new Species of *Scaphula*.—J. H. Lloyd and Edith M. Sheppard: A Contribution to the Anatomy of a Hammerhead-Shark (*Zygæna malleus*).—R. H. Mehra: Two new Indian Species of the little-known Genus *Aulodrilus* (Bretscher), aquatic Oligochæta belonging to the Family Tubificidæ.—Dr. J. Stephenson: The Oligochæta of the Oxford University Spitsbergen Expedition.—R. J. Ortlepp: The Nematode Genus *Physaloptera*, Rud.—G. M. Vevers: The Cestode Parasites from Mammalian Hosts which died in the Gardens of the Zoological Society of London, during the Years 1919–1921; with a Description of a new Species of *Cyclorchida*.

INSTITUTION OF CIVIL ENGINEERS, at 6.—E. O. Forster-Brown: Underground Waters in the Kent Coalfield, and their incidence in Mining Development.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—G. J. Steinheil: The Evolution of the Nobel Diesel Engine (Part II.).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. L. Coburn: Astrological Portraiture.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss M. A. Murray: Recent Excavations in Malta.

ROYAL GEOGRAPHICAL SOCIETY AND THE ALPINE CLUB (at Central Hall, Westminster), at 8.30.—Captain J. B. Noel: First Exhibition of the Mount Everest Expedition Kinematograph Film.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Dr. O. L. V. de Wesselow: The Calcium and Phosphorus of the Blood in Nephritis.—Dr. C. E. Dukes: A New Fermentation Tube.—Dr. A. J. Eagleton, Dr. C. C. Okell, and Miss E. M. Baxter: The Serological Classification of B. Diphtheriæ.

*WEDNESDAY*, NOVEMBER 22.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. H. C. Jacobaeus: The Practical Importance of Thoracoscopy, especially in the Pneumothorax treatment of Pulmonary Tuberculosis. (Occasional Lecture.)

ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Napier Shaw: An account of the work of the Meteorological Section of the International Union of Geodesy and Geophysics during the meeting at Rome in May, 1922.—A. H. R. Goldie: Circumstances determining the Distribution of Temperature in the Upper Air under conditions of High and Low Barometric Pressure.—Rev. J. Algué: The Manila Typhoon of May 23, 1922.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. A. S. Eddington: The Borderland of Astronomy and Geology.

ROYAL SOCIETY OF ARTS, at 8.—Bailie W. Smith: The Economy of Smoke Abatement.

*THURSDAY*, NOVEMBER 23.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN (at the Bethlem Royal Hospital), at 2.45.—Prof. G. M. Robertson: The Discovery of General Paralysis, from Haslam to Bayle.—Dr. E. W. Scripture: The Treatment of General Paralysis by Malaria and the use of Speech Inscriptions for Early Diagnosis.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Dr. T. E. Stanton: The Characteristics of Cylindrical Journal Lubrication at High Values of the Eccentricity.—Prof. F. C. Thompson and E. Whitehead: On the Changes in Iron and Steel at Temperatures below 280° C.—Dr. J. H. Jeans: The Propagation of Earthquake Waves.—Prof. F. A. Lindemann and G. M. B. Dobson: A Theory of Meteors and the Density and Temperature of the Outer Atmosphere to which it leads.—C. F. Jenkin: The Fatigue Failure of Metals.—Dr. S. Brodetsky: The Line of Action of the Resultant Pressure in Discontinuous Fluid Motion.—Dr. R. A. Houstoun: An Investigation of the Colour Vision of 527 Students by the Rayleigh Test.

CAMERA CLUB, at 8.15.—Dr. G. H. Rodman: The Story of the "Cuckoo Spit."

*FRIDAY* NOVEMBER 24.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at 11 Chandos Street, W.1), at 5.—Dr. A. R. Friel: The Ionisation Treatment of Otorrhœa.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—E. G. Richardson: The Theory of the Singing Flame.—Prof. R. Ll. Jones: Vibration Galvanometers with Asymmetric Moving Systems.—Miss Alice Everett: Unit Surfaces.—P. Schilowsky: Demonstration of some Practical Applications of the Gyroscope.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Adjourned discussion on paper by W. Reavell: Air Compressors.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—F. E. Murrell: Notes on Waterworks Plant in India.

INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 7.30.—G. Hey: Standardisation.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. F. M. Turner: A Statistical Study of the Age Incidence of Scarlet Fever.—Dr. J. Brownlee: A Note on the Relation between Rainfall and Scarlet Fever.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—C. H. E. West: The Fascination of North Africa.

*SATURDAY*, NOVEMBER 25.

ASSOCIATION OF SCIENCE TEACHERS AND THE ASSOCIATION OF UNIVERSITY WOMEN TEACHERS (at University College), at 11 and 2.30.—Joint Conference on the Teaching of Science in Schools and Colleges.

### PUBLIC LECTURES.

*SATURDAY*, NOVEMBER 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—A. D. Howell Smith: Textiles and their History.

*MONDAY*, NOVEMBER 20.

ROYAL SANITARY INSTITUTE, at 4.—Dr. A. Balfour: The Sanitary Inspector in the Tropics.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—General Sir W. B. Leishman: Bacteriology of Disease.

*TUESDAY*, NOVEMBER 21.

ROYAL SANITARY INSTITUTE, at 4.—Lt.-Col. W. W. Clemesha: Hookworm Disease and the Method of Controlling It. At 5.15.—Miss A. D. Muncaster: Some Hygienic Aspects of Food and Food Preparation. II. The Hygiene of Food Preparation (Chadwick Lecture).

*WEDNESDAY*, NOVEMBER 22.

ROYAL SANITARY INSTITUTE, at 4.—Prof. R. T. Leiper: Parasitic Worms and their Migrations.

*THURSDAY*, NOVEMBER 23.

ROYAL SANITARY INSTITUTE, at 4.—Lt.-Col. H. J. Walton: Flies and Mosquitoes.

UNIVERSITY COLLEGE, at 5.—Prof. H. R. Kenwood: The Pasteurisation of the Public Milk Supply.

WESTFIELD COLLEGE (Hampstead), at 5.15.—Sir Oliver Lodge: Matter and Ether.

*FRIDAY*, NOVEMBER 24.

ROYAL SANITARY INSTITUTE, at 4.—Dr. H. B. G. Newham: Malaria and other Diseases.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Law and the Humanities.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—M. L. W. Laistner: Ancient University Life.

*SATURDAY*, NOVEMBER 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: British Water-beetles.