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The Development of Industrial Research Associations.

MANY of the Research Associations, founded under the auspices of the Department of Scientific and Industrial Research, have been in existence for five years, and consequently it is possible to form some idea of their future development and usefulness.

The reasons for their establishment are well known. It was recognised that British industries are in the main highly developed arts and crafts, basing their technical methods on slowly gained practical experience rather than on the broader foundations afforded by scientific method. The knowledge in any industry consists of a number of well-established but often unrelated facts; what is lacking is the scientific substratum which binds these facts into a coherent whole.

It must be clear to all who have given thought to the subject, that industries established in this manner now find that, before much further advance can be made, problems of such a fundamental and purely scientific nature have to be faced that no single firm could undertake their solution. Generally speaking, British industry in the past has fought shy of research, especially of the more fundamental kind. The necessity for it is, therefore, all the more pressing. Fortunately, industrial leaders have a growing belief in its utility, and are readier than ever before not only to avail themselves of the results that research can place at their disposal, but also to bear its cost. The only debated point with them has been the nature of the scheme to be adopted in order to bring about the desired end. In these circumstances it is hard to conceive a better plan than that evolved by the Department of Scientific and Industrial Research, since for the first time it enables fundamental problems to be worked on by an Association representative of, and supported by, the whole industry, which is ready to pool its experience and place it at the disposal of the scientific workers who are responsible for carrying out the investigations.

Probably, if Research Associations did not exist, British industry would still be chary of recognising its obligation to undertake fundamental research work, and the fact that industrial belief in Research Associations is undoubtedly spreading, constitutes one of the strongest arguments in favour of the creation and continuance of these bodies.

Research Associations have many advantages over academic research institutes in attacking industrial problems which, as a rule, are many-sided scientifically, and require not only deft handling by an expert in any one science, but also organised and co-operative attack by experts in several sciences. Nor does the matter end here, for when the scientific data are ascertained

and the laboratory solution has been found, there still remains what is often the most difficult and costly part of the work, namely, the application to large-scale practice. Neither the man of science nor the technologist can, individually, handle this side of the question successfully: the closest co-operation is necessitated, in which the technical side must be represented by both employers and employed. The future success of Research Associations largely depends on the reality and effectiveness of this co-operation.

Far-reaching inquiries into the scientific foundations of industrial practice are not, however, likely to bear fruit in a brief period of time; and on this account great faith and patience are required on the part of those who are supporting them. How are this faith and patience to be created? The hard-headed business man with no knowledge of scientific method would not be won over by the statement "subscribe to the Association for five, ten, or perhaps fifteen years and good will come to you." He is, however, strongly appealed to when he sees everyday difficulties surmounted, and newly discovered facts, which probably at first he regarded with little interest, usefully applied in unexpected directions. The gradual accumulation of scientific data should make it comparatively easy for Research Associations to give this form of assistance.

This raises the question, to what extent should Research Associations do consulting work? This is undoubtedly not their prime object; yet it seems inevitable that some work of this description will have to be undertaken, for as the confidence of a trade in its Association increases, so naturally will the desire of the former to refer more and more of its difficulties to the latter. Moreover, the solution of these minor problems is of undoubted educational value to the scientific staff of an Association, who, as they are devoting their whole energies to the scientific side of a trade, must eventually become "the" authorities in their respective branches. The relative amount of such work to be undertaken must be left to the decision of the governing body of each Association, but the most useful test to apply in relation thereto should be: Is the particular point raised of importance to the trade in general, or does it affect one firm only? If the former, the work might well be done and the solution given to the trade as a whole. But it must never be forgotten that, although this kind of work can greatly improve general efficiency, it is unlikely to effect a revolution in any industry. Really great advances can only result from the discovery of new starting-points, which will be established by probing more deeply into the intrinsic properties of the raw materials employed, and by laying bare the scientific principles involved in each process of manufacture.

Five years—the first period of Government support to the Research Associations—is certainly too short a time in which to prove the value of fundamental scientific work to those who have never had any knowledge of its possibilities, especially when the scientific staffs of Research Associations have had to acquire a considerable knowledge of technical detail of the industry, and perhaps the additional five years, for which new grants have been made, may not prove adequate to allow the Associations so to gain the confidence of their trades as to render outside assistance no longer necessary. It is, however, at once granted that such must be the ultimate goal, and there seems little doubt but that the goal will be reached. In support of this statement no more striking example could be quoted than that of the cotton industry, the members of which have recently proved their faith in co-operative research by agreeing to double their subscriptions to their Association and to guarantee them for five years. The Cotton Research Association has now an assured income of more than 40,000*l.* a year, and although this sum may be considered small for an industry of the magnitude of that concerned with cotton, and further, may not be sufficient to allow the fullest possible developments at the moment, it is at least sufficient to demonstrate the value of what may well prove to be one of the greatest movements in the advance of modern British industry.

It is hoped that many of the trades which have entered into the scheme may reap early benefit as a result of their foresight, but the main object in the founding of Research Associations was surely not so much consideration for the immediate present, as a desire to associate science with industry in such a manner that the future would show the continued supremacy of British trade, on which the welfare of the nation depends. KENNETH LEE.

The Life of Lord Rayleigh.

John William Strutt, Third Baron Rayleigh, O.M., F.R.S., Sometime President of the Royal Society and Chancellor of the University of Cambridge. By his Son, Robert John Strutt, Fourth Baron Rayleigh. Pp. xi+403+5 plates. (London: E. Arnold and Co., 1924.) 25*s.* net.

LORD RAYLEIGH has completed a very difficult task with great success; he has written a life of his father which has the intimacy which only near relationship could give, combined with a frankness which leaves the conviction that he has shown true filial piety by omitting nothing that would help to make his portrait of a very great man true to life. He says in the preface that it has been his aim not so much

to give an account of his father's scientific work as to depict him as a man. He tells us about his father's boyhood, how he went first to Eton and then after an interval to Harrow; bad health, however, prevented him from staying more than a term or two at either. The greater part of his school education was at Mr. Warner's, a well-known private school at Torquay, a school by the way where no unmarried lady of less than sixty years of age was to be mentioned at the dinner table. The love for a joke, which Rayleigh never lost, began soon, for we find from a letter written at school that he and another boy invented a language which they called Russian, and set the smaller boys at work learning the declensions. The mathematical teaching at Warner's seems to have been good, and Rayleigh remained there until within a few months of going up to Trinity College, Cambridge. As a boy he was very fond of photography, which he began at about the time when he went to Warner's, and he often in after life declared that he owed much to the practice he got in manipulation with the old wet collodion process.

Between the spring of 1861, when he left Warner's, and the October of the same year, when he came to Trinity, Rayleigh began with a private tutor to read the differential calculus, so that his stock of mathematical knowledge as a freshman was a great contrast to that of Lord Kelvin, who had written papers on Fourier's theorem before coming to Cambridge; it was, however, greater than that of Stokes, who had not commenced the differential calculus when he came into residence. At the time when Rayleigh was an undergraduate, the teaching of mathematics to the best men was very largely in the hands of Routh. College lectures counted for little, and professor's lectures for still less. Routh's method of teaching was as different as possible from the popular idea of private coaching. It consisted of admirably clear and carefully prepared lectures given to a class of perhaps ten or twelve pupils. Many examples were set for solution, and each week there was a problem paper the marks for which were made public so that it acted as an incentive. Lord Rayleigh expressed in a speech quoted in his biography the gratitude which he and many other pupils felt to Routh for his teaching. At Routh's the physics were in abeyance, and when in his third year Rayleigh attended Stokes's lectures on optics, it was an epoch in his life. "This was what I really liked," he said many years afterwards, quoting from his note of Stokes's lectures: "a beam of coloured light was passed through a dilute alcoholic solution of the green colouring matter of leaves; the transmitted rays were green, but the part of the liquid traversed by the rays shone with a deep blood-red light."

Rayleigh prepared with great care for the tripos examination, going so far as to study the idiosyncrasies of the examiners so as to form some idea of the questions they were likely to set. Like others before and after him, he was reduced to despair by the problem paper in the first part of the tripos: a diabolical contrivance full of "low mathematical dodges." However, all went well in the end, and he came out senior wrangler and first Smith's Prizeman in January 1865. Marshall, the political economist, was second wrangler, and H. M. Taylor third. Some of Rayleigh's answers were so good that one of the examiners said they might have been sent straight to press without correction. The correspondent of the *Times*, in announcing the result of the tripos, said that "the success of Mr. Strutt is attributed more to his perseverance than to his brilliant talent"! It is disconcerting to find that when at Trinity the future Chancellor indulged in roof-climbing about the College, a practice which now at any rate is not regarded with favour by the authorities. He also played real tennis; one result of this was his delightful little paper "On the irregular flight of a tennis ball."

After taking his degree Rayleigh found great difficulties in getting opportunities for experimental research or instruction in laboratory work. This, he said afterwards, "wasted three or four years of my life." In 1868, after a trip to America, he started experimenting on his own account at Terling, and in the course of the next ten years published, along with many other things, papers on the theory of resonance, on the scattering of light by small particles, on the resolving power of optical instruments, and his great book on the "Theory of Sound."

When on Clerk-Maxwell's death in 1879 the professorship of experimental physics at Cambridge became vacant, Lord Rayleigh received an invitation, signed by 125 members of the Electoral Roll, inviting him to become a candidate for the professorship. After considerable hesitation he accepted the invitation and was elected to the professorship in December 1879. He began at once to reorganise the laboratory and the teaching. Finding the supply of apparatus inadequate, he raised a fund of 1500*l.*, towards which he gave 500*l.*, for buying more. In collaboration with Glazebrook and Shaw he organised a system of teaching practical physics which is in essentials the same as that still in force. His own work before coming to Cambridge had not been especially on electrical subjects; but, as he told me, he found that the interest which Maxwell had aroused in electricity was so strong that he was led himself in the same direction. He organised and carried out, with the assistance of Mrs. Sidgwick and Sir Arthur Schuster, those classical determinations of the fundamental electrical units which raised electrical measurements to a new level. An admirable account of these investigations is given in the

biography. In starting the work on electrical units he had in his mind a scheme of identifying the laboratory with a research planned on an extensive scale in which a large number of workers in the laboratory might take part. I think it is doubtful whether, considered from the point of view of training for young physicists, such a scheme is advantageous in a university laboratory. Most men are much more interested in, and more enthusiastic about, one branch of physics than another, and a young man develops his powers more rapidly and puts more independent thought into his work if he tackles a problem which he has, to some extent, selected for himself, than if he joins a scheme of work already planned.

As one who worked in the laboratory while Lord Rayleigh was professor, I can testify to the assistance we got from him; there never was, I think, a man whose judgment in scientific matters was sounder or more free from prejudice; if he questioned a conclusion or a result one felt there was a real difficulty which required further investigation. Yet even with these qualities he found prophecy was not free from danger. He says in a letter written at this period: "Yesterday I had an opportunity of seeing the telephone which every one has been talking about . . . it is certainly a wonderful instrument, though I suppose not likely to come to much practical use." Having quoted a bad guess I ought not to omit a good one in his presidential address to the Royal Society in 1908. He says: "We may expect to see flying machines in use before many years are past."

Lord Rayleigh had only undertaken to hold the professorship for five years, and at the end of 1884 he resigned. In spite of attacks of rheumatic fever he had worked desperately hard and published sixty important papers in five years. Mr. Gordon, who had been his assistant at the Cavendish laboratory, went with him to Terling; it is pleasant to find in the biography kindly reference made to Gordon, who, by the assistance he gave to Lord Rayleigh, rendered good and faithful service to science.

On leaving Cambridge in 1884 Lord Rayleigh continued his experimental work in his laboratory at Terling. The absence of the facilities of a large laboratory would have been a serious handicap to most men, but Lord Rayleigh possessed to an extraordinary degree the power of getting important results with simple apparatus: it has been said of him that he only required a few pieces of glass tubing and a stick of sealing-wax to make the most fundamental discoveries. It was immediately after leaving Cambridge that he began the work which led to his discovery of argon and incidentally caused him much annoyance. The story of the discovery of argon is told by his son in a chapter which is a masterpiece of clear and impartial statement; every line carries conviction, and after reading it we are convinced that there is nothing further to be said on the subject. The discovery of argon is a most striking instance of the necessity of utilising physical methods in chemical analysis—what can they know of chemistry who only chemistry know?

Besides his almost unparalleled activities in research, Lord Rayleigh did no inconsiderable amount of official and executive work. These aspects are dealt with in the biography in a chapter on "Public Work": a very clear and interesting account of the foundation of the National Physical Laboratory is given, and the debt which that laboratory owes to him is certainly not overestimated. He was the chairman of the Treasury Committee which in 1898 reported in favour of establishing the laboratory, and he was chairman of the executive committee to which it was entrusted from the time of its formation until shortly before his death. His judgment, his wisdom and his influence contributed in no small measure to the growth of that institution from very modest beginnings to the foremost place among National Physical Laboratories. His work at the Royal Society, at the Royal Institution, as scientific adviser to Trinity House, and as gas referee, are admirably described.

Not the least interesting part of the book is the account of Lord Rayleigh's connexion with psychical research. As a young man he realised the immense importance of the subject, and it is stated in the biography that he contemplated throwing the greater part of his energies into the investigation of such problems. He says in a letter written in 1874: "A decision of the existence of mind independent of ordinary matter... would be the most important possible scientific discovery." He attended many seances, but came, as others have done, to the conclusion that he was unlikely from his own personal experience to be able to arrive at conclusions definite enough to justify him in making it his life work. In his presidential address to the Society for Psychical Research a few months before his death, and showing that clearness of thought and perception of essentials so characteristic of him, he offers no definite opinion, but says: "Some of those who know me best think that I ought to be more convinced than I am. Perhaps they are right."

Lord Rayleigh was a lover of good stories, and a list of some of those which appealed to him is given in an appendix to the biography. This is a novel feature in a book of this kind, but it makes us, I think, feel we know him better than if it had been omitted.

Lord Rayleigh has been fortunate in his biographer, for no one can read this admirably written work without increased admiration and respect for one of the great names in British science, a great discoverer and a counsellor whose judgments were never clouded by prejudice or by a shadow of self-seeking. J. J. THOMSON.

Practical Farming.

(1) *The Production of Field Crops: a Textbook of Agronomy.* By Prof. T. B. Hutcheson and Prof. T. K. Wolfe. (McGraw-Hill Agricultural and Biological Publications.) Pp. xv+499. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

(2) *Grassland Farming, Pastures and Leys.* By W. J. Malden. Pp. xxiv+314. (London: Ernest Benn, Ltd., 1924.) 30*s.* net.

THE agricultural industry is passing through a critical period not only in Great Britain but also—if for very different reasons—in the United States of America. It would almost appear as if these difficult times are operating to bring the man of science and the man of practice closer together, and as if the movement in the direction of universal agricultural education and research, quickened by the stress of adversity, is on the threshold of bearing very substantial fruit. It is a noteworthy fact that the later post-War period has been remarkable for the appearance on both sides of the Atlantic of a large number of books on agricultural subjects. There has been discernible in many of these books a tendency to write as much, or more, for the benefit of the farmer as for the enlightenment of the student.

This tendency is well exemplified in the two volumes under notice, and is shown by nothing so much as the fact that the chapters are not burdened with attempts to teach elementary chemistry or elementary botany or with digressions in the realm of pure science irrelevant or more or less irrelevant to the subject matter. The subjects under discussion are dealt with from the practical point of view and with resort to the minimum of technical terms. It is presumably coming to be realised that the farmer does not wish to be taught the technicalities of science, but he demands that the practical information and advice given him shall be both correct and sound; it must therefore be based on accurate scientific knowledge born of experimentation, and should be backed by prolonged farming experience.

(1) The work of Profs. Hutcheson and Wolfe constitutes the nineteenth of the excellent series of agricultural and biological publications of which Dr. Charles V. Piper is the consulting editor, and is based almost entirely on the results of properly conducted field trials.

The authors state that the standard introductory course in field crops recently adopted by the American Society of Agronomy (see Journal of the American Society of Agronomy, vol. 14 (4), April 1922; vol. 15 (2), February 1923; and vol. 16 (1), January 1924) has been followed as closely as practicable. The work is therefore essentially a text-book adapted for the use of American farmers and students, and deals explicitly with American conditions. This is emphasised by the fact that of the 396 citations in the bibliography, all except about a dozen refer to American investigations.

The book should be of considerable value, however, not only to the British student seeking accurate information with reference to American crops and to American literature, but also to such as desire concise information, based on scientific investigation, as to the fundamentals of successful crop production. Thirty-seven of the forty-five chapters are devoted to a general discussion of the culture of crops. In addition to subjects like tillage, fertilisers, and lime, which in the past have so largely dominated works on crop production, it is significant of the American point of view that no less prominence is given to the treatment of the factors more or less inherent in the crop itself, such as the adaptation of crops, crop improvement, and the value of good varieties and of good seed. The part that seed associations of farmers have played in the distribution of improved or suitable varieties and of good seed, based on the extensive trials undertaken by the Experimental Stations, is emphasised in these chapters and should afford food for thought to the British agriculturist. Similarly the chapter on grain grading directs attention to an important question which has recently been given much prominence by the teachers of farm crops in the various agricultural colleges in the United States. Grassland is adequately dealt with in chapters on haymaking, pasture, and meadow management.

The chapters on the individual crops are enhanced in value by maps indicating the geographical range of cultivation of each within the United States, and in the case of the more important crops the belts devoted to certain groups of varieties in particular are also shown, while statistics are given both as to world production and to production within the United States.

(2) Mr. Malden's volume on grassland farming is severely practical, and the information supplied, although supplemented by references to numerous trials, is based largely on the author's considerable experience of farming. That the results of exact experimentation have not been more extensively drawn upon, or at all events not more extensively relied upon, is perhaps in the main to be accounted for by the simple fact that very little experimental work bearing explicitly on the management of grassland as a whole—as opposed to experiments on isolated aspects of grassland husbandry, such as manuring, seeding-down, and the like—has been conducted in Great Britain. In several instances,

however, the author undoubtedly attaches more importance to his own interpretation of his own experiences than to the largely accepted teaching of more or less recent experimental trials. This is noteworthy in respect of his paragraphs relative to the feeding of cake on grassland, and as to the use of inorganic nitrogenous fertilisers on pastures; it is also apparent that the author has a decided predilection in favour of the so-called complicated mixture. Thus on p. 87 he quotes and apparently approves of a seeds mixture for light land consisting of sixteen species, no less than four of which are included in amounts of less than 1 lb. It is true that at the end of the chapter on seeds mixtures he quotes, but without comment, those of a simpler character recently advocated by the Royal Agricultural Society.

In the chapter "Plants of Permanent Pasture" valuable and concise information is given relative to the chief species; it is unfortunate, however, that the author perpetuates the term "cow-grass" for single cut cow grass or late flowering red clover, and that he also quotes without contradiction the time-worn view that this strain of red clover originated from crossing *Trifolium pratense* with *T. medium* or zigzag clover, a view for which there is no possible botanical justification.

The chapters on the management of temporary and permanent pastures are exceedingly interesting and very suggestive, while that on haymaking should be read with the greatest care by every farmer who operates in regions of high rainfall. R. G. S.

The Manufacture of Sulphuric Acid.

(1) *The Manufacture of Sulphuric Acid (Chamber-Process)*. By W. Wyld. ("The Manufacture of Acids and Alkalis," by George Lunge. Completely revised and rewritten under the Editorship of Dr. A. C. Cumming. Vol. 2.) Pp. xii + 424. 31*s.* 6*d.* net.

(2) *The Concentration of Sulphuric Acid*. By J. W. Parkes. ("The Manufacture of Acids and Alkalis," by George Lunge. Completely revised and rewritten under the Editorship of Dr. A. C. Cumming. Vol. 3.) Pp. xii + 394. 31*s.* 6*d.* net.

(London and Edinburgh: Gurney and Jackson, 1924.)

THERE is no treatise in any language which gave more detailed accounts of the manufacture of sulphuric acid than that of Lunge. The earlier editions of this were based directly on the experience of the author and were very practical. In the course of revision the new matter took the form of extracts from patents, and very little critical discussion of these was added. In the latest edition, two volumes of which form the subject of the present review, there is considerable difference in the method of treatment.

(1) The new volume dealing with the chamber process is essentially the same as the later editions of Lunge, but a fair amount of the text of these has been omitted. The new matter added consists mainly of rather sketchy descriptions of pumps for acid and of patent packings for towers. The practical details of construction and working remain essentially those of Lunge, so that the larger volume of the previous edition will remain perhaps the more complete account of the subject. The new diagrams also are of a sketchy character, *e.g.*, that on p. 83 representing a tower system used by Mr. Wyld. The description of this occupies only about half a page, and the diagram is merely a rough sketch. The description of tower systems consists mainly of brief extracts from patent specifications.

Mr. Wyld states in the preface that he is himself carrying out extensive investigations on tower plant, and it would seem that it would have been wiser to have deferred the publication of this volume of the series until information of practical value had been obtained. Even if the book is to be considered merely as a collection of patent references, then it must be regarded as incomplete. The lack of detailed new information may be merely an indication that the chamber process has not been found capable of improvement, but there was obviously need for a fuller and more critical discussion of the newer tower systems. It is assumed that all the references given in the former edition have been checked with the originals; some were incorrect, and at least one is incorrect in the present edition.

(2) Mr. Parkes's volume dealing with the concentration of sulphuric acid is a very decided improvement of the previous edition of Lunge's book and contains a large amount of new information of great practical value. Much of this is derived from the experience gained during the War in the national factories. The admirable methods of control used in these factories have resulted in the accumulation of a large amount of important and useful information which is now collected, arranged, and critically discussed in one volume.

There can be no doubt that Mr. Parkes's book will be the standard treatise on the concentration of sulphuric acid. The densities are given in accordance with Domke and Bein's work, and the thermal data are collected from the critical memoir of Prof. A. W. Porter. The calculations based on these figures are therefore the most accurate available, and the results may be safely assumed as a basis of plant design. The newer types of concentrating plant, such as the cascades of various materials, the Gaillard tower, the Gilchrist apparatus,

and the modern Kessler plants, are described in full detail, with excellent working drawings and reproductions of photographs of actual plant. The condensation of fumes, a most important part of the operation of a concentration plant, is discussed, and the Cottrell and Calder-Fox systems described. The recovery of waste acid and the transport of acid are also included.

Mr. Parkes's revision has been thorough, and his book is a complete treatise on the theory and practice of the concentration of sulphuric acid. J. R. P.

Psychology as a Science.

The Nature of Intelligence. By Prof. L. L. Thurstone. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi+167. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1924.) 10*s.* 6*d.* net.

THE fact which is, perhaps, most obvious to readers of psychological literature is that each School uses language which is entirely unmeaning when applied to another School; the behaviourist, the experimentalist, the psychiatrist, and the academic psychologist all appear to be talking in different languages, and Prof. Thurstone attempts both to unravel the reasons of the medley and also to construct an intelligible science out of it. His book is thus the first real attempt to bring into a composite whole the different branches of psychology and, for that reason alone, commends itself to all serious students.

Prof. Thurstone finds the chief reason of the differences to be that the specialists lay stress on diverse entities in conduct; they look at the subject from entirely dissimilar points of view, and (in the author's view), wrongly, build up a science which is not really true to the facts. Thus the behaviourist stresses "overt conduct," the experimentalist mere stimulus and response, the academician "consciousness and its states," and the psychiatrist abnormal psychology. The author, however, would combine the different points of view and, by shifting the stress of the special branches, construct a science at once more human and accurate.

Our author begins by showing how the stimulus-response theory must give way to the theory that impulses generate in the organism and only use stimuli in so far as they are able to satisfy the feeling generated by the activity. He then goes on to show that consciousness is an evolutionary development the sole use of which is that it leads to activity and thereby helps to gain the object desired. But this is not enough. After consciousness and its states we must have the overt act, the behaviour of the organism in order to complete the cycle. Thus a complete view of psychology begins with the "energy-source" in the individual, passes through consciousness by means of ideation to the external stimuli, proceeds to the overt act, and ends with the satisfaction of the impulse and the quiescence of the "energy-source." Looked at from this basis, intelligent conduct depends upon whether it is possible for the individual to focus in consciousness at an early stage of the impulse the specific universal meaning of the impulse and thereby make use of "trial and error" conduct. Grades of intelligence are grades of powers of inhibition, powers, that is, effectively to control mere reflex actions in order better to satisfy the impulse.

We cannot enter into details of the book. It is doubtful whether Prof. Thurstone really means the phrase "consciousness is unfinished conduct"; if he does, then he is severely limiting the use of the word "consciousness" and his definitions, both of consciousness and intelligence, appear to savour of descriptions, and, at any rate, are both debatable. The book, however, is simply written and is illuminated by profuse and clear diagrams, and his theory is backed up by a wealth of good psychological examples. It should be read, if only as a stimulus to thought and to give a clear view of the real need for a science which will combine the different branches of psychology.

Cotton in Australia.

Cotton in Australia: the Possibilities and the Limitations of Australia as a Cotton-growing Country. By Richard Harding. Pp. xviii+270. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

THE author describes this book as the result of eighteen months' investigation made in Australia, when secretary of the British Cotton Delegation, 1922. He sets out to prove that great areas of that continent can produce cotton commercially; of course he succeeds. At first one is inclined to resent the facile optimism of the fourth chapter, which is especially devoted to this proof, where the author openly omits a drought year from his averages and guesses the available resources in six significant figures; but having duly discounted his rather uncritical attitude, we can welcome this book as the first available general statement of the Australian cotton position. That the country has large potential cotton areas is clear; the Government proposes to face the basic difficulty of getting labour for the picking season (from white men in a cotton-growing climate) by planting many small areas, each on one man's small holding. Whether the plan will work remains to be seen, but Mr. Harding certainly puts his finger on two essentials; one is the cultivation of a big boll type, since the labour of picking a given weight of crop is almost inversely proportional to the boll weight; the other is the advisability of insisting

on quality, though we think he perhaps overrates here the agricultural virtue of the white as compared with the coloured man.

Structurally the book is weakened by a dual purpose. Not only does it present Australian cotton to the rest of the world—for which we welcome it, though more explicit references to sources of data would be useful—but it has also another purpose; and both would have been better achieved by shuffling the chapters into two parts. This second purpose, not explicitly stated by the author, is the presentation of the world's knowledge of cotton to the Australian; and this is necessarily a compilation. Some obsolete matter and ancient tags are included in the first two chapters, which are of dubious value; we have often heard previously of Lancashire's climate (p. 19) and men of business (p. 18); the point is missed that the Nigerian cotton supply to us is merely surplus production from their own local cotton industry (p. 23); and the artificial silk industry is making long-distance predictions of cotton consumption (p. 28) rather risky. The chapters on seed supply and cultivation, which have the same instructive aim, are of real use; the author describes some procedures which certainly ought to be followed as if they commonly were followed, thus giving a valuable tinge of practical idealism, perhaps deliberately, to his exposition. Some statistical and descriptive appendices, also of dual purpose, complete the book, which, though in many ways unsatisfactory, will be useful not only in Australia, but also outside. W. LAWRENCE BALLS.

Our Bookshelf.

(1) *The Common Sense of the Theory of Relativity.* By Dr. Paul R. Heyl. Pp. 44. (Baltimore, Md.: Williams and Wilkins Co., 1924.) n.p.

(2) *Relativity for Physics Students.* By Prof. G. B. Jeffery. Pp. vii+151. (London: Methuen and Co., Ltd., 1924.) 6*s.* net.

(3) *The Foundations of Einstein's Theory of Gravitation.* By Erwin Freundlich. Translated from the Fourth German edition, with Two Essays, by Henry L. Brose. Second edition, revised and enlarged. Pp. xvi+140. (London: Methuen and Co., Ltd., 1924.) 6*s.* net.

(4) *Darstellung der Relativitätstheorie im Dreidimensionalen Lobatschefskijschen Raume.* Von Prof. Vladimir Varićak. Pp. x+104. (Zagreb: Zaklada Tiskare Narodnih Novina, 1924.) n.p.

HERE are four more books on relativity, ranging from the highly popular and amusingly written booklet of Dr. Heyl to the extremely technical and ponderous representation of the theory in three-dimensional Lobatschefsky space. (1) The common sense of relativity can apparently be expounded in 44 pages of light reading for the man in the street, but naturally this is possible only by a use of analogies which must not be too closely scrutinised. We doubt whether it is actually "common sense" which is content to be fobbed off in this way. Nevertheless, as a booklet for whiling away a half-hour's railway journey, it is admirable.

(2) Prof. Jeffery's book is on a different plane. It introduces the theory to students of science capable of using their mathematics to a moderate extent as an instrument of thought, but not yet fully equipped with the mathematical weapons required for the thorough investigation of the subject. The result is an excellent little book which we trust all science students still nervous and suspicious of a field apparently subversive of their training, will study carefully. The ideas are clearly and concisely expounded before any mathematical treatment is entertained, and even then the analysis is economised to correspond closely to the object in view.

(3) That the translation of Freundlich's book is worth study there can be no doubt, but it is needlessly difficult to read, not so much because it is a translation but because so much more has been included between the covers than the original work. An introduction by H. H. Turner (8 pp.), followed by the material giving the title to the book (68 pp.), then 28 separate notes to this material (36 pp.), and tacked on at the end two essays by the translator (35 pp.), all contribute to produce a lack of homogeneity and the impression that the same courses are being served up several times under different guises.

(4) This is an interesting and lucid analysis of Lobatschefsky space, displaying its properties in such a form as to present their intimate relationship with the ideas of relativity.

Everyday Physics. By H. E. Hadley. Pp. viii+474+4 plates. (London: Macmillan and Co., Ltd., 1924.) 6*s.* 6*d.*

THE headmaster of a secondary school has to solve the problem of providing a satisfactory course of general science for the average pupil (including the budding specialist in language or history) along with a course which will equip a student of science for an advanced course in chemistry and physics. The chemistry of air and water, so far as it is necessary for the study of geography and botany, is taught in most schools in Great Britain to boys and girls alike, and presents no great difficulty; but the subject of physics, which is subdivided by examining bodies into three heads, becomes a Cerberus guarding the gate of a sound general education. To pass an examination *either* in heat, light, and sound, *or* in mechanics, *or* in electricity and magnetism may give admittance to the gate of the School Certificate, but that is not quite the same thing. It is undesirable that any boy should leave school without an acquaintance with the main facts of all three, and this is essential to the specialist in science.

The course in general physics outlined by the University of London provides an opportunity for a wider study of physics in the elementary stages, and is suitable for both classes of candidates. Experienced schoolmasters have already found that boys who have passed in the general physics paper are better equipped for an advanced course in science than those who have followed a more intensive course in one branch of physics only. The mathematical difficulties of such matters as lenses and specific heats are not formidable to older students who have made some progress with their mathematics, and if the earlier work is based on

sound teaching of facts and the exact meaning of words, the theory can follow later with greater appreciation.

For such an early course Mr. Hadley's book is eminently suitable. The author's name is a sufficient guarantee of its soundness to those who know his other books. The illustrations are good and for the most part new, and the number of modern appliances described and explained is remarkable. Some attention has been given to the historical side; but among the great names which appear in the index in thick type we have been unable to find Kelvin, Clerk Maxwell, and J. J. Thomson, although wireless telegraphy and atomic structure are treated with some fulness.

Hyper and Ornate Magic Squares, 15th and 16th Orders. Constructed by Major J. C. Burnett. Pp. 36. (Grantham, Lincs.: The Author, Barkston, 1924.)

MAGIC SQUARES having certain properties were known to the ancients. In modern times they have been studied by mathematicians since Albrecht Dürer's celebrated magic square picture of 1514. A magic square of order n involves in its cells the first n^2 natural numbers in such manner that the sum of the numbers in each row, column and diagonal is the same. Certain of these termed "pandiagonals" introduce the broken diagonals possessing the same additive property. If also every pair of numbers equidistant in a straight line from the centre have the constant sum n^2+1, the squares are further specified as associated or symmetrical. Squares are said to be doubly magic if the properties held show the numbers are replaced by their squares. Again, prime numbers exclusively and the knight's path, etc., have been introduced and the squares, to some extent, studied.

Major Burnett presents in his booklet examples of some of these of the 15th and 16th orders. The last square that he gives is doubly magic of the order 8. They will be of service to those who are interested in the subject. There is an extensive literature. Ahrens deals with it in Chaps. xii. and xiii. of his second volume ("Mathematische Unterhaltungen und Spiele," Bands I., II. B. G. Teubner, Leipzig, 1918), and at the end of the volume gives no fewer than 182 references. W. R. Rouse Ball ("Mathematical Recreations") gives an interesting account and many references. Squares which possess row and column properties without any restriction upon the magnitudes of the cell numbers have also been studied. The theory of these is fairly complete since it has been shown that a syzygetic scheme indicating ground forms and syzygies can be constructed. The allied theory of the Latin Square of Euler has also been connected with the theory of differential operations.

It is much to be desired that some competent person should take up (say) the bibliography of Ahrens and give a good account of the present state of knowledge concerning the various natures of magic squares. This will take time and will involve a book of a fair size; but it ought to be undertaken, because the subject is no longer isolated from other parts of mathematics. Several substantial links have been forged during the last thirty years, and without question others are in prospect. P. A. M.

Bristol Geology and Geography: for the Use of School Teachers and Others. By Prof. Sidney H. Reynolds. Pp. 98. (Bristol and London: J. W. Arrowsmith, Ltd., 1924.) 2s. net.

BRISTOL is situated in a district rich in interest to the geologist and one which is well adapted to the study of physical geography. This little handbook has been produced by its author specially to meet the needs of teachers and students of geography and others whose interest in geology is only general. To this end the use of unfamiliar geological terms has been avoided, so far as possible, and, in addition, a glossary is provided.

The district described extends over a somewhat wider area than might be inferred from the title, and includes most parts of Gloucester and Somerset lying east of the Severn, up to within about 25 miles of Bristol, and takes in a little of Wiltshire. Prof. C. Lloyd Morgan's stimulating introduction to Reynolds' "Geological Excursion Handbook for the Bristol District," which outlines the historical and physical geology of the country surrounding Bristol, is reprinted in the book under notice.

Prof. Reynolds, after tabulating the geological strata and chief features of general interest in the district as a whole, proceeds to describe fourteen smaller physically or stratigraphically separable areas.

Detailed geological information, such as is given in the author's "Excursion Handbook," has, for the most part, been omitted, nor are there any references to previous literature. Prominence is given to the physical characteristics of each area, and the reader is assisted by a number of simple sketch maps and diagrams. A novel section of the book is that describing points of geological interest visible from a railway compartment to travellers in the vicinity of Bristol.

Prof. Reynolds' new handbook should serve its limited purpose very well, and may be recommended to visitors to Bristol, by whom it should be studied in conjunction with the geological model of the Bristol district on exhibition at the Museum there. "Bristol Geology and Geography," however, cannot, as its author points out, replace the "Excursion Handbook" as a guide in the field. V. A. E.

Flora of the Presidency of Madras. By J. S. Gamble. Part 6: *Scrophulariaceæ* to *Plantaginaceæ*. (Published under the authority of the Secretary of State for India in Council.) Pp. ii+963-1160. (London: Adlard and Son and West Newman, Ltd., 1924.) 10s. net.

THE feature of the present contribution to the Madras flora is undoubtedly the account of the Acanthaceæ, which occupies more than a third of the entire part. To most workers this family has been one of considerable perplexity, which has not been lessened by the use some recent authors have made in the classification of the genera of minute pollen characters. It is just this that will make the field-worker of S. India, for whom indeed the flora is chiefly written, grateful to Mr. Gamble for giving him a clear analysis of the family which does not necessitate the use of a compound microscope. The excellent keys of some of the larger genera are also improved by the addition of rather full specific details.

One of the most interesting genera treated of is Strobilanthes. So long ago as 1888 the author published in the *Indian Forester* a special study of the genus and an account of the curious periodic flowering of many of the species. Even in the condensed letterpress of this work, room has been found for brief details of this phenomenon. We learn, for example, that a gregarious shrub like *Strobilanthes Kunthianus* grows in such continuous masses on the grassy downs of the Nilgiris and other neighbouring hills that, when it all comes into flower together about every six years, it covers large tracts with blue. It is believed, indeed, by some that the name of that famous range was derived from this circumstance. Some of the other species have even a longer period of flowerless growth; *S. consanguineus*, for example, probably flowers only at intervals of twelve years.

Another family which shows evidence of a great deal of useful work is the Labiatæ, and near the beginning of this part is a valuable contribution to S. Indian botany in the treatment of the genus Utricularia.

La structure des cristaux: déterminée au moyen des rayons X. Par Prof. Ch. Mauguin. (Recueil des Conférences-Rapports de documentation sur la Physique. Vol. 6, 1re Série, Conférences 14, 15, 16. Édité par la Société *Journal de Physique*.) Pp. 281. (Paris: Les Presses Universitaires de France, 1924.) 20 francs.

THIS is an excellent introductory treatise describing the methods of X-ray crystal analysis and the results which have been obtained. A difficulty in the presentation of our new knowledge of crystal structure is due to the fact that we all dislike being asked to think in three dimensions. Prof. Mauguin has realised this, and provides numerous illustrations, many of them very ingenious, which force the reader to visualise the structures which are described. The book is well planned and deals thoroughly with the subject, while yet being concise. The student will find a short introduction to the geometry of space lattices which provides the necessary foundation for a study of crystal structure. The different methods of analysis are illustrated by examples of the more simple crystals. Three short chapters are devoted to atomic dimensions, the structure of the atom, and the interatomic forces, and a final chapter to a description of the principal types of crystals.

Prof. Mauguin has contented himself with a very brief reference to the more speculative aspects of the new science; a list of papers at the end of each chapter will aid the reader who wishes to pursue the subject further. The lucidity of the style makes the book easy to read, and it is a valuable addition to the literature on the subject.

Dairy Farming Projects. By Prof. Carl Edwin Ladd. (Macmillan Agricultural Project Series.) Pp. xix + 327. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 7*s.* 6*d.* net.

THERE are many novel features in this volume which, although it applies to American conditions, still contains such an amount of information and suggestion that it cannot fail to be of great value to the teacher or student of dairy farming, and ought also to be of considerable interest to any farmer or owner of dairy stock. The whole field of dairy farming is covered: types of cattle; breeding, feeding, and management; methods of arranging and working the farm; business and financial aspects of dairy farming, even to suggestions for advertising stock and produce. There are also chapters on the diseases of dairy cattle, clean milk production, preservation of manure, etc., the whole being arranged under appropriate months from September to June.

It is perhaps doubtful whether the somewhat elaborate course of study which the author maps out could be worked in its entirety, but there is no question as to the educational value of what he proposes, and the ideas and methods could by slight adaptation be made to apply to any country.

The Vegetable Proteins. By Dr. T. B. Osborne. (Monographs on Biochemistry.) Second edition. Pp. xiii + 154. (London: Longmans, Green and Co., 1924.) 9*s.* net.

A NEW edition of this well-known work has now appeared. While it contains all the essential material of the first edition, it has been largely rewritten and considerably amplified. The chapter on the proteins of green plants is brought up-to-date by details of Chibnall's work on leaf proteins. The new volume also contains a chapter by L. J. Henderson on the relation of proteins to acids and bases. This discusses the titration curves of vegetable proteins in an extremely lucid manner and presents an interesting addition to the literature of the subject. Frankel's work on the rate of hydrolysis of plant proteins is cited at length in the chapter on the products of hydrolysis, and recent work dealing with the subjects discussed in the original edition appears to be included throughout in sufficiently detailed manner.

The Philosophical Writings of Richard Burthogge. Edited with Introduction and Notes by Margaret W. Landes. Pp. xxiv + 245. (Chicago and London: The Open Court Publishing Co., 1921.) 10*s.* net.

RICHARD BURTHOGGE (1638–1698) was an English medical practitioner who, with the exception of an early medical tract in Latin, "Disputatio de Lithiasi et Calculo," wrote entirely on philosophical and theological subjects. The chief of his works, "An Essay upon Reason and the Nature of Spirits" (1694), is interesting for the light it throws on the general state of philosophical opinion in England at the time when Locke's Essay appeared. The present work is not a reprint of any one of Burthogge's writings but a selection from several, accompanied by notes and collated facts concerning extant editions.

Le Principe constitutif de la Nature organique. Par Édouard Jung. (Bibliothèque de Philosophie Contemporaine.) Pp. 694. (Paris: Félix Alcan, 1923.) 30 francs net.

THIS large treatise seeks to bring under one comprehensive and constitutive principle the whole scheme of the conscious life from its basis in physiology and evolutionary biology to its manifestation in cognitive, moral, and æsthetic activity. It is mainly founded on the philosophy of Kant, and is an application of the logical categories and the Kantian method generally to the whole modern scientific biological problem.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor 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 Word "Scientist" or its Substitute.

I HAVE long thought that it is desirable, but perhaps not possible, to control the use of the words "science" and "art" and derivatives from them. The popular tendency is to make rubbish both of the original words and of the adjectives derived from them. Thus "science" is definitely used to describe the skill of the boxer, the text of Aristotle's writings, the highest mathematics, the twaddle of Mrs. Eddy, and the elements of chemistry.

In hopeless effort to define science it used (a hundred years ago) to be asserted that every art is based on a science and every science has its related art—a piece of glib and baseless assertion. It is Cicero, I believe, who says "*Scientiæ mentis artes*," the sciences are the arts of the mind, whatever "arts" may be. The French speak of "les Sciences," including therein all the "'ologies." In England we like to make-believe in an obscure essence or pervading entity which we call (when we are journalists) "Science" with a large S. Probably the historic and most luminous use of the word "science" is that in the plural, as in "l'Academie des Sciences." The British Association is for the advancement of *science*, not sciences, as it should be, whilst the Royal Society did not three hundred years ago use that word, but declared that it aimed at the promotion of "natural knowledge"—that is, knowledge of Nature, as distinguished from human tradition and Divine revelation.

We get some glimpse of a synonym for the word science when we find Cicero writing "*Physiologia naturæ ratio*," which must be translated "Physiology, the ratio (or 'reasoned story') of Nature." All the "'ologies" or branches of science are ratios or reasoned stories of those sciences. But I can find no word which will serve to distinguish one who deals with many branches of science or to name a body of men dealing with many distinct sciences. It is easy to name those who take up this or that science, as geologist, phytologist, zoologist, chemiologist (chemist), electrologist (electrician), etc. But we soon get into a muddle, even here, since words derived from φύσις have been insanely perverted in meaning during the past three hundred years—for example, *physic* and *physics*, *physicien* and *physician*, as well as *physiology* (this last to mean *not* "natural history," as it should, but the study of the activities of the organs of animals and plants).

I hope NATURE will continue to refuse to use the word "scientist." Its formation can be defended, it is true, as parallel to that of "artist." But the example of the word "artist" gives us no encouragement, for it is the most vague and ill-used word in our language. All sorts of mysterious qualities are claimed for "the artist," and any impostor can defend his claim to be "an artist," and to worship art with a big A. We shall have others saying they "stand for" science with a big S and calling each other "Scientist." The eminent scientist Barney Bunkum is already flourishing in the United States and in English newspapers. I think *we* must be content to be anatomists, zoologists, geologists, electricians, engineers, mathematicians, naturalists (that last is a term I like and wish to use). We cannot find a name to join all the followers of different branches of science, but I think that "rationalist" rightly designates those who, in their inquiries into the unknown in whatever field, strictly follow the scientific method.

It is well to remember in this connexion what Clifford wrote in one of his essays: "There are no scientific subjects. The subject of science is the human universe—that is to say, everything that is, or has been, or may be related to man."

What then *can* we mean by calling a man a scientist? We cannot mean that he studies or pursues any *special* subject. Every subject can be the subject of science. "Science" and "scientific," of course, have reference to the method and habit of mind. Our "man of science" is a man who makes use of and cultivates a special habit of mind or method which is known as the scientific method or experimental method. Assuredly this is *not* what the journalist means when he calls a person "an eminent scientist."

In old times the word "philosopher" was quite properly used for those we now call men of science: they were called "philosophers" or sometimes "natural philosophers," but custom—the most absurd jade we tolerate—actually nowadays restricts "philosophy" to speculations about metaphysics. Hamlet's "philosophy" was wider and all-embracing. The founders of the Royal Society called themselves "Philosophers." I am afraid that word will not do, to-day, for what is wanted; and I feel pretty sure there is not one which will. I should call myself alternatively a philosopher, a natural philosopher, a naturalist, or a rationalist. Rationalist is really the best designation. All men of science are rationalists, but many shrink with fear from the word, since they have been told that the devil himself is a rationalist. It is, however, a just and honourable title. On the other hand, "scientist" has acquired—perhaps unjustly—the significance of a charlatan's device.

E. RAY LANKESTER.
44 Oakley Street,
Chelsea, S.W.3.

IN my little book on "Notes on the Composition of Scientific Papers" I have defended the use of "scientist": it is quite a normal word, such as artist, economist, etc. Against it is the dislike of all new words or spellings; they are contrary to our habits. But there is more than this: in England (especially as compared with Germany or Scotland) there has been a certain prejudice against science as a *profession*. Many of our great men (*e.g.* Darwin, Rayleigh, Clerk Maxwell, etc.) have been great amateurs; and the generations bred upon letters only (*e.g.* Swift) have regarded science as too arid for exclusive culture. The amateur is saved from being narrow or inhuman. So there has been an unconscious antipathy to science as a calling or profession. But I am speaking of our prejudices—remnants of the past—which now are cobwebs, and no more. I should accept the word were I in your place. NATURE has set a good example in another very important—far more important—linguistic matter, namely, the use of "*fact*" as distinct from opinion, or inference, or axiom, or principle, or truth, etc., in the sense of general statement founded upon (assumed) facts. We collect our facts, and upon them are built fallible conclusions or laws, which not a few contributors call also "*facts*." We must keep the word fact for the several events, and call our inferences opinions, conjectures, hypotheses, etc., and ultimately, when relatively certain, theories; theory is our highest scientific category. To mistake inferences or axioms for facts has been a curse of science.

CLIFFORD ALLBUTT.
St. Radegund's, Cambridge.

THE "Oxford Dictionary" defines *scientist* simply as "A man of science." It defines *man of science* (*s.v.* Science, 6) as: *a* (a sense ruled out as obsolete); *b*, "In modern use, a man who has expert knowledge of some branch of science (usually, of physical or natural science), and devotes himself to its investigation." All this with no suggestion whatever that the usage is blameworthy or questionable, or that there is any other modern acceptation.

Accordingly, in the "Pocket Oxford Dictionary" published this year, the only definition of *scientist* given is "(esp.) person learned in one or more of the natural sciences," in which "(esp.)" merely indicates that the limitation to the natural sciences is, though usual, not so far obligatory that, *e.g.*, a pure mathematician might not, exceptionally, be called a scientist.

My opinion is, then, that to refuse the word the now prevalent and extremely convenient sense that you mention, "a worker in the field of physical or biological science," is antiquated pedantry. I may add that nothing is gained by the substitution of *man of science*, so far as meaning is concerned; for any undesirable vagueness that may attach to *scientist* comes to it only as a consequence of *science's* having also more than one sense. But I suspect that those who really have an instinctive (as opposed to a merely imitative) aversion to this use of *scientist* are influenced not by doubts of its meaning, but by dislike of its (and many other -ist words') slightly abnormal formation; but that is not the point raised in your question. H. W. FOWLER.

Moulin de Haut, Guernsey.

So long ago as 1840, according to the "Oxford Dictionary," Dr. Whewell, eminent as man of letters as well as man of science, wrote: "We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist." I do not think the objections to the word on merely literary or linguistic grounds can be maintained. It is a hybrid, but the language is full of hybrids: moreover, it may well be argued that *-ist* is naturalised as an English termination.

There is, however, another sort of objection which has to be weighed. Like other words in *-ist*, it has a professional air, as if the man who so described himself were claiming an *ex cathedra* authority for his utterances. Hence its use is not always complimentary. We see this in its derivatives "scientism" and "scientistic." Similarly, when I have been introduced to a public meeting as an "educationist" or "educationalist," I have wished to be saved from my friends: I would rather be called a schoolmaster. My conclusion is that the term scientist is too convenient to be wholly rejected, but that writers would do well to remember its less complimentary use as a label, and not resort to it too frequently.

J. H. FOWLER.

16 Canynge Square, Clifton, Bristol.

THE word "scientist" is, in itself, neither better nor worse than dentist, oculist, socialist, or violinist. It would be pedantic, at the present day, to object to it merely on the ground that it begins in one language and ends in another. If it were a new word, introduced for the sake of brevity and convenience by some respectable writer, I should have little objection to it; I should be reluctant to use it myself, but I should not dream of objecting to its use by others.

It seems to me, however, that the word has already got a sort of taint about it, very much as the word "sophist" did in Greek. It is often used in an equivocal, or even disparaging, sense, by people who have no great respect either for science or the "scientist." Most men of science would surely rather be called so than be dubbed scientist. The widely used term "Christian Scientist" has helped to make matters worse; what that phrase means I do not know, but if I did know I am sure I should not like it any the better.

On the whole, I take it that the word scientist has been in low company, and I should be very slow to introduce it into better.

D'ARCY W. THOMPSON.

St. Andrews.

REGARDING the inquiry contained in your letter, I would say that the word "scientist" has fully established itself in the written and spoken language of scientific workers as well as of non-scientific persons. It is, of course, when one stays to examine it, a hybrid, but like that other hybrid, the mule, it does useful work. After all, there are numbers of hybrid words in our language also doing useful work, and one does not now trouble to look them in the mouth. For example, take the Latin stems with the Greek termination *-ist*. The psychologists do not blush to use the word "animist"; they even say "behaviourist." In my opinion, "scientist" is a gentle-born word alongside of "behaviourist," which may well have besmirched the pages of NATURE.

W. J. SEDGEFIELD.

The University, Manchester.

I HAVE submitted your inquiry to my son, who is a literary critic. He sees no objection to "scientist," and is rather surprised that it has not been adopted before. He thinks it as well-formed as "artist." He does not much like words ending in "ist," but concludes that they cannot be avoided.

For myself, I dislike the word, but cannot give a clear reason for the dislike—unless it be that the preposterous term "Christian" prefixed to it has given it an alien significance. On the whole, I feel that the public has forced the word upon us, and that we must succumb. OLIVER LODGE.

Normanton House,
Lake, Salisbury.

PERSONALLY, I should say "man of science" rather than "scientist"; but I do not think one can deny to the word scientist its legitimate place in English. It is recorded in the "Oxford Dictionary," together, I admit, with a good many words which a man does not use if he can help it. But the place of "scientist" in the English vocabulary must have been fairly safe since Whewell wrote in 1840, "We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist."

R. W. CHAMBERS.

University College,
Gower Street, W.C.

IN spite of the objections which have been raised to the use of the word "scientist," it may with advantage be used in place of "scientific worker" or "man of science." Whewell seems to have coined the word to describe "a cultivator of science in general." On the whole, there is much to be said in favour of it. It should not, however, in my opinion, be limited to a worker in the field of physical or biological science. ISRAEL GOLLANCZ.

King's College, London.

MY intense dislike of the word "scientist" is due to the fact that it debases the currency. The word is not applied to a man to indicate respect for his scientific or philosophical attainments, but to indicate a certain disdainful attitude towards the truth claims of æsthetic, moral, and religious values. The distinction so often expressed between philosophers and scientists is a false one when it implies (and it is meant to imply) that philosophers are uninterested in or indifferent to the positive results of science.

H. WILDON CARR.

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The Biology of Verse.

IN NATURE for October 11, 1924, p. 534, I have reported the results of the only registrations of verse ever made and analysed. They show that verse is a current of speech energy of varying amount so adjusted as to come in more or less regular waves. When the centroids of these waves are calculated, they are found to occur at approximately equal periods.

The next problem is that of the source of this current of energy. The replies of many living poets to a question-paper agree without exception with all the statements I have been able to find from the poets of the past: they have no ideas whatever on the subject. They all assert, moreover, that the verse-form comes to them ready-made along with the poetic content. This poetic content, they all declare, is forced upon them by some inner power. The source of verse, therefore, must be sought in the source of poetry.

The poets all agree that the source of their poetry lies entirely outside of their consciousness. In psychological terms it is a product of the unconscious. In physiological terms it is a product of bodily processes that result in producing poetical feeling and ideas in consciousness. In either sense it is a biological phenomenon of which the ultimate explanation must be in biological terms.

On the psychological side there are the statements of famous poets of the past. Many say that they write because they must (Pope, Goethe, Schiller, Grillparzer, Hebbel, Brentano, and so on). One of them says that whenever a new poetical idea struck him he had to write it down even at the cost of his life. They often write in over-excited or half-conscious conditions (Goethe, etc.). They write to relieve themselves from mental strain or trouble (*e.g.* Byron). They write out their own inner selves (Byron, Goethe, Schiller, Hebbel). They write because they feel themselves mentally ill (Grillparzer, Heine). They write because they feel themselves to be criminals in need of confession (Hebbel, Ibsen). A poet is a lunatic (Shakespeare). Poetry flows from the poet like gum from a tree (Shakespeare). The statements that I have collected from living poets are along the same lines.

Further psychological information is furnished by the work of Freud and his gifted disciple, Otto Rank. Poetry is the result of an inner conflict. On one side is the fundamental part of the Unconscious, the "It," with its one impulse to have its own inflexible way and to obtain peace; on the other side is the Self, or the "I," with the wish to live, love, and enjoy by adapting itself to the environment. Out of the struggle there is engendered the Conscience, a kind of council of the League of Nations that sits in judgment over the self. Again, like the League of Nations, it is controlled by the stronger powers of the "It" and has the one function of condemning the weaker "I." At the instigation of the "It," Conscience takes every opportunity of declaring the "I" to be a criminal worthy only of annihilation and death. It is kept from doing so only by the power of the Self to resist it. The details of this conflict must be sought in the works of Otto Rank.

The result of the conflict depends on the amount of fundamental energy, or kinetic drive, at the disposal of the Self. When this becomes small, as in misfortune, weakness, illness, or grief, the Self can no longer resist the efforts of "It" to get Conscience to pass a condemnation of the Self to some degree of death varying from withdrawal from social life to suicide. With more fundamental energy the Self struggles with varying success but never gets real control; this produces the condition of the neurasthenic failure. With a larger amount of fundamental energy the result depends on what compromise can be effected. Sometimes the Self compromises with the "It" by carrying out some of its anti-social demands; this produces the criminal. Sometimes the Self can win only by denying the truths of the environment; this produces the lunatic. Sometimes the Self can escape by affording the "It" a means of letting off its force in a way that partially lightens the pressure but yet does not bring the Self into conflict with the environment. This produces the class to which the poet belongs.

Poetry is thus the expression of the impulses of the "It" in a form acceptable to the environment. These impulses are familiar to Freudian analysts. Some of them have been exhaustively treated by Otto Rank. A complete general treatment of the poetic conflict has not yet been made.

It is my own belief, however, that this conflict can be reduced to biological terms that can even be measured. In NATURE for March 15, 1924, p. 386, I have shown that records of speech show the presence of three biological forces; the impulse to conform to the speech of the environment, the hindrance to successful conformity, and the impulse to correct the resulting defect. The three forces correspond quite well to the Freudian concept of the Self, the "It," and Conscience. In many speech records—both normal and pathological—the prevalence of one or another of these forces can be plainly seen and measured. It is a commonplace of my laboratory to use the size of the probable error in making speech sounds as a measure of the successful adaptation of the speaker to his social environment. A large probable error indicates either an increase of the inner hindrance to adaptation or a decrease in the impulse to correction—or in Freudian terms either an increase in the power of the "It," or a decrease in the force of the Self or a decrease in the power of Conscience. Quite characteristic is the fact that a very large probable error is diagnostic of general paralysis, a disease the earliest characteristic of which is a decay of the social sense, that is, of Conscience.

Whether the result of this conflict depends on metabolism or the presence or removal of toxins in the blood or on the hormone balance, biochemistry must determine. It is my belief that a physiological explanation quite parallel to the psychological one can be found.

In any case poetry is the product of a compromise among biological forces whereby the social force is strong enough to affect the adjustment by allowing the anti-social force some degree of expression.

The source of the verse form itself is now clear. Rhythmic speech is the primitive form of language. The linguist Prof. Jespersen of Copenhagen agrees with the poet that

> Thus Nature drove; warbling rose
> Man's voice in verse before he spoke in prose.

OEHLENSCHLÄGER.

The natural speech expression of the more primitive savage Unconscious is in verse form. That is why, as so many poets report, their poems come to them suddenly in completely finished form (Goethe, Grillparzer, Hebbel, Brentano, Fontane, Goncourt, Flaubert, and many living poets). The source of the verse form thus lies, like the source of poetry, in a partial yielding of the Self to the demands of the Unconscious for expression.

E. W. SCRIPTURE.

University of Vienna.

Experiments on Sex in Mushrooms and Toadstools.

MISS MOUNCE,[1] working under my direction, found that *Coprinus sterquilinus*, *C. stercorarius* (a sclerotium-producing species), and *C. narcoticus* are all homothallic. All the spores in each of these species are sexually of one kind, and each spore gives rise to a mycelium which becomes diploid and fruits perfectly without fusion with any other mycelium.

Hans Kniep [2] has shown that in *Schizophyllum commune* and *Aleurodiscus polygonius*, segregation in the basidium results in the production of four sexually different haploid genotypes, so that the spores sexually are of four different kinds. Normally one kind can react with only one of the others. Two Mendelian pairs of factors are involved. The diploid fusion nucleus in the basidium bears both pairs of factors and may be represented as (AaBb). The haploid nucleus of each of the four spores bears only one of each pair of factors, so that sexually the four kinds of spores may be represented as (AB), (Ab), (aB), and (ab).

W. F. Hanna,[3] working in my laboratory upon *Coprinus lagopus*, has confirmed Kniep's results. His experiments, which have involved some 1500 matings, clearly demonstrate that, here again, we have a species which bears spores which sexually are of four different kinds: (AB), (Ab), (aB), and (ab).

There has just come into my hands a paper by Vandendries,[4] in which he records experiments which prove that *Coprinus radians* is bisexual, *i.e.* that this fungus produces spores which fall into two sexually opposite groups, and not into four groups as found by Kniep for *Schizophyllum commune* and *Aleurodiscus polygonius* and by Hanna for *Coprinus lagopus*.

Miss Dorothy Newton,[5] who has been studying the problem of sex in my laboratory for upwards of a year, has obtained results with *Coprinus Rostrupianus* which are exactly similar to those Vandendries obtained with *C. radians*; for, as a result of upwards of 400 matings, she has found that in *C. Rostrupianus* the spores fall into only two groups which are sexually opposite.

In *Aleurodiscus polygonius*, under certain abnormal moisture conditions, the four spores of each basidium are shot away together in a single mass. Kniep [6] noted this fact and took advantage of it to analyse the sexual reactions of the four spores on each of thirty-five basidia. He found that each basidium bore two kinds of spores, two of one sex and two of another, and that there were two kinds of basidia, so that the two pairs of spores of one group of basidia were different sexually to the two pairs of spores of the other group of basidia. The four spores of one group may be represented as (AB), (AB), (ab) and (ab), and the four spores of the other group as (Ab), (Ab), (aB) and (aB).

Kniep's method of obtaining the four spores of a single basidium and separating them by shaking them apart in agar is applicable, so far as is at present known, only to *Aleurodiscus polygonius*; and Vandendries was unable to analyse the sexual reactions of the four spores of a single basidium of his *Coprinus radians*.

A method for removing the four spores of a single basidium and sowing them separately has been devised in my laboratory, and it has the advantage over the method used by Kniep in that it is not dependent on an abnormality but is generally applicable to normal fruit-bodies of Coprini and other Hymenomycetes.[7] The method is as follows. A gill is placed on a slide and a cover-glass is lowered down upon it and pressed gently against the hymenium. The cover-glass is then raised, inverted, and examined under the microscope. The four spores of each of a number of basidia are then seen to be attached by their apices to the cover-glass, so as to form tetrads resembling those which may be observed on isolated basidia when one looks down on a gill from above with the microscope. Using the dry-needle method, described by Hanna,[8] it is then not difficult to remove the other spores around a perfect tetrad and afterwards to pick up the four spores of the tetrad one by one and sow them individually in hanging drops of a culture medium.

By employing the methods just described, both Hanna and Miss Newton have successfully analysed the sexual reactions of the four spores of a considerable number of individual basidia. In Hanna's quadrisexual species, *Coprinus lagopus*, some of the basidia were found to bear spores of two kinds only, a pair of one sex and a pair of another and opposite sex, while other basidia were found to bear spores of all four kinds: (AB), (Ab), (aB), and (ab). The occurrence of four different kinds of spores on a single basidium proves that the reduction process in the basidium takes place with the second division of the nucleus, and not with the first as found by Kniep in the case of *Aleurodiscus polygonius*. In Miss Newton's bi-sexual species, *Coprinus Rostrupianus*, all the basidia have been found to be exactly alike, for they all bear only two kinds of spores, two of one sex and two of the other and opposite sex.

A. H. REGINALD BULLER.

The University of Manitoba,
November 13.

Negative and Doubly Charged Positive Ions in Argon.

IN letters to NATURE (June 16, 1923, and July 26, 1924), and elsewhere (Proc. Roy. Soc. A, vols. 102, 104, 105), Dr. H. D. Smyth has described investigations he has made of the ionisation of several diatomic gases. By using positive ray analysis he was able to correlate different ionisation potentials with the production of ions of different ratio of mass to charge. I have now used the same apparatus to study the ionisation of argon, chiefly to explain, if possible, the "blue" spectrum of this element.

[1] Irene Mounce: (1) "Homothallism and the production of fruit-bodies by monosporous mycelia in the genus Coprinus," Trans. Brit. Mycolog. Soc., viii., 1921, pp. 198-217. Also (2) "Homothallism and heterothallism in the genus Coprinus," *ibid.* 1922, pp. 256-269. An account of the experiments made with *Coprinus narcoticus* has not yet been published.

[2] Hans Kniep: (1) "Über morphologische und physiologische Geschlechtsdifferenzierung," *Verhandl. der physikal.-med. Gesellschaft zu Würzburg*, xlvi., 1919; (2) "Über Geschlechtsbestimmung und Reduktionsteilung," *ibid.* xlvii., 1922; (3) "Über erbliche Änderungen von Geschlechtsfactoren bei Pilzen," *Zeitsch. Indukt. Abstamm. u. Vererb.*, xxx., 1923.

[3] W. F. Hanna, "The Problem of Sex in *Coprinus lagopus*." To appear shortly in the *Annals of Botany*.

[4] R. Vandendries, "Contribution nouvelle à l'étude de la sexualité des Basidiomycètes," *La Cellule*, xxxv., 1924.

[5] D. Newton, paper shortly to be sent to the press.

[6] Hans Kniep, "Über Geschlechtsbestimmung und Reduktionsteilung," *Verhand. physikal.-med. Gesellschaft zu Würzburg*, xlvii., 1922, pp. 1-29.

[7] The method is described in Hanna's paper on *Coprinus lagopus*. It was devised and perfected by Miss Dorothy Newton, W. F. Hanna, and the writer, working conjointly.

[8] W. F. Hanna, "The Dry-Needle method of making monosporous cultures of Hymenomycetes and other fungi," *Annals of Botany*, xxxviii., October 1924.

From a preliminary analysis of results I found that singly charged, positive, atomic argon ions were first produced in detectable numbers when an accelerating potential of about 17 volts (uncorrected) was applied to electrons striking the atoms. I do not consider that the accuracy of the determination is sufficient to distinguish between the varying results of other observers.

Doubly charged, positive atomic ions were not produced at all until an accelerating potential of more than about 45 volts was applied. For the most part these must have been produced by single impacts as the pressures and thermionic currents used were so small as to make successive impacts very improbable. This result is contrary to the assumption that the critical potential of about 34 volts at which the first part of the blue spectrum appears (Horton and Davies, Proc. Roy. Soc. A, 102, p. 131 (1922), and Déjardin, *Ann. de Phys.*, 10th Series, v. ii., p. 241 (1924)) corresponds to the production of doubly charged ions. Therefore this portion of the blue spectrum cannot be the entire first enhanced spectrum of argon. It may be due to excitation of the singly ionised atom, but the detailed application of this hypothesis meets difficulties which are too complicated to discuss here.

I also found that large quantities of negative ions could be produced. These apparently originated in a region of the tube where impacting electrons had just sufficient energy to excite the atoms. It therefore appears that in argon it is a necessary and sufficient condition for the capture of an electron that the atom first be in an excited state.

A full report of this work is to be published shortly.

HENRY A. BARTON.

Palmer Physical Laboratory,
Princeton University,
November 3.

Flow of Sap in Trees.

IN recent discussions on the upward movement of sap in trees, I have seen no mention of an interesting observation of Charles Darwin to be found in his "Voyage of the Beagle" (p. 258, John Murray, 1912 edition). He was exploring the Campana or Bell Mountain about 26 miles from Valparaiso, and he writes as follows, for the quotation is worthy to be reprinted in full:

"In a few places there were palms, and I was surprised to see one at an elevation of at least 4500 feet. These palms are, for their family, ugly trees. Their stem is very large, and of a curious form, being thicker in the middle than at the base or top. They are excessively numerous in some parts of Chile, and valuable on account of a sort of treacle made from the sap. On one estate near Petorca they tried to count them, but failed, after having numbered several hundred thousand. Every year in the early spring, in August, very many are cut down, and when the trunk is lying on the ground the crown of leaves is lopped off. The sap then immediately begins to flow from the upper end, and continues so doing for some months; it is, however, necessary that a thin slice should be shaved off from that end every morning, so as to expose a fresh surface. A good tree will give ninety gallons, and all this must have been contained in the vessels of the apparently dry trunk. It is said that the sap flows much more quickly on those days when the sun is powerful; and likewise, that it is absolutely necessary to take care, in cutting down the tree, that it should fall with its head upwards on the side of the hill; for if it falls down the slope, scarcely any sap will flow; although in that case one would have thought that the action would have been aided, instead of checked, by the force of gravity. The sap is concentrated by boiling, and is then called treacle, which it very much resembles in taste."

The effect of the sun and the great quantity of sap from a felled tree are both noteworthy, but the effect, or rather inhibition, due to gravitation, adds mystery to an obscure subject. A friend has proposed to test this gravitational effect with two young felled sugar maples next spring.

A. S. EVE.

McGill University, Montreal,
November 1.

The Colour of Sulphur Suspensions.

IN the review of Ostwald's "Licht und Farbe in Kolloiden" which appeared in NATURE of November 8, p. 672, the reviewer alludes to the investigations of Keen and Porter on "sulphur suspensions containing particles *large compared with wave-lengths* and indigo in *transmitted light*." He adds, "No theory of this phenomenon is available so far; until one is found there will be a distinct gap in the optics of disperse systems."

A theory of the effect observed by Keen and Porter was given by Prof. C. V. Raman and Mr. B. Ray in 1922 ("On the Transmission Colours of Sulphur Suspensions," Proc. Roy. Soc. A, vol. c., pp. 102-109), the explanation offered being that the colour of the transmitted light is due to interference between the primary wave and the light scattered by the particles in the direction of the primary wave. Results were given of calculations based on Rayleigh's theory of the scattering of light by a transparent sphere.

Raman and Ray repeated Keen and Porter's experiments and found that the diameter of the sulphur particles when the indigo colour first appeared was considerably less than that quoted by Keen and Porter, but that the amended value agreed satisfactorily with the theory. The theory appears to be adequate, although the computation of numerical results is extremely tedious. A more complete comparison of theoretical with experimental results than has yet been published is desirable.

E. T. PARIS.

Signals Experimental Establishment,
Woolwich Common, S.E.

Absorption Spectra of Mixed Metallic Vapours.

DURING work on the absorption spectra of mixtures of metallic vapours, I have obtained band spectra peculiar to mixtures of magnesium and alkali metals, and also to mixtures of calcium and alkali metals. A sodium-potassium band spectrum has already been described (Proc. Roy. Soc., 1924). The existence of such band spectra is of interest, as it points to the presence of molecules of volatile alloys of these metals in the mixed vapours.

I have incidentally observed that lines of the series $1S - md$ are developed in the absorption spectra of rubidium and cæsium vapours. As has been remarked by Datta, who observed the corresponding absorption in potassium, the development of such series in the absence of an electric field is a contravention of the selection principle, since it involves a change of two in the azimuthal quantum number.

I have, further, been unable to trace any previous observation of the cæsium series $1S - md$, either in emission or absorption, and wave-length measurements, as well as experiments upon the conditions necessary for its appearance, are at present in progress.

S. BARRATT.

University College, Gower Street, W.C.1,
November 12.

The Ages and Masses of the Stars.

By J. H. JEANS, Sec. R.S.

AS is well-known, a rapidly moving electron has a greater mass than a stationary one; more force is required to deflect it from its path or to produce a specified acceleration. The theory of relativity shows that this is not an isolated phenomenon, but an example of a universal principle. Every natural system, on acquiring additional energy E increases its mass by E/C^2, and a loss of energy causes a corresponding loss of mass.[1] For example the sun, losing energy by radiation at the rate of $3{\cdot}8 \times 10^{33}$ ergs per second, must be losing mass at the rate of $4{\cdot}2 \times 10^{12}$ grammes (about four million tons) a second.

Changes of energy and changes of mass are, then, the same thing: it is immaterial whether we specify the change in terms of energy or of mass. It is a somewhat different question whether absolute mass can be specified as absolute energy or vice versa. For example, setting an electron in motion with a velocity $0{\cdot}866C$ doubles its mass, but in what sense does it double its energy? If m was the mass of the electron when at rest, the addition m to its mass has represented an addition mC^2 of kinetic energy, but did the original mass m also denote energy mC^2?

Clearly an electron at rest must be thought of as having some energy, for it consists of electric charges which have been brought very close to one another in opposition to their mutual repulsions. If an electron is regarded as a negatively charged sphere, its electrostatic energy is $\frac{3}{4}mC^2$. To satisfy the conservation of energy when the electron is in motion, there must be further energy $\frac{1}{4}mC^2$ of unknown type,[2] making energy mC^2 in all. Presumably the whole of this would be set free if the electron could be persuaded to explode and scatter to infinity.

The energy mC^2 just discussed may be called "sub-electronic" energy, any further energy which electrons may have in virtue of their motion or positions in space being "super-electronic" energy. The two energies become equal when an electron moves with a velocity $0{\cdot}866C$, corresponding to a temperature of 4,000,000,000° Centigrade; for an atom the corresponding temperature is thousands of times higher. In all actual systems, then, the super-electronic energy is insignificant in comparison with the sub-electronic. In the sun the ratio of the two kinds of energies is probably at most of the order of one to a million, and the same is of course true of the two kinds of mass. Of the sun's total mass of 2×10^{33} grammes, not more than about 2×10^{27} grammes can be "super-electronic."

The sun, as we have seen, is radiating mass away at about four million tons per second. The usual estimates of the sun's age have all been based on the supposition that the only mass available for radiation is the "super-electronic" mass. The estimates reached in this way, about twenty million years, have been too short to satisfy either astronomers or geologists. Some years ago I suggested that the source of stellar radiation was to be found in an actual destruction of matter in a star's interior, the mechanism probably being that positive and negative electric charges fell together and annihilated one another. The essential novelty in this suggestion was that it made the enormous "sub-electronic" mass of a star available for radiation, in addition to the comparatively puny "super-electronic" mass; thus it immediately extended our estimate of the sun's life by a factor of the order of a million. Whatever else may be thought of this suggestion, it must be admitted that it solves, with a comfortable margin to spare, the age-long problem of the source of the energy of stellar radiation.

Nothing in the suggestion appears to conflict with modern atomic physics. According to classical electrodynamics, the mutual destructiveness of positive and negative charges was such that all the matter of the universe ought long ago to have melted away in a blaze of glory. The quantum-theory has introduced restrictive forces which, in some way unknown to us, keep positive and negative charges apart, but these forces are not unfailing in their action. At times the electron in the hydrogen atom eludes them and drops down from orbit 3 to orbit 2, at times it drops farther from orbit 2 to orbit 1; let it sometimes also drop from orbit 1 to orbit 0, and what we have been imagining becomes an accomplished fact.

In the form in which we have so far put it, the whole question looks somewhat speculative. It takes on an entirely new complexion in the light of the definite results recently obtained by Eddington (cf. NATURE, May 31, 1924). Both as a matter of theory and of observation, Eddington finds that a star's luminosity is a function, approximately, of its mass alone. All the stars that are about as massive as Sirius have about the same luminosity as Sirius, stars as massive as our sun are about as luminous as our sun, and so on. At present Sirius has 2·5 times the mass of our sun, and 36 times the luminosity. Not having an unlimited store of energy it cannot go on radiating at its present rate for ever; its luminosity must eventually decrease, and some day this will only be equal to that of our present sun. When that day comes, Sirius will be only about as massive as our present sun, so that between now and then it must lose 60 per cent. of its present mass. This is enormously more than the total "super-electronic" mass of Sirius, so that we conclude that the main part of its loss of mass will of necessity be "sub-electronic." Further, we know of no normal process by which mass can escape except by radiation, whence we conclude that the diminution of mass is the equivalent of the energy radiated away.

If this be conceded, Eddington's relation between luminosity and mass fixes quite definitely the rate at which stars change both their luminosity and mass. For example, the sun with a mass of 2×10^{33} grammes, is radiating away $4{\cdot}2 \times 10^{12}$ grammes a second. Thus, after 1,500,000 millions of years its mass will be reduced by 10 per cent., so that from Eddington's table, its luminosity will be reduced by about 30 per cent. In the same way we find that the interval on the evolutionary ladder between Sirius and our sun is approximately $6{\cdot}4 \times 10^{12}$ years. Between a giant sun of ten

[1] Here and throughout C denotes the velocity of light, 3×10^{10} cm. a second.

[2] Jeans, "Electricity and Magnetism," 4th edition, § 667.

times the mass of our sun and our sun, the interval is $7{\cdot}5 \times 10^{12}$ years. These two figures do not differ greatly, for a star squanders its mass at a great rate during its highly luminous giant state; it is the last part of the journey that takes the time. Both figures are of course enormously large in comparison with any estimates heretofore made on the ages of the stars.

If nothing unexpected intervenes in the next $6{\cdot}4 \times 10^{12}$ years—and it must be admitted that there is time enough for the unforeseen to occur—Sirius will at the end of that period be similar to our present sun. We cannot, however, assert that $6{\cdot}4 \times 10^{12}$ years ago our sun was in the state of the present Sirius. The old-fashioned astronomer believes that the whole universe was created only some 10^9 or 10^{10} years ago, and until the contrary is proved he has a right to his opinion.

The geologist insists that life on our earth must have existed for millions of years because fossil bones occur under deposits which, he estimates, must have taken millions of years to accumulate. A similar method of reasoning is available to the cosmogonist, who has the advantage over the geologist that he can calculate, instead of estimating, his periods of time.

All calculations in cosmogony have hitherto been made on the supposition that stellar masses remained constant. The conception of diminishing masses brings new features into almost every problem of cosmogony. For example, the orbit of a particle about a gravitating mass is no longer an endlessly repeated ellipse; it is an ellipse of ever-increasing size, the major axis of which varies inversely as the mass of the attracting body. After 1,500,000 millions of years, when our sun will only have nine-tenths of its present mass, the radius of the earth's orbit will be ten-ninths of its present size and the year will have lengthened to 451 days. The whole universe of stars is expanding for the same reason and in the same way as the solar system. When, if ever, in the past the average star had four times its present mass, the stars must have been 64 times as closely packed as now, and stars must have interfered with their neighbours 64 times as much as they now do. When due allowance has been made for this, it is found that features are shown by the stars which could be produced by the influence of neighbouring stars in periods just about equal to those we have had under consideration, say six or seven millions of millions of years. These features are the fossil bones of cosmogony.

Foremost among such features must be placed the orbits of binary stars. A newly formed binary star has generally a period of a few hours and an almost circular orbit of radius of the order 5×10^{11} cm. Old binaries show much longer periods, orbits which are frequently highly eccentric and of radius much greater than those of new stars. Statistically, the orbits tend towards conformity with what may be called the "equipartition law"—the law which would be obeyed exactly if the binaries were pushed and pulled about by their neighbours for an unlimited time. Calculation shows that the observed partial conformity to this law indicates a knocking about for a period of the order of that just mentioned, say six million million years.

The same period is indicated by the velocities of the stars in space. Statistically, the most massive stars have the lowest velocities, and there is a pronounced tendency to obey an "equipartition law" under which the velocity varies inversely as the square-root of the mass. This would be obeyed perfectly if the stars had influenced one another for ever; the partial extent to which it is obeyed again indicates a period of the order of six million million years.

A somewhat less convincing "fossil-bone" is provided by a study of the ratios of the masses of the two components of binary stars. As a binary gets older, its components become more equal in mass. According to Aitken,[3] 20 spectroscopic binaries of early type (B to B8) show an average mass-ratio 0·70, while 7 of late type (F to G) show an average mass ratio of 0·89. Calculation shows that to pass from a mass-ratio 0·70 to one of 0·89 would require a period of 4·5 million million years. The numerical result is entirely satisfactory, but it must be admitted that it is based on scanty material.

Finally, it may be remarked that the extension of the time scale which is now proposed increases enormously the chance of solar systems being formed by tidal action. With a time scale of 10^9 years, we had to think of systems of planets such as our own as being of necessity extremely rare. With the longer time-scale and the recognition that our system of stars must have been more closely packed in the past than now, we can think of planetary systems as being, if not quite the normal accompaniment of a sun, at least fairly freely distributed in space.

[3] "The Binary Stars," pp. 206, 207.

The Ages of Peat Deposits.

By Dr. W. H. PEARSALL.

RECENT work on the Yorkshire peat has raised some very interesting problems as to the ages of various types of peat deposit in the British Isles. One of the striking features of the Pennine peat is the normal absence of any marked differences in composition, such, for example, as the definite forest layers observed in the Scotch deposits by Prof. Lewis. Typical Pennine peat is usually composed entirely of cotton-grass remains, though here and there the remains of heather or birch point to local desiccation, which can usually be traced to drainage. In the Ingleborough district, Messrs. Cheetham and Burrell find the basal vegetation to differ very slightly from that of the main peat, though rushes are often present. Birch scrub with local pine and oak is also very widely distributed up to 1900 ft. The presence of oak is suggestive, since this tree is not known from deposits older than Neolithic, either in England or Scandinavia.

Mr. J. Holmes first pointed out that neolithic flints occurred about the base of the peat, and now further information is accumulating, largely through the efforts of Mr. F. Buckley and Dr. T. W. Woodhead. They

have found among the trees at the base of the peat, a horn of *Bos primigenius* and a triangular arrow-head of the Neolithic Dolmen period. At a somewhat higher level, a piece of bronze and a barbed arrow-head suggest the Bronze Age horizon. Added to this, are previous discoveries of two horizons in the sand underlying this peat. The lower layers of sand contain flint implements of the Belgian Tardenois culture, while similar traces of the later Tardenois period are found in the upper layers of sand.

If the facts so far ascertained are completely substantiated, they form a very valuable chronological sequence. The question then arises as to their relation to the Scottish peat deposits studied by Lewis. These show fairly definite horizons roughly corresponding to Geikie's well-known climatic periods, namely, from below upwards, a Sub-arctic or Tundra zone, a Lower Forest, a Lower Turbarian or peat layer with some arctic plants in places, an Upper Forest, and finally an Upper Turbarian or deep peat layer.

Now, tree layers in peat are not *necessarily* an indication of climatic change. There is, for example, at present a general tendency for woodlands on poor soils (owing to the progressive leaching of the soil) to be replaced by moorland types of vegetation. Wood layers at the base of the peat may indicate a similar natural succession of vegetation. The study of plant successions on lowland peat also indicates that stages of woodland may alternate with stages in which peat is formed more rapidly, without the intervention of climatic change. It is obvious that extreme caution is necessary in interpreting the wood layers in peat deposits. The validity of the assumption made by Lewis that the Scottish peats show evidence of climatic change, largely rests on two facts. In the first place, the peats studied were mostly from high levels, where the general conditions are unfavourable to tree growth. Secondly, Lewis lays emphasis on the continuity of the main horizons almost all over Scotland. The Scottish wood layers are thus, apparently, signs of widespread changes. Samuelsson has reinvestigated the Scottish deposits and his main conclusions agree with those of Lewis.

So far as it can be ascertained, there is at present little evidence as to the archæological age of the main horizons. We can, however, obtain a rough correlation with the English results by indirect methods. According to Clement Reid, the submerged forests round the English coast are apparently of Neolithic age. Reid also estimated the period of coast depression to occur between 3500 and 1500 B.C., since when the coast has remained fairly stable. He pointed out that as no arctic or tundra species occur in these forests, they were probably formed a long time after the last considerable glaciation. The submerged forests apparently approximate to the tree layer at the base of the Pennine peat and the period of its replacement by moorland. Now along the Scottish coasts, the submerged forests are replaced by the 40-50 foot beaches, also of Neolithic date, and these beaches correspond in time to the Lower Turbarian stage of Lewis. If this approximation is correct, we then obtain the suggestion that the destruction of the Pennine forest coincides with the colder climate assumed for the Lower Turbarian. It would also indicate the Scottish Upper Forest to be approximately Bronze Age, while the Palæolithic horizons might lie below the Lower Forest. It is of interest to compare this approximate sequence with that obtained from the very detailed studies of Scandinavian peats. The following summary, taken chiefly from von Post, avoids most of the controversial points.

VEGETATION-CLIMATIC PERIODS.

1. Sub-Atlantic—Colder and moist.	Recent.	
2. Sub-Boreal—Drier: the warmest part of the post-glacial period	Bronze Age Stone Cists Passage Graves Dolmens	*circa* 2000 to 1000 B.C. Neolithic. English submerged forests are later than Littorina depression.
3. Atlantic—Warm and moist	First Swedish Stage Transition — including Tardenoisien	Maximum extent of Littorina Sea.
4. Boreal—warmer	Ending about 6000 B.C.	
5. Sub-Arctic	End of Palæolithic—beginning about 10,000 B.C. (De Geer).	

The warm Sub-boreal period in Scandinavia could scarcely fail to exert some influence in Scotland. Hence the estimate of the Upper Forest as being approximately of Bronze Age would receive some justification. The Neolithic Dolmen period apparently indicated at the base of the Pennine peat lies at the beginning of the Scandinavian Sub-boreal period, and we are apparently faced with the difficulty that the Scandinavian climate was becoming drier and more favourable to woodland vegetation while British climate was becoming colder (and moister ?). The evidence clearly suggests that either the Scandinavian and British culture periods were reached at different times or else that the climatic sequences were actually somewhat different. Much would depend, therefore, on the determination of cultural horizons in the Scottish peat. To these problems, one must in honesty add one more. The Pennine upland peats, as a whole, show few, if any, traces of Lewis's Upper Forest layer, although this is supposed to represent a time when the forest limit was very greatly raised both in Britain and Scandinavia. Further, in the Danish and Swedish lowland moors, this horizon is marked by a definite layer of "horizon peat"—the Sub-boreal surface.

A similar surface presents the only strikingly uniform horizon in the upper peat of the North Lancashire "mosses." It occurs about 3 to 4 feet below the surface, and below the peat is brown and partly decayed remains of Sphagnum and Eriophorum. Above this horizon, the peat is "white" and undecayed Sphagnum peat. Dr. Osvald, to whom I showed this, considered that it coincided with the Swedish Sub-boreal horizon. It certainly corresponds with a long period when the development of all the North Lancashire moors was arrested and when, according to Mr. Rankine, the surface was sufficiently firm to allow a corduroy road to be laid on it. Why is this horizon and that of the Scottish Upper Forest so conspicuously absent from the typical Pennine peats? It must be confessed that these problems suggest that the climatic theories of peat succession are not nearly so firmly anchored in Great Britain as in Scandinavia. The further investigation of peats is likely to assume great importance and, in particular, the establishment of cultural horizons in the Scottish peats. The present indications clearly raise more problems than they solve.

New Measurement of the Velocity of Light.[1]

By Prof. A. A. MICHELSON, For. Mem. R.S.

THE velocity of light is one of the most fundamental of the constants of Nature, and this fact alone would justify the attempt to measure its value with the highest possible precision. But in addition to its scientific importance, it may prove to have a practical value if the result of such a measurement can be obtained with sufficient accuracy.

The mean of the various measurements thus far attempted is 186,330 miles per second, with an uncertainty of twenty or thirty miles. If this uncertainty could be reduced to one mile per second, the timing of light could be utilised to obtain distances between stations from 50 to 100 miles apart far more expeditiously and with an order of accuracy at least as great as that obtainable by the usual method of triangulation. Indeed, there are possibilities of utilising the velocity of light in cases where triangulation would be difficult or impossible.

An invitation tendered by Dr. G. E. Hale, then Director of the Mt. Wilson Observatory, and supported by Dr. J. C. Merriam, Director of the Carnegie Institution, made it possible to install the necessary apparatus on Mt. Wilson, with Mt. San Antonio, twenty-two miles away, as the distant station, during the summer of 1923; but smoke and haze from burning oil and from forest fires made it impossible even to test the feasibility of the method at so great a distance.

This feat was accomplished during the past summer with very promising results. The set-up of apparatus involved several important changes in the arrangement employed in previous investigations, the most important of which consisted in the substitution of an octagonal revolving mirror for the usual plane-parallel, together with the introduction of a system of reflectors which eliminated all direct and diffuse extraneous light. Finally, a simple method for returning the light from the distant station to the source was substituted for the plane mirror used for this purpose in previous work, and this equipment functioned so well that no readjustment was required during the entire two months of the work.

[1] Address delivered at the University of Pennsylvania on September 19, on the occasion of the observance of the centenary of the Franklin Institute. Reprinted from the Journal of the Institute for November 1924.

The advantage of the octagonal revolving mirror, in addition to the higher speed obtainable, lies in the possibility of receiving the return light on a succeeding face, thus eliminating the measurement of the angular deflexion of the returned beam; or rather, transferring this measurement to the construction of the octagon, the angles of which were tested and found to be equal, with an uncertainty of only one part in a million.

The determination of the velocity of light is thus reduced to the measurement of the distance between the stations, and of the speed of rotation of the mirror. The former operation was carried out by the U.S. Coast and Geodetic Survey, and the result obtained was 35,426·3 metres (about twenty-two miles), with an uncertainty of the order of only two parts in a million. The errors in the measurement of the speed of the revolving mirror were much greater, as no very effective means were employed to ensure its constancy. (This defect will be eliminated in the continuation of the work next summer.)

Notwithstanding the inconstancy of the speed of the mirror, the choice of the most favourable moment, when the speed was that corresponding to the frequency of a control tuning-fork, made the resulting uncertainty of the measurements of the order of one ten-thousandth part, which is about that of the mean of all the previous measurements. It is hoped that next year's work will furnish results four or five times more accurate.

The result of eight independent observations in the present preliminary work is, for the velocity of light *in vacuo*, 299,820 kilometres per second.

Following is a table of results of the more important investigations to date, with an estimate of the weight which should be assigned to each:

Investigator.	Method.	Distance.	Weight.	Velocity.
		km.		
Cornu	Toothed wheel	23	1	299,950
Perrotin	Toothed wheel	12	1	299,900
Michelson	Revolving mirror	0·6	2	299,895
Newcomb	Revolving mirror	6·5	3	299,860
Michelson	Revolving mirror	35·4	3	299,820

Obituary.

DR. FRANZ DOFLEIN.

IT seems but a short time since we deplored the premature death of Prof. Minchin, and now protozoologists have lost another distinguished leader, Prof. Doflein of Breslau, who died at the age of fifty-one on August 26. It is by his excellent text-book, "Lehrbuch der Protozoenkunde," that Doflein is most widely known. The fourth edition, which appeared in 1916, has been out of print for some years, and he had been working for the last three or more years on a fifth edition, although often interrupted by illness, aggravated by depression caused by the War. However, it is some satisfaction to learn that this new edition may be expected soon to appear, as it is being prepared for the press by Prof. Reichenow, of the Institute of Tropical Medicine in Hamburg.

Many in Great Britain will remember Prof. Doflein's charming personality and his readiness to help any one interested in his subject. He attended the Dundee Meeting of the British Association in 1912 and worked much at the Zoological Stations of Naples and Rovigno as well as in the Musée Océanographique at Monaco.

Franz Doflein was born in Paris in April 1873, his mother being of English origin and his father a German merchant. At seven years of age, on the death of his father, he was taken to Germany to be educated. In 1896 he went to the University of Munich to study medicine, but, coming under the influence of Prof.

Hertwig, he decided to devote himself to zoology. After graduating, several university posts were held by him in Munich until 1912, when he was appointed Weissman's successor as professor of zoology at Freiburg. Here he taught for six years, finally moving to Breslau in the autumn of 1918 to become Director of the Zoological Institute in succession to Kükenthal.

A many-sided naturalist, Doflein published work on crabs, ants and Bdellostoma as well as his numerous important papers on the protozoa. The first edition of his text-book appeared in 1901 under the title "Die Protozoen als Parasiten und Krankheitserreger." The second edition five years later was the first to be known as the "Lehrbuch der Protozoenkunde," and it included descriptions of free-living as well as parasitic protozoa. In collaboration with his friend Richard Hesse, Doflein recorded their observations on living animals in a popular book entitled "Tierbau und Tierleben," which appealed to a large circle of readers. In addition to this, he wrote popular books on three scientific expeditions undertaken by him—to the West Indies, Japan and Macedonia. The last, on his Macedonian travels, published in 1921, is illustrated with his own water-colour sketches.

In the early part of 1923, owing to continued ill-health, Doflein resigned his appointment in Breslau, and he died of pneumonia on August 26, 1924. Thus was tragically cut short a life of great achievement, for not only did he contribute much to biology himself but he also attracted many students to his laboratories, where they were allowed to follow their own lines of research, although always sure of his help in difficulty. His liberality and broad-mindedness were indeed part of that artistic temperament which delighted all with whom he came in contact.

THE *Chemiker Zeitung* of November 4 records the death, on October 25, at the age of seventy-two, of Dr. Carl Huggenberg, one of the pioneers among German public analysts. Huggenberg's name is associated with the well-known Analytical Institute founded by him at Chemnitz, where most of his public work was carried out. Born of Swiss parentage at Winterthur, he studied first at Zurich and later at Würzburg, where he became assistant to J. Wislicenus, and graduated in 1876. During the following three years he held an official appointment as analyst of foodstuffs in the Canton of Zurich. This special branch of applied chemistry was still in its infancy at that time, but in all the German towns, associations were being formed with the object of fighting against the adulteration of food. In 1882, the association which had been founded five years previously at Chemnitz by L. Friedrich, offered Huggenberg the direction of its laboratory. Here he found full scope for the development of his natural powers. His analytical skill, his comprehensive knowledge of chemistry, and his practical insight into the needs of industry and commerce were invaluable assets to him, and his opinion on technical matters was soon widely sought. His interest in technology led him to make numerous valuable investigations in oils, fats, and soaps, and he made numerous contributions to scientific literature on the refractometry of soap-fats, the recovery of waste fat, and on soap analysis. Until 1902 he also held the post of food controller at Chemnitz. In 1910 he retired to Zurich.

Current Topics and Events

THE Fishery Board of Scotland recently issued a notice to fishermen and others directing attention to the protection afforded to the grey seal under the Grey Seals Protection Act of 1914, which lays open to a penalty of 5*l*. any person taking, killing, or wounding grey seals during a close season, October 1-December 15. The publication of the notice has led to correspondence in the Scottish newspapers, the protection of this seal being condemned on the ground that it is increasing in numbers and is responsible for the destruction of some of the Hebridean cod fisheries. The weight of the evidence, however, seems to indicate that the grey seal is very rapidly decreasing in numbers on the west coast, and that the constant slaughter of the young in certain breeding haunts, their pelts being sent in considerable numbers to furriers in Glasgow, threatens the existence of the species in these waters. As regards the destruction of fisheries, the assertion is made that dog-fish and not cod form the diet of the seal, and that the destruction of seals and consequent increase of dog-fishes are responsible for the deficiency of cod. The point is an important one, which is left undecided by the assertions of the correspondents. It might readily be settled by the examination, by an expert in fragmentary fish remains, of a few series of stomach contents taken at appropriate seasons.

THE Field Museum of Natural History, Chicago, has arranged a series of twelve free programmes of moving pictures, with occasional lectures, illustrating natural history subjects, for children on Saturday mornings from October to December. The subjects include "Wild Animals I have known," by Mr. Ernest Thompson Seton, Capt. Kleinschmidt's "Polar Adventure," Theodore Roosevelt's "Visit to a Bird Reservation," and a number of films illustrating particular facts and aspects of zoology, botany, and geology. At each entertainment a little printed "museum story" is given to each child. This story gives, in simple language, some brief facts about the men, animals, and plants seen in the pictures, and directs the child to the case or cases in the Museum in which they are exhibited. By directing attention to the permanent exhibits in this way, opportunity is afforded to the child to crystallise the general impressions and information gathered from the films, and the real educational value of the scheme is thereby enormously enhanced. It surely is more than a series of entertainments, as the programmes are described on the syllabus. The experiment will be watched with great interest not only by those who believe in the vast potentialities of museums in education, but also by those who are convinced of the possibilities of the cinematograph as an aid in the same field.

THE proposal made by James Watt in 1783, that international units of weights and measures should be adopted, was the direct origin of the metric system. The strongest argument in favour of this system, as was pointed out by Sir Richard Gregory in his presidential address to the Decimal Association on November 26, is its international character. Scarcely a year passes without the addition of one or more countries to the list of those which have adopted metric weights and measures as their sole standards, while not a single country has introduced British measures to supersede its own. One of the latest additions to this Metric League of Nations is Japan, where metric weights and measures became official on July 1 of this year. The change was made as the result of the report of a Commission of Inquiry, which gave careful consideration to the advantages, from the points of view of industry and commerce, of the British, metric and other systems. Great Britain and the United States are responsible for so large a proportion of the world's trade that it would seem that this of itself would have led to the adoption of their weights and measures by other countries; yet whenever a country has appointed a Commission to inquire into the desirability of a change of units, it has always reported in favour of the metric system and never of the British. When Germany introduced the metric system, it seemed to be against immediate manufacturing interests on account of the overpowering superiority of British trade at the time. What decided the question then, as it should now in Britain, is that the metric system is an international system. At the annual meeting of the Decimal Association, Mr. A. J. Stubbs was elected vice-chairman of the executive committee, and the following were elected new vice-presidents: Sir Hedley le Bas, Mr. Llewellyn Atkinson, Mr. Harold Cox, and Mr. Gordon Selfridge.

AN interesting and little known chapter was added to the history of mechanical transport by Col. R. E. Crompton in his paper on "The Motor Car: its Birth, its Present, and its Future," read to the Royal Society of Arts on November 12. Col. Crompton's aim was avowedly "to vindicate the memory of that great Scotsman" Robert William Thomson, who was born on June 29, 1822, and died on March 8, 1873. A prolific inventor, Thomson as a young man came in contact with Faraday, Cubitt, and Stephenson, and then in 1844 set up in business for himself. The following year he took out his patent for the pneumatic tyre, an invention made possible by the rubber pioneers Macintosh, Goodyear, and Hancock. Thomson's tyre, however, was used but little, and Dunlop's re-invention of it forty years later was an independent one. By 1862 Thomson had a consulting practice in Edinburgh, and in 1867 he built a three-wheeled steam road locomotive for colliery work in Labuan, the wheels having heavy ring rubber tyres. Col. Crompton, then a young lieutenant in the Rifle Brigade in India, learning of this, got into correspondence with Thomson and was able to persuade the Government authorities to try steam locomotives on the Indian roads. In 1870 Col. Crompton came to England, spent some time at the home of Thomson, who by then was an invalid confined to his sofa, and supervised the building of two road engines, the "Chenab" and "Ravee." With a permit to test the engines on the roads at speeds greater than those allowed by the notorious Red Flag Act, the "Ravee" in September 1871 went from Ipswich to Edinburgh and back, hauling a large omnibus, and near Doncaster attained a speed of 25 miles per hour. In India the engines were in the first place used for Post Office work and then for military transport. It was the experience thus gained which led to Lord Roberts' advocacy of mechanical transport in South Africa in 1900. Thomson's achievements as one of the great pioneers of modern road haulage have often been acknowledged, and two years ago the Royal Automobile Club placed a tablet to his memory on the site of the house in which he was born in Stonehaven, Kincardineshire.

THE Engineering Department of the University of Cambridge has attained a leading and distinguished position among the engineering schools of Great Britain, and the illustrated descriptions of its new laboratories published in the *Engineer* for October 24 are of great interest. There are indications that the number of engineering students at Cambridge will become stabilised at about 500, which is approximately the present figure. The new laboratories stand on the Scroope House site in Trumpington Street, which occupies an area of about 4 acres. The buildings mostly consist of one-storied north-lighted structures of the factory type. The laboratories were completed and equipped in 1922 at an approximate cost of 100,000*l*., but no money was available for the construction of the projected two-storied lecture room block. In consequence, lecture rooms and laboratories are separated by a considerable distance, and the authorities hope that this inconvenience may be remedied soon by some generous benefactor; a further sum of 60,000*l*. is required. Provision is made in the laboratories for experimental work on heat engines, including engines and boilers, materials, structures, hydraulics, electrical engineering, including wireless telegraphy, and metallurgy. The equipment of all these laboratories is on a generous scale, and a large number of the machines has been presented by engineering firms. Whilst the Department also possesses workshops, we note with approval that students are encouraged to spend some of their vacations in real engineering workshops, and are advised, if possible, to serve in an engineering workshop for about six months prior to starting the course at the University.

NOMINATIONS for the award of the Elliot Medal of the National Academy of Sciences, Washington, for the year 1924 should be addressed to the secretary of the Academy. The terms of the award in the Daniel Giraud Elliot deed of gift are as follows: "One such medal and diploma shall be given in each year and they, with any unexpended balance of income for the year, shall be awarded . . . to the author of each paper, essay, or other work upon some

branch of zoology or palæontology published during the year as in the opinion of the . . . judges in that regard shall be the most meritorious and worthy of honor. The medal and diploma and surplus income shall not, however, for more than two years successively, be awarded for treatises upon any one branch of either of the sciences above mentioned. . . . The medal and diploma and surplus income may be conferred upon naturalists of any country and . . . no person acting as judge shall be deemed on that account ineligible to receive this annual gift . . . if, in the opinion of his associates, he shall . . . be entitled to receive them." The treasurer of the Academy reports that the Elliot Fund has increased since the original donation of 8000 dollars. The best idea of the kind of work for which this award was designed may be gathered from a résumé of previous awards: 1917, to Frank M. Chapman for his "Distribution of Bird Life in Colombia"; 1918, to William Beebe for his "Monograph of the Pheasants," volume i.; 1919, to Robert Ridgway for his "Birds of North and Middle America," Part VIII.; 1920, to Othenio Abel for his "Methoden der paläobiologischen Forschung"; 1921, to Bashford Dean for his "A Bibliography of Fishes," volume i.; 1922, to William Morton Wheeler for his "Ants of the American Museum Congo Expedition"; 1923, to Ferdinand Canu for his "North American Later Tertiary and Quaternary Bryozoa." Unlike other awards, the Elliot Medal is always for a special piece of research in zoology or palæontology completed and published in the year for which the award is made. The Committee particularly desires that nominations shall be received for foreign as well as for American work during the year 1924. Recommendations should be accompanied by a printed copy of the research submitted for consideration.

HEATHFIELD HALL, Birmingham, where James Watt lived from 1768 up to the time of his death, and where many of his experiments were carried out, having been sold, the former owner, Major Gibson Watt, has presented to the Science Museum, South Kensington, the contents of the attic workshop in which Watt worked. After Watt's death the room remained closed for some forty years, and all the contents still remain practically as he left them. A room, which will reproduce as closely as possible the attic at Heathfield Hall, is about to be constructed in the Science Museum on the ground floor of the new Museum buildings not far from the two Boulton and Watt engines which are preserved there. In this room the furniture, tools, two or three machines which Watt used, as well as many trial pieces, etc., will be placed on view.

ACCORDING to messages which have appeared in the daily papers, photographs were successfully transmitted by radio across the Atlantic in some tests carried out on Sunday, November 30. The transmitting apparatus was installed at Radio House, London, and the radio signals were picked up at Long Island and transmitted to New York by land lines. Brief descriptions of the apparatus have been issued, from which it appears that a photographic film is attached to a rotating glass cylinder and the actual emission of radio signals is regulated by a photo-electric cell under the influence of the light which traverses the photographic film. After each revolution of the drum carrying the film, the latter is automatically moved by a fixed amount; in the recent experiments the shift was $\frac{1}{128}$ in., but it is stated that $\frac{1}{64}$ in. would be sufficient. It takes about twenty minutes to transmit a half-plate film. The invention has been developed by Mr. D. H. Ranger, of the Radio Corporation of America. According to the New York correspondent of the *Times*, the receiving apparatus executes on paper a pen-and-ink reproduction resembling an engraving, and it is stated that the photographs transmitted in the test were easily recognisable. The general principles of the transmission of a film record by means of the action of light on a selenium cell were described by Prof. A. O. Rankine in articles in NATURE of February 5, 1920, p. 604; October 27, 1921, p. 276; and June 2, 1923, p. 744.

PROF. RISLER, working in the Laboratoire Physiologique des Sensations at the Sorbonne, has produced tubes filled with air or other gas at low pressure, excited by high-frequency current, with phosphorescent and fluorescent materials and pigments, either applied to the tubes or incorporated in the glass. The result is an emission of light, with little or no long wave-length red or infra-red radiation and no green, to which the name "cold light" has been applied. It is claimed that a large tube gives 12,000 candle power with an input of 2·5 kilowatts. A special arrangement of the electrodes maintains the pressure automatically at the optimum point, so that some of the tubes have worked for 9000 to 10,000 hours without any noticeable diminution in their illuminating power. A large quantity of ultra-violet radiation is given off, and the tubes have proved valuable for therapeutic purposes. When the current is switched off, the tubes continue to glow with phosphorescent light, the colour of which is different from that emitted previously, and the tubes appear suitable for use in advertising. Particulars of the tubes can be obtained from Mr. D. L. Daponte, 147 Cannon Street, E.C.4.

PROF. A. W. BICKERTON has been elected an honorary member of the New Zealand Astronomical Society in recognition of his work on cosmic evolution.

PROFS. THEODORE LYMAN, of Harvard University, and Gilbert N. Lewis, of the University of California, have been elected honorary members of the Royal Institution, London.

MR. E. LEONARD GILL, assistant in the Natural History Department of the Royal Scottish Museum and formerly Curator of the Hancock Museum, Newcastle-upon-Tyne, has been appointed Director of the South African Museum in succession to the late Dr. Louis Albert Péringuey. The assistantship in the Royal Scottish Museum therefore becomes vacant and applications are invited.

AT the opening of the hundred and fifty-fourth session of the Royal Physical Society of Edinburgh, the following new office-bearers were elected: *President*, Dr. James Ritchie; *Vice-Presidents*, Dr. Marion Newbigin and Prof. J. Arthur Thomson; *Secretary*, Dr. H. M. Vickers; *Assistant Secretary*, Prof. J. Russell Greig; *Librarian*, Mr. J. Kirke Nash; and *Councillors*, Prof. D'Arcy W. Thompson, Principal O. Charnock Bradley, Prof. J. H. Ashworth, Prof. J. Graham Kerr, Dr. J. R. Henderson, and Mr. Hugh Miller.

THE Rivers Memorial Medal of the Royal Anthropological Institute for the year 1924 has been awarded to Dr. A. C. Haddon. This is the first occasion on which the medal has been awarded. In future one or more medals will be given annually in recognition of meritorious anthropological work in the field, in memory of the late Dr. W. H. R. Rivers, who was president of the Royal Anthropological Institute at the time of his death. Apart from Dr. Haddon's unquestioned claims as a field worker in ethnology, it is peculiarly appropriate that he should be the first recipient of this honour in view of the close association of Dr. Rivers with him when the latter first took up his investigations among primitive peoples.

A GROUP of papers on "Base Exchange in Soils" will be presented for discussion at a meeting of the Faraday Society to be held in the rooms of the Chemical Society, Burlington House, London, on Tuesday, December 9, at 4.30-7.30 P.M. The chair will be taken by Sir Daniel Hall, scientific adviser to the Ministry of Agriculture, and an introductory address will be given by Dr. D. J. Hissink, of Groningen. Further particulars may be obtained from the Secretary of the Faraday Society, 90 Great Russell Street, London, W.C.1. Papers will be presented by Prof. N. M. Comber (University of Leeds), Messrs. H. J. Page and W. Williams (Rothamsted Experimental Station), Prof. G. W. Robinson and Mr. Rice Williams (University College, Bangor), Mr. S. J. Saint (University of Leeds), and Mr. E. A. Fisher (Research Association of British Flour-millers).

AN extra meeting of the Institution of Civil Engineers will be held on Thursday, December 11, at 6 P.M., in conjunction with the Institutions of Mechanical Engineers, Electrical Engineers, and Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, and the British Engineers' Association. These bodies are co-operating in the work of the special committee on tabulating the results of heat-engine and boiler trials, and the chairman of the committee, Capt. H. Riall Sankey, will submit for discussion: "Standards of Comparison in connection with the Thermal Efficiency of Steam Engines."

THE before-Easter lecture arrangements at the Royal Institution have just been issued. The general courses will begin on Tuesday afternoon, Jan. 13, at 5.15, when Prof. A. Fowler will commence a course of two lectures on the analysis of spectra; on succeeding Tuesdays there will be two lectures by Dr. H. R. Hall on the prehistoric Greek and ancient Egyptian civilisations, four by Prof. Barcroft on the colour of the animal creation, two by Prof. E. N. da C. Andrade on the evolution of the scientific instrument, and two by Prof. A. S. Eddington on the internal constitution of the stars. Thursday afternoons at the same hour beginning on Jan. 15, Mr. J. S. Huxley will give two lectures on the courtship of animals and its biological bearings; Sir William Bragg, four on the properties and structure of quartz; Sir A. Smith Woodward, two on dinosaurs; Dr. Leonard Hill, two on the biological action of light; and Mr. T. Thorne Baker, two on chemical and physical effects of light. The Saturday lectures will include four by Sir Ernest Rutherford on counting atoms, and two by Prof. J. H. Ashworth on a zoological topic. The Friday evening meetings begin on January 16 with a discourse by Sir William Bragg on the investigation of the properties of thin films by means of X-rays. Succeeding discourses will probably be given by Dr. A. W. Crossley, Profs. J. W. Gregory, R. W. Chambers, T. H. Pear, Gilbert Murray and J. W. McBain, Principal Irvine, Mr. W. B. Hardy, Sir Ernest Rutherford, Sir Daniel Hall and other gentlemen.

THE autumn issue of *Bird Notes and News*, the journal of the Royal Society for the Protection of Birds, is a double Dominions number and contains interesting papers written by prominent bird-protectionists relating to the work of bird protection in Australia, New Zealand, Canada, British Columbia, Newfoundland, and South Africa. A comprehensive report on the bird-life of the sanctuaries in the Royal Parks in London, by a member of the sanctuaries committee, forms an enlightening and encouraging leading article; and the effort the Society is making to combat the oil menace to sea-birds is further evidenced.

THE National Research Council of Japan has initiated an active programme of scientific publication, in several series of "Japanese Journals" under the separate headings of chemistry, physics, geology and geography, botany, zoology, medical sciences, engineering, mathematics, and astronomy and geophysics. The first two of these journals each appear in ten numbers annually, the third appears quarterly, while the remainder are occasional publications. The second part of volume ii. of the *Japanese Journal of Astronomy and Geophysics* has just been issued, and contains six memoirs, occupying about sixty octavo pages. The papers cover a wide range of interests—precise levelling, theory of monsoon rainfalls, gravitational fields, thermal expansion of rocks, and tidal undulations — and in some cases originate from

research institutes, independent or connected with universities or colleges. They indicate a highly satisfactory state of activity and interest in geophysical research in Japan. All the papers are in English.

INSTRUCTIONS and information relative to wireless reports of weather on the coast of Brazil have been issued by the Brazilian Meteorological Service. The Director, Señor Sampaio Ferraz, who is responsible for the issue of the information, is thoroughly conversant with the meteorological requirements. With the view of assisting navigation, twelve transmitting stations have been established on the coast and send observations six times a day, every four hours, of the force and direction of wind and the state of weather and sea. In case of storms and dense fogs, these frequent messages should prove useful to approaching vessels. The reports are expressed in Portuguese, but very simply. The messages from the transmitting stations are sent on 600 m. waves spark. Rio's special messages, sent out twice daily, include detailed forecasts for the south coast of the State of Rio de Janeiro and general forecasts for the rest of the southern Brazilian coast and up to Buenos Aires; the first part, organised by the international code, gives barometric pressure, force and direction of wind, state of weather and air temperature. The instructions contain specifications of the international codes, and every facility is afforded for commanders navigating these seas to draw for themselves weather charts which will give them full information of the conditions of the weather over the whole neighbourhood.

THE British Dyestuffs Corporation, Ltd., Manchester, has issued a booklet entitled "Medicinal Products: A booklet issued to the Medical Profession," which gives an account of the various dyestuffs which have found a therapeutic application, and also of some chemicals that are used as reagents in clinical tests. The formula is given in each case, together with a considerable number of references to papers in which the use of the products is described. The main section is devoted to a consideration of the flavine antiseptics, and is followed by one on the di- and tri-phenyl-methane series: namely, auramine, crystal violet and brilliant and malachite green. Among other dyes considered may be mentioned trypan blue, Biebrich scarlet, gentian violet, methylene blue and picric acid with their therapeutic uses, and indigo-carmine which has been used for testing the function of the kidneys. In the last section a brief account is given, amongst other compounds, of benzidine, dimethylp. aminobenzaldehyde and phenylhydrazine hydrochloride and their use in clinical tests. The booklet should be useful to all those who desire information on the constitution and reactions of any substances in the above groups which they may happen to be using.

Our Astronomical Column.

THE GREAT FIREBALL OF NOVEMBER 11.—Mr. W. F. Denning writes that the fireball of November 11, 5 h. 40 m. G.M.T., was observed by a great number of persons in Ireland and extreme north of England. Sixty-nine accounts of it have been received, and though the observers were taken by surprise and most of them inexperienced in recording meteors, their results are in very fair agreement. At most of the stations the moon, which was nearly full, was near the beginning point of the meteor and furnished a useful guide to position.

The fireball had an exceptionally lengthy flight, and a very long duration, the average time being 33 seconds, when proper allowance is made. The whole of the luminous course appears to have extended over 510 miles, and the velocity was 16 miles per second. It passed from over the North Sea, 80 miles east of Hartlepool, across the extreme north of England and south of Scotland and onwards over the Atlantic Ocean, to Long. 11¾° west, Lat. 56½° north. The average height was about 53 miles. The radiant point was as nearly as possible at 31° - 6° near Mira Ceti. As the fireball sailed along in its nearly horizontal course it showed some curious variations of colour; in the head blue and yellow predominated, while flakes of red were distributed along the tail. The effect produced was that of a brilliantly coloured snake-like object wriggling its course through our resisting atmosphere. Some of the observers compared the oval head to the size of a football; others thought it equal to the moon's diameter or to half the latter value. Adopting the smaller estimate, the nucleus would be half a mile in diameter, but this included the outlying flames and luminous off-come resulting from its combustion. The real size of the solid nucleus may not have been more that two or three feet.

OBSERVATIONS OF MARS.—*L'Astronomie* for October contains a number of drawings of the planet, made in September at Juvisy and Meudon. The large dusky areas are represented in much the same manner as by the American draughtsmen, but the canals as a rule are broader and more diffused; some of them appear on almost all the drawings, so that there is practically a consensus as to the existence of the markings, the difference only extending to their exact aspect. Thus, M. Quénisset on September 19 drew the Ganges as a very broad dark streak, fully 300 miles wide, with straight parallel edges.

M. E. M. Antoniadi has again observed the planet with the great Meudon refractor and contributes some very beautiful drawings. As is well known, he rejects the geometrical aspect of the canals and draws them as broad irregular shadings. He reproduces for comparison his drawings of Pandoræ Fretum made in 1909 and 1911, which show a marked change of intensity of this region from one year to another. He lays stress on the planet being a living world, and is inclined to return to the old notion that those dusky areas that do not show a seasonal change of tint are veritable seas.

M. Quénisset also observed Uranus with the Meudon refractor, and distinctly saw two equatorial belts and dusky regions at the poles. The aspect was quite like that of Jupiter except that the belts were nearly vertical.

Research Items.

MEDIEVAL METALLURGY.—An interesting article on medieval metallurgy, by M. L. Becker, appears in the Memoirs and Proceedings of the Manchester Literary and Philosophical Society (1923–1924, No. 4). No important metallurgical information of early times can be obtained from works prior to those of Dioscorides (first century A.D.), who describes brass and the recovery of zinc oxide. Pliny at the same period describes the smelting of metals, but he does not appear to have had practical experience in this direction. The really important literature dates from the eleventh century onwards, and includes the works of Theophilus and Agricola. The latter's contributions to metallurgical science, embodied in his book "De Re Metallica," are considered in detail, many illustrations being reproduced.

PAUPERISM IN THE UNITED STATES.—Prof. Raymond Pearl contributes to *Science* of October 31 an interesting note on the racial composition of paupers in public almshouses in the United States. Between 1910 and 1923 the proportion of foreign-born white paupers decreased from 42·6 per cent. to 32·6 per cent. The countries of origin which showed the greatest proportional excess of the paupers, having regard to their percentage shares in the whole population, were Ireland, Germany, and England, in that order. "With a few trifling exceptions," writes Prof. Pearl, "all the countries from which the present law *encourages* immigration contributed to almshouse pauperism in 1923 in *excess* of their representation in the population in 1920. On the other hand, again with a few trifling exceptions, those countries from which the present immigration law was especially framed to *discourage* immigration appear in the lower part of the diagram, because they contribute a *smaller* proportion to almshouse pauperism in 1923 than their representation in the general population in 1920."

ASYMMETRY OF THE AXIS IN THE PRIMATES.—In the course of a comparative study of the mammalian axis, Dr. Delattre has found that the axis of primates, and particularly of the anthropoids, is asymmetrical in a large proportion of cases. In the current issue of the Bulletin of the Société d'Anthropologie de Paris (Sér. VII. t. iv. fasc. 4-5-6), he describes the deformation and endeavours to account for its occurrence. Beyond the primates it does not occur among the mammalia except in certain carnivora and ungulates. There are several theories which are held to account for its occurrence in man, such as unequal action of the spinal muscles on one side. Any inequality in the lower limbs involves a compensating curvature in the vertebral column, as will also any deformity or defect tending to unilateral action. Although an inequality of the lower limbs is of sufficiently common occurrence among the primates, the asymmetry of the axis is rather to be attributed to a special attitude which is an accompaniment of the arboreal life. One of the upper limbs being employed constantly in prehension is habitually raised and held in a more forward position than the other. The torsion of the trunk and the constant thrust forward of the head causes an unequal action of the muscles which produces a deformation of the cervical vertebræ.

HISTORY OF CIVILISATION.—An Occasional Paper (No. 6) lately issued by the Royal Anthropological Institute is of the first importance for students of races and history. The early pottery of the near East has been summed up by Mr. H. Frankfort of Amsterdam, in a thesis for his M.A. degree in the University of London. He deals with Mesopotamia, Syria, and Egypt and their earliest interrelations in 142 well-illustrated pages. During the last third of a century our view of the past has been immensely enlarged; the four civilisations known before the present one have been extended now to eight. The great mass of new facts remained mostly in their original monographs, in which they had been partly explained. The summing up of them as a whole, in full view of all the material, was a work much needed, and Mr. Frankfort has done it with great diligence, searching out unpublished specimens, and with remarkable judgment and sanity. He carefully distinguishes the ideas often vaguely expressed, of racial and artistic terms, and seeks to secure every precision and definition available. The discussion of Mesopotamian material leads to the conclusion that the earliest Susian civilisation was crushed by drought, which drove the people down to the rivers. They were neither Semite nor Sumerian, and the Sumerians came up later from the Persian Gulf. Their possible Indian connexion has been rendered much more likely by the recent discovery of quasi-Sumerian engraving and signs in India. As to Egypt, it is well to find that the explanations given at the time of new discoveries during the last quarter of a century hold good in almost every point. The scantiness of the Asiatic discoveries is scandalous, now that the regions are more accessible, and sites are liable to be destroyed by commercial business. The opportunity will not keep, and both men and money are wanted speedily for Eastern research in civilisations.

FUNGI AND EPILEPTIFORM CONVULSIONS.—In the Transactions of the Mycological Society, 10, p. 121, Prof. J. Russell Greig describes the association of fungus spores with epileptiform convulsions in dogs. In three cases showing the symptoms (two of which died), the fæces and intestines were found to contain spores of *Tilletia Tritici*, the stinking smut of wheat. These were present in very large quantity and were conceivably derived from straw used for bedding. In the cases examined, no macroscopic lesion was visible in the body, but in one case in which the cranium was also investigated, an acute cerebral meningitis was observed, associated with numbers of spores. The fungus spores are often present as isolated specimens in the fæces of normal dogs. There appears to be evidence that they can be absorbed by the intestines, though how this is accomplished in the case of an inert body of about 18μ in diameter, remains to be determined.

TRANSPIRATION OF XEROPHYTIC PLANTS.—It is now generally recognised that the thick cuticle, sunken stomata and other structures characteristic of plants growing in dry places do not necessarily produce any noteworthy modification in the rate of transpiration. This point has now been examined for a number of typical Australian xerophytes by Mr. H. W. Wilson (Proc. Roy. Soc. of Victoria, 36, N.S., pp. 175-237), who was unable to find that these plants had any special powers of accommodation when subjected to rapid increases in temperature or to hot winds. The so-called xerophytes are, in fact, provided with a high average number of stomata, and they respond very rapidly to changes in the evaporating power of the air. The phyllodes of the Acacias and the leaves of the Eucalypts in particular, are regarded by Mr. Wilson as almost perfect transpiring organs. One of the curious features of the results to which no reference is made, is that the average transpiration rate per

million stomata bears no apparent relation in different species to the depth to which the stomata are sunk or to the degree to which they are protected by hairs or other excrescences.

BROWN BAST DISEASE OF RUBBER TREES.—In the *Malayan Agricultural Journal*, Vol. 12, September and October 1924, pp. 290-343, Messrs. A. Sharples and J. Lambourne record a very large number of further field experiments upon this subject in continuation of the experiments referred to in NATURE of February 17, 1923, p. 234. These experiments leave them still more firmly convinced of the physiological origin of this disease, as opposed to the bacterial origin suggested by P. E. Keuchenius. On the other hand, they are unable to agree with Prof. J. B. Farmer and Mr. A. S. Horne that phloem necrosis is a significant primary feature of the disease, as they find lignification of the sieve tubes a common feature of the phloem in healthy trees. They conclude that over-extraction of latex is the most important factor in initiating the disease, and suggest that this may cause an excessive loss of water to the plant at times or seasons when this loss of sap seriously affects the water balance in the tissues. These authors seem somewhat pessimistic as to the possibility of developing successfully high yielding plantations by methods of vegetative propagation (bud-grafting). It is difficult to select the tree in which high yield of latex is an intrinsic quality and not the result of favoured position and climate, and difficult to know whether such high yield is associated with resistance to brown bast disease. The authors argue that such high-yielding trees will have leaves more liable to fungus attacks, though their reasons for such a pessimistic conclusion do not read very convincingly.

FOG AT THE SCILLY ISLES.—Fog frequency at Scilly during summer months in relation to weather types indicated by barometric pressure is discussed by Mr. E. G. Bilham in Professional Notes, vol. 3, No. 37, issued by the Meteorological Office, Air Ministry. The investigation is somewhat tentative, more complete work being in hand, but as fog at the entrance to the Channel is of considerable importance to seamen, the facts at present to hand are published. In the summer months "fog" as distinct from "mist" is reported at Scilly on one day in seven, and including "mist," the frequency is at least twice as great. Only days with fog are included in the present inquiry. The period dealt with is the fourteen years 1905 to 1918, which gives 1288 days, and as there were 192 fogs the chances against fog are nearly 6 to 1. Of the total fogs, 61 occurred in June, 60 in July, and 71 in August. In individual months the fogs varied from none in August 1905 to 12 in June 1915. In individual years the number of fogs for the three summer months combined varied from 8 in 1909 to 24 in 1914. The numbers are given for each of several types of pressure distribution. Illustrations are given of the several foggy types and of the clear weather types. With a large area of high barometer over Scandinavia and several smaller ones to the south-west, the chances are only 1·4 to 1 against fog at Scilly. No fog was recorded during the summer months in 14 years at Scilly with a "V" shaped depression over the east of England or with a high barometer over Scandinavia and low over Mediterranean. With high barometer to the north-west of the British Isles and low over the north of France, the chances against fog are 24 to 1.

THE RECOIL OF THE ELECTRONS WHICH SCATTER γ-RAYS.—Mr. D. Skobelzyn describes, in the *Zeitschrift für Physik* of October 14, an investigation of the γ-rays of radium, in air, by the Wilson cloud method. A magnetic field was employed, perpendicular to the path of the γ-rays. This caused the resulting β-rays to move in spiral and often in circular paths. It prevented β-rays produced on the walls from penetrating into the space surrounding the γ-ray beam, and made it easy to investigate the β-rays from the gaseous atoms. Although the energy given by a hard γ-ray to an electron is in some cases nearly equal to $h\nu$, in many others it is only a small fraction of this quantity. It is also found that the initial velocity of the electrons has always a forward component, and that the energy depends on the angle θ between the direction of the initial velocity and that of the γ-ray, being on the average smaller as θ increases. These results are in accord with the hypothesis of Compton that, in the case of the lighter atoms, the secondary β-rays are recoil electrons, and contrary to that of Wilson and Bauer, according to which the scattering of the γ-ray takes place as a spherical wave, and that the whole elementary impulse of the radiation $h\nu/c$ is given up to the electron.

HEAT INSULATORS.—Special Report No. 5 by the Engineering Committee of the Food Investigation Board (First Report on Heat Insulators, Experiments. Second Edition. London: H.M. Stationery Office. 2*s*. net), deals with the first series of measurements made by Dr. E. Griffiths at the National Physical Laboratory of the heat conductivities of some of the heat insulators used in the construction of refrigerating stores. Dr. Griffiths finds that the heat conductivities of good dry cork, slagwool, charcoal and wood fibres at ordinary cold stores temperatures are all about 0·00011 C.G.S. units. Different brands of the same material differ to some extent in conductivity, and some of the materials at present used for heat insulation are liable to deterioration in situations where they may be subjected to heat or vibrations. In one case the conductivity had increased 40 per cent. Of the 17 materials tested, one—expanded rubber—appears to be little known as a heat insulator although its heat conductivity is about the same as that of cork.

COAL DUST EXPLOSIONS.—Prof. H. B. Dixon's presidential address before the Manchester Literary and Philosophical Society, which dealt with coal-dust explosions, is printed in the Memoirs and Proceedings of the Society for 1923–1924. A general account of the work carried out at Eskmeals is given. A coal-dust cloud can be ignited and can propagate a flame, but this cloud must pre-exist before the flame reaches it. The effect of the presence of inert dust varies; if the explosion wave is set up in pure coal dust it will continue to travel for some distance when it meets a dust containing as much as 75 per cent. of inert dust. A mixture of equal parts of coal dust and inert dust may propagate an explosion, provided there is an intense explosion flame to start it; such a mixture may be exploded by the discharge of 24 oz. of blasting powder.

DIAZONIUM TETRACHLOROIODIDES AND PLUMBICHLORIDES.—These compounds are described by F. D. Chattaway, F. L. Garton, and G. D. Parkes in the October issue of the Journal of the Chemical Society. The tetrachloroiodides are among the most stable of diazonium derivatives and they separate as yellow crystals when cooled solutions of diazonium chlorides are poured into cooled concentrated hydrochloric acid solutions of iodine trichloride. They are decomposed by hydriodic acid to the corresponding iodobenzene derivative; on heating with alcohol the diazo-group is mainly replaced by chlorine. Diazonium plumbi-

chlorides are prepared as above with the substitution of lead tetrachloride for iodine trichloride. They react with hydriodic acid and alcohol in the same way as the tetrachloroiodides. They all decompose explosively at a definite temperature; the tetrachloroiodides melt sharply, although always with decomposition.

EXPLODING AMMONIA WITH ELECTROLYTIC GAS.—The products obtained by exploding ammonia with varying amounts of oxygen and of electrolytic gas have recently been examined by J. R. Partington and A. J. Prince, the results being published in the Journal of the Chemical Society for October. Mixtures of electrolytic gas with ammonia are explosive when the former constituent is in slight excess; 79 per cent. of the ammonia is decomposed under these conditions. Complete decomposition occurs when the proportion of electrolytic gas just exceeds 75 per cent. When more than 1·6 parts of ammonia are exploded with 1 part of oxygen, the latter unites preferentially with the hydrogen, leaving a residue of nitrogen and excess hydrogen. When less than 1·6 parts are used, oxides of nitrogen are formed; the maximum oxidation of nitrogen is 16 per cent. and occurs when the ratio of the exploding gases is 1·22 : 1. The amount of nitrogen oxidised when mixtures of nitrogen, hydrogen, and oxygen are exploded is always less than when the ammonia which would be formed from these mixtures is exploded with the same ratio of oxygen.

PENANG HILLS RAILWAY.—The island of Penang consists of mountainous and broken country and is situated not far from the equator. The capital, Georgetown, is at sea-level, and the climate is trying for Europeans. It is therefore not surprising that a hill suburb is growing up on Penang Hills. Access to the summit has, until quite recently, been possible only by a tiresome and difficult journey by hill track some 5 miles long, and impossible for vehicles of any kind. A new railway was completed and opened on October 21 last year, the work having been carried out under the direction of Mr. A. R. Johnson of the Federated Malay State Railways. An illustrated account of this railway appears in *Engineering* for November 14, and the scheme has novel features. The total length is 1 mile 435 yards, and the upper station is 2381 feet above sea-level. In any funicular railway, the haulage engine has to move not only the cars but also the haulage rope, which may be considerably heavier than the useful load. The load on the engine is variable as the relative positions of the cars alter. The ideal arrangement is one in which the tractive force required from the haulage engine is a constant, and this effect is secured by making the profile of the railway a parabola. The Penang Hills Railway has been set out with a parabolic profile, and one of the striking features of the line is not only the practically constant loading of the haulage engine, but also the remarkably small power which it demands for its operation. The line is divided into two sections, and there is an electric-motor-driven winding engine at the top of each section. At the bottom of each section a short circular curve, tangential to the parabola, has been introduced. The object of this is to ease the starting grade so that the load does not rise above the normal during the period of acceleration. The total time for the journey to the top is about 25 minutes. The article is of interest also from the constructive point of view on account of the difficulties of the site.

A POCKET MICROSCOPE.—We have received through Messrs. Ogilvy and Co. (18 Bloomsbury Sq., W.C.), the British agents, an example of the new Leitz "Minor" folding microscope, which when folded is contained in a leather case only 6 in. long. Coarse focussing is by sliding tube and fine focussing by a screw collar encircling the tube. By means of a duplex combination lens, two eyepieces and the draw-tube, magnifications of from 50 to 250 diameters may be obtained. A low power objective can also be supplied giving magnifications of from 7 to 26 diameters. The folding foot may be so adjusted as to form a handle, so that with the low power objective the microscope may be used as a hand lens. The microscope is a handy little instrument, very suitable for field work or travel.

A NEW DEW-POINT HYGROMETER.—The issue of the *Physikalische Zeitschrift* for September 15 contains a short description of a dew-point hygrometer constructed by Dr. M. Holtzmann of the Geophysics Department of the Central Physical Observatory of Leningrad. A polished copper tube 2 cm. in diameter and 15 cm. long is placed with its axis vertical, and round its upper end is wound an insulated wire through which an electric current is sent so as to warm the upper end of the tube a few degrees above the temperature of the air. A short distance below the coil, a horizontal line is drawn round the tube and the two wires of a thermo-couple are soldered to the tube at points on the line. A stream of liquid at a temperature two or three degrees below the dew-point is then sent up the tube, and its speed so regulated that dew is deposited on the tube up to a point above the line. The stream is then stopped and the heating current reduced until the top edge of the deposit of dew descends to the line. The electromotive force of the thermo-circuit is then read on a galvanometer in circuit. The author claims that the instrument gives the dew-point with an accuracy of 0·02° or 0·03° C.

A NEW SPECTROMETER.—We have received from Messrs. Bellingham and Stanley, Ltd., of 71 Hornsey Rise, N., their catalogue of spectrometric apparatus, polarimeters, and refractometers, containing particulars of instruments suitable for many types of work. Particular attention is directed to a new model universal spectrometer, which may be used as a wave-length spectrometer for the visible and ultra-violet spectrum, a monochromatic illuminator, an infra-red spectrometer, a spectrograph, or, with the addition of the Bellingham and Stanley photometer, a high precision spectrophotometer. The instrument is arranged on the Littrow principle. Light from the slit is directed by a small totally reflecting prism to a concave mirror and thence to a 30° prism, from which it returns to the mirror and passes to a second slit, carrying an eyepiece adapter, by means of which the particular spectrum line required is isolated. The prism may be rotated so as to bring the required line into view. The prism and mirror inserted vary with the purpose for which the instrument is to be used. The photometer necessary to convert the instrument into a spectrophotometer has a number of new features in its design. The polarimeters, of which there are several models, consist of two solid components of Iceland spar mounted in such a way that no totally reflecting cement is required, and the risk of disintegration is reduced to a minimum by locating the sharp edge in one of the natural cleavage planes of the crystal. The refractometers include a high accuracy critical angle instrument specially designed to meet the objections to existing instruments working on the same principle.

Anniversary Meeting of the Royal Society.

THE report of the Council of the Royal Society, presented at the anniversary meeting on December 1, records that a bequest of 10,000*l.* has been received "for the prosecution of original research in medicine for the prevention of disease and relief of suffering with special attention to tropical diseases in British possessions and to cancer and tuberculosis." On the recommendation of the sectional committee for physiology, the subject of kala azar has been chosen for investigation, in view of its grave and increasing prevalence in India, and of the complete ignorance which exists as to the mode of infection. A further donation of 500*l.* has been received from Mrs. Tyndall, who in 1910 made a generous gift of 1000*l.* for the purpose of encouraging and furthering research in all matters pertaining to mining. It is the wish of Mrs. Tyndall that the income from this additional donation be used, at the discretion of the Tyndall Mining Bequest Committee, solely as a fund to meet out-of-pocket expenses incurred by the Tyndall research student in the carrying out of his investigations. The nineteenth and final volume of the Catalogue of Scientific Papers is now in the printers' hands. This contains about 44,200 entries under the letters T-Z, bringing the total number of entries for the period 1884–1900 to about 384,000. The publication of this volume will complete the great work of cataloguing the scientific papers of the nineteenth century. The first volume of this permanent record of the achievements of science during the period 1800–1900 was published in 1867. The cost of the catalogue has been very great, and might have prohibited the completion of the undertaking but for the assistance of the late Dr. Ludwig Mond and other donors, and for the generosity of the Syndics of the Cambridge University Press. Even apart from this assistance the total direct cost to the funds of the Royal Society has amounted to 24,970*l.*

President's Address.

In his address, Sir Charles Sherrington referred to the scientific careers and work of the twenty fellows, one foreign member, and one on the selected list of election as a fellow, who had died since the anniversary meeting of last year. He referred also to the original work on the emission of electrons from hot bodies carried out by Prof. O. W. Richardson, who was recently appointed to the third Research Fellowship founded by the munificence of Sir Alfred Yarrow, and to the retirement of Sir Arthur Schuster from the foreign secretaryship of the Society, after completion of the usual four years of office. The remainder of Sir Charles Sherrington's address is summarised below.

If I may finally pass for a moment to biological progress which the year has witnessed, I would advert to the work which Prof. Magnus and his collaborators have recently brought to approximate completion, their admirable research in nerve-physiology engaging the Utrecht laboratory during the past fifteen years. Its field has lain in nervous mechanisms which, though the highest part of the brain can have touch with them, can yet of themselves work wholly reflexly and separably from mind.

A number of simpler acts, studied for the most part in lowlier animal forms, have, of course, long been known to stand in that relation to the higher brain. But the Utrecht researches prove a like relation, and in the superior mammals, for acts surprisingly complex, the assumption and maintenance of the erect posture of walking, running, and so forth, in all their ordinary completeness. Not only have Magnus and his colleagues observed this, but they have also analysed the reflex processes by which these acts are thus accomplished. They have traced the seat and nature of the stimuli at work, the principles of the co-ordination of the nervous arcs and muscles involved, and indeed all the mutual interaction, which grade and secure the nicety of adjustment exhibited in such complexity.

Plant-growth orientates itself in regard to the line of gravity, geotropism; and so in the rabbit, cat, and monkey, standing, walking, running, with one element in common, the erect attitude, are shown by Magnus and de Kleyn to be, shortly said, refined geotropic reflexes. Any position other than the erect excites in the reflex animal restoration of its erectness. The head, for example, is righted by an act having its unconscious source in the pull and pressure of two microscopic stones in the special pair of tiny gravity organs bedded in the skull. With righting of the head goes rotation of the eyeballs in the opposite sense, keeping the vertical meridian of each retina in correspondence with the actual vertical. Appropriate reflexes bring the whole animal from any other position into the symmetrical right-side-up position. The well-known manœuvre which enables the cat, when inverted and falling from a short height, to right itself in the air during its fall, alighting squarely on its feet, is shown by Magnus and his colleagues to be executed perfectly by reflex action, after removal of the entire higher brain. Detailed analysis proves this whole reaction to be a chain of reflexes again essentially geotropic.

Following these researches we see, therefore, that it is less true to say that the higher animal under direction of its mind keeps itself right side up, than to say that the animal body by automatic mechanism is kept right side up. From the animal's point of view, as a sentient being, for it to be right side up to the world is, of course, for the world to be right side up to it. In other words, the body's automatism ensures that the mind looking, so to say, out from the body, finds the world right-side-up. By the Utrecht researches that relation is shown to be maintained by processes as non-mental as is digestive secretion of the bile. Hence, this right-side-upness being settled without mind, and indeed prior to mind, and naïve mind being, whatever else it is, utilitarian, the situation has not invited consideration from naïve mind. Mind has not needed, so to say, to think about a relation already existent and given it from the outset.

Prof. Magnus's researches enable us, therefore, to trace how, in the make-up of mind, right-side-upness of the world comes as an innate unargued datum, an immediate intuition, and therefore largely eludes mental analysis, there being no direct sense-experience of its origin or elemental processes, although confusion in mental space when its elements conflict. William James, with characteristic picturesqueness, wrote that our "prehistoric ancestors discovered the common-sense concepts," among them what he termed "one-space." With that we may set "world right-side-upness"; but as for dating its "discovery" to our prehistoric ancestors, it, as an immediate intuition, must date back not to the merely prehistoric but to the entirely prehuman.

Presentation of Medals.

The Copley Medal is awarded to Sir Edward Sharpey-Schafer. Sir Edward's work, extending from 1874 to the present time, has illuminated many parts of physiology, and the field of microscopical

anatomy no less. In 1894 he discovered, in conjunction with Dr. George Oliver, the remarkable effects of intravenous injection of extract of the adrenal gland, tracing their source to the small medullary portion of the gland. This research proved the starting point for a great volume of work, and was followed by somewhat similar work on another ductless gland, the pituitary, which opened a modern chapter of physiological knowledge of that organ, again with important consequences to medicine.

The Rumford Medal is awarded to Mr. C. V. Boys. Mr. Boys has advanced physical science by producing apparatus for accurate physical measurements and by making measurements of a high order of accuracy. He invented the first method for producing quartz fibres and investigated their elastic properties; he showed that they were practically free from fatigue, and demonstrated how admirably suited they were for the measurement of very small forces. He measured the extremely minute forces due to the mutual attraction of small masses, and he made a torsion balance of beautiful design for measuring the constant of gravitation. He took the first photographs of a bullet in flight and studied the wave disturbances produced by them, and has made a series of researches on soap bubbles and films. Recently he has developed a gas calorimeter which is the standard instrument prescribed by the gas referees for ascertaining the calorific value of the gas supplies of towns, work of special appeal in regard to a medal commemorative of Count Rumford.

A Royal Medal is awarded to Sir Dugald Clerk. In 1886, Sir Dugald described his experiments on the explosion of gaseous mixtures, providing data fundamental for the scientific development of internal-combustion engines. As chairman of the British Association Committee for investigation of gaseous explosions, he drew together workers concerned with the thermodynamics of internal-combustion engines who have contributed results of high importance. Sir Dugald himself investigated the effect of turbulence in a gas-engine cylinder and was successful in explaining the difference between the rate of combustion of the charge fired in a gas-engine cylinder in ordinary conditions of working, and the rate of combustion of the charge fired in a bomb. That to-day the internal-combustion engine is taking the place of steam power in smaller ships and in workshops as a prime mover of moderate power, and that to-day that engine renders possible the motor-car, the aeroplane and the submarine, is due largely to the scientific work of Sir Dugald Clerk.

A Royal Medal is awarded to Dr. Henry Hallett Dale. Working with successive collaborators, Dr. Dale showed that histamine, an amine derived from ergot, produces a condition resembling wound shock and toxæmic collapse. By analytic experiments he succeeded in establishing that histamine, while causing spasm of arterial and visceral muscle, conversely paralyses the active contraction of the capillary blood-vessels; and this analysis was reached at a time when the property of contractility of those vessels had not been generally recognised. He showed that their paralysis is the dominant feature in the shock and is responsible for a virtual break-down of the whole blood circulation. He has shown further that in histamine "shock" we have a paradigm for the shock effect of a large class of protein poisons, and also for the grave condition known in medicine as secondary surgical shock, toxæmic collapse, and anaphylactic shock.

The Davy Medal is awarded to Prof. A. G. Perkin. Prof. Perkin is distinguished for his researches on the natural organic colouring matters. During the course of his researches on luteolin, morin, apigenin, quercitrin and other flavone compounds, he discovered and investigated certain derivatives which such dye-stuffs form with acids—substances which he was able to employ for determining the molecular weights of these colouring matters. His classical researches on natural indigo have left few questions unanswered as regards the chemical constitution and behaviour of this important product, and he was the first to show that one of the constituents—indirubin—played no part during the process of vat dyeing with this agent. He was also the first to prepare in large quantity crystalline indican—the essential glucoside of natural indigo—and to study its properties. More recently he has investigated other natural products, notably the colouring matter of cotton flowers, and has dealt with the formation and structure of the important vat-dyes derived from benzanthrone.

The Darwin Medal is awarded to Prof. T. H. Morgan. Prof. Morgan's studies on polarity, on fertilisation, and later on gynandromorphism and sex determination, mark distinct advances in knowledge. The discovery of two kinds of spermatozoa in phylloxera and observations on chromosomes in these and other insects helped to elucidate the nature of the determination of sex in parthenogenesis. Of late years he has devoted himself to the study of heredity in various animals, and especially in the fly, Drosophila. The results obtained by him and his collaborators have thrown light on the relation of the factors of heredity to the chromosomes, on sex-linked and sex-limited characters, and other difficult problems in heredity.

University of Leeds.

TRIBUTE TO PROF. A. SMITHELLS, C.M.G., F.R.S.

THE movement which was set on foot some time ago for signalising the distinguished services of Prof. Smithells to the University of Leeds, and in other directions, reached its culminating point on November 25, when a portrait of Prof. Smithells, painted by Mr. Fiddes Watt, A.R.S.A., was presented to the University at a ceremony held in the Great Hall. At the same time, it was announced that the fund had reached the sum of 2462*l.* 6*s.* 11*d.*, of which approximately one half had been contributed by the gas industry, to which Prof. Smithells had been able to render such distinguished service.

The proceedings were opened by the pro-chancellor of the University, Mr. E. George Arnold, who spoke in the warmest possible terms of what Prof. Smithells had done during his 38 years' tenure of the chair of chemistry not only as professor of that subject but also in connexion with the wider matters of policy which the University had had to face at the time of its foundation and in the years that followed.

Mr. Arthur Lupton, who was pro-chancellor of the University during most of the long period of Prof. Smithells' service, presented the portrait on behalf of the subscribers, who numbered more than 800. He was followed by Prof. J. W. Cobb, who supported Mr. Lupton in the presentation and spoke as an old student of Prof. Smithells and a colleague in the Senate and on the Board of Science and Technology. He pointed out that when it was decided to make Leeds a centre of university education, not merely was it that a new university was instituted but a new kind of university. Its distinguishing mark was that not only was science to have a place of honour, but that a Faculty of Technology was to be created

in the University to rank along with the other Faculties of Art, Science, and Medicine, and to live alongside them in the closest intimacy. To do this effectively required judgment, imagination, and particularly courage and the faculty of dealing wisely with men and affairs. Prof. Smithells had written and spoken on this subject but always impersonally. On this occasion it was only proper that prominence should be given to the personal aspect, and the dominating part played by Prof. Smithells in this work fully and freely acknowledged.

Further support came from Prof. B. M. Connal, speaking as an old Arts colleague, and from Mr. J. Ferguson Bell, the president of the Institution of Gas Engineers, who, speaking for the gas industry, acknowledged the great indebtedness which they felt to science in application to their industry and particularly to the work of Prof. Smithells and the University of Leeds.

The portrait was received by the vice-chancellor on behalf of the University.

Prof. Smithells then described how his scientific work on flames had brought him into contact with the gas industry and its problems, and acknowledged, in impressive terms, its generosity to the University and the honour now paid to him. Referring to his colleagues, past and present, he paid a tribute to the founders of the old Yorkshire College and the remarkable group of men of science—Green, Rucker, Thorpe, and Miall—who in the early years so successfully disseminated the right spirit in the young institution, which ensured its initial success and later progress. To the late Prof. L. C. Miall he expressed a special personal tribute and the belief that no man did more for the spirit of the College and University. Speaking of the scholarship to be founded with the funds subscribed, he had wondered for a moment whether unity of knowledge might not receive appropriate illustration by devoting it to some literary end, but the idea was no doubt somewhat fantastic in this connexion. After all, he believed in science and shared the conviction expressed by a great man of letters, Mr. Galsworthy, that the future of the race was in the hands of science. It was right and proper, therefore, that this scholarship should be devoted to its advancement. In complimenting Dr. Baillie on his appointment as vice-chancellor, he assured him of a generous welcome, and expressed a firm faith in the modern university.

It was announced that the Smithells Fund would allow, after payment of the portrait and incidental expenses, of the establishing of a scholarship bearing the name of Prof. Smithells, within the University, of approximately 100*l.* per annum.

The British Dirigible Programme.

THE decision to take up again the development of dirigibles in Great Britain has probably been influenced by the example of the United States.

The following table gives a basis of broad comparison with German craft:

Name.	Length.	Diam.	Volume.	Displacement.	Power.	Speed.	Length/Diam.
	m.	m.	cub. m.	tons.	k.w.	km./hr.	
R 101 .	220	39·9	143,000	165	7×430	115 est.	5·5
"Burney"	212	40·5	143,000	165	7×430	115 est.	5·25
ZR 3. .	203	28	70,000	81	5×300	140 max.	7·25
L 59 . .	226·5	23·9	68,500	79	5×180	131 max.	9·5
Bodensee	121	18·7	20,000	23	4×180	135 max.	6·45

German practice shows much greater ratios of length/diameter; in the case of the L 59, this was perhaps due to the greater ease with which existing airsheds can be increased in length than in height and width; but the *Bodensee*, a successful post-War commercial craft, and the ZR 3, the latest example of German design, were free from this restriction.

In passing from the ZR 3 to the R 101 and the "Burney" the volume and power are both doubled, so that with similar shapes there should be an increase in speed of about $2^{1/9}=1{\cdot}08$, or from 140 km./hr. to 151 km./hr., as compared with 115 km./hr., which is a heavy margin in estimating. The shapes are, however, very different.

Tests at the National Physical Laboratory on relatively minute models in the wind-tunnel indicate a "best" ratio of length/diam. between 4·5 and 6. Presumably the British designers are not relying solely on a very doubtful aerodynamical similarity, and it would be interesting to know the full size data on which they are departing so boldly from German practice.

The United States naturally hold for themselves the only supplies of helium, and the best method open to other nations for reducing fire risks is by installing heavy oil engines as is specified for the new British craft. The specification of "stainless" steel for the metal framework indicates a surprising advance in the design of members to resist local buckling in the very thin webs and flanges as compared with lighter and bulkier duralumin.

In a previous note (NATURE, October 11, p. 548), the useful life of a dirigible was estimated from German records as less than two serious voyages per month for eighteen months, excluding fire and war risks. It remains for time to show how far the ZR 3 in American hands, and the new British craft in British hands, will compete with this standard of performance set up by the Germans after more than twenty years' experience.

No doubt it is difficult for the authorities to neglect completely a potential weapon, even though the aeroplane has proved an almost perfect antidote. From this point of view alone, their decision is entirely defensible. The long delay in coming to it may well be explained by the formidable nature of the problem taken as a whole.

University and Educational Intelligence.

CAMBRIDGE.—The time having lapsed during which the University can suspend the Jacksonian professorship of natural philosophy, and no new scheme for it having been adopted by the University, the Vice-Chancellor has declared that the professorship is vacant. An election will take place on January 5 next.

Mr. F. Balfour Browne, Gonville and Caius College, has been appointed University lecturer in zoology.

LONDON.—The title of professor of anatomy in the University has been conferred on Mrs. M. F. Lucas Keene, in respect of her post as head of the Department of Anatomy at the London School of Medicine for Women. Prof. Lucas Keene was appointed lecturer in anatomy and embryology, with charge of the department, at the London School of Medicine for Women in 1919, and the title of reader in anatomy in the University was conferred on her in respect of this post in 1921.

A course of free public lectures on "The Anatomy and Physiology of the Sympathetic Innervation of the Striated Muscle" will be given at University College, at five o'clock on December 8, 10, and 12, by Prof. J. I. Hunter, of the University of Sydney. No tickets will be required.

Applications are invited for the chair of pathology at the London (Royal Free Hospital) School of Medicine for Women. Twelve copies of each appli-

cation should be received by, at latest, the first post of January 29 by the Academic Registrar, University of London, South Kensington, S.W.7.

APPLICATIONS are invited by University College, Nottingham, for a lectureship in psychology. The person appointed will take charge of the psychological laboratory and be expected to assist in the teaching of philosophy. Forms of application (returnable not later than December 10) can be obtained from the registrar.

A FULL-TIME male teacher of chemistry is required at the Northern Polytechnic Institute, Holloway, N.7, with a knowledge of the application of chemistry to the building and rubber trades. Candidates must be university graduates, preferably with honours degrees. Application forms are obtainable from the Secretary of the Institute.

IT is stated in the *Chemiker Zeitung* that two newly created professorships in the medical faculty of the University of Münster have been filled by the appointment of Dr. Heinrich Többen to the chair of forensic medicine, and of Dr. Hermann Freund, of Heidelberg, to the chair of pharmacology.

PROF. W. H. MOBERLY, professor of philosophy in the University of Birmingham, has been appointed principal of University College of the South-West, Exeter, in succession to Principal Hetherington, who is becoming professor of philosophy in the University of Glasgow.

THE Leeds University Calendar for 1924–25 refers to the jubilee celebrations which will take place during the week December 15-20. Fifty years have elapsed since Yorkshire College was established as a College of Science, and forty since it was united with the Leeds School of Medicine, founded in 1831. The College formed part of the Victoria University, Manchester, from 1887 to 1904, when the University of Leeds was established by Royal Charter. The new Calendar, unlike previous issues, gives no particulars of the staff.

THE *Educational Record*, published quarterly by the American Council on Education, gives in its July number an interesting series of reports on the various activities of the Council and its committees during the past year. Like the Standing Committee of Vice-Chancellors in Great Britain, it was formed under the stress of war-time conditions, and has steadily grown during the past six years in importance. It is now the most influential voluntary body for the promotion of the interests of education in the United States. Some idea of the scope of its work can be gathered from the following list of subjects dealt with by its several committees: educational finance, federal legislation, college and university personnel, foreign language teaching, Franco-American exchange, international educational relations, foreign travel and study, college standards. The Director classifies the Council's activities under five main headings—standards, personnel, national relations, international relations, and research. It is his special care to ensure that work done under each of these heads is guided so as to contribute most fully to the advancement of the work in progress under the other heads. One of the most important of the Council's enterprises is the "Division of College and University Personnel" created two years ago for compiling a perpetual register of college teachers, their academic careers and qualifications, for the whole of the United States.

THE annual meeting of the Geographical Association will be held on January 1-3 at the London School of Economics, and arrangements have been made for members to travel to the meeting at reduced railway fares. Prof. J. L. Myres will deliver his presidential address on "A Geographical View of the Historical Method in Ethnology" on January 2, and he will also broadcast a message on "Wayside Geography" on the previous evening. Included among the numerous illustrated lectures which will be given is one by Mr. R. U. Sayce, of the Department of Geography, Natal University College, on aspects of the human geography of Natal. On January 1, a discussion, to which all university teachers of geography are invited, will be opened by Prof. J. L. Myres on "Departmental Research Programmes," while on the next day there will be a symposium on the life of fiord people, at which Dr. A. Sommerfelt (Kristiania), Mr. Henry Balfour (Oxford), Mr. C. E. P. Brooks (Meteorological Office), and Mr. C. B. Fawcett (Leeds) will speak. January 3 is to be devoted to special sessions on the teaching of geography. The first discussion, on school geography, will be opened by Mr. S. W. Rider (Gowerton County School) and Capt. T. K. Mortimer Booth (Christ's Hospital). At midday, four simultaneous discussions will be held: on the beginnings of geography, the teaching of climate, home geography, and school geography clubs and journeys. The afternoon will be devoted to excursions to various parts of London, including a party under the leadership of Mrs. Ormsby to beat the bounds of the City of London. On the first two days of the meeting a publishers' exhibition of books and maps will be open. Further particulars of the meeting can be obtained from the secretary of the Association, 11 Marine Terrace, Aberystwyth.

"CONTINUITY" was the text of a speech by the president of the Board of Education at the annual dinner of the London Teachers' Association on November 29. He hoped that in the coming year careful surveys of the field of education would be made by local authorities with the view of framing comprehensive schemes of development. Such a scheme has just been drawn up by the West Riding Education Committee providing for new capital expenditure during the years 1926 to 1932 on sites, buildings, and equipment, of 1,000,000*l.* for elementary, 543,000*l.* for secondary, and 300,000*l.* for technical education, entailing maintenance charges of 270,000*l.* per annum. Among the improvements aimed at are: (1) the reduction in size of classes (at present 946 classes contain more than 50 and 1332 from 41 to 50 children each); partly by means of (2) Central Schools in which adequate provision, impossible under present conditions, will be made for (3) instruction in handicraft and domestic subjects; (4) increasing the proportion of attendance at secondary schools from 9·5 to 15 per thousand of the population; (5) to provide for technical and other forms of further education 84 new schools and 10 enlargements or replacements. Under the last-mentioned head are included not only technical schools in buildings provided for the purpose or used jointly as secondary or middle schools, but also technical classes with "facilities for practical work in Science, Manual Training, Cookery, History, Social Science, Pure Natural Science, Botany, Entomology, etc., that might suitably be incorporated in the buildings of a Central School or a Central Top for a group of elementary schools." The annual additional charge on the rates, assuming that the capital is to be borrowed, will, it is estimated, amount to 6*d.* in the pound on the basis of existing assessable values.

Early Science at the Royal Society.

December 6, 1677. Dr. Croune related, that Sir Peter Colleton had taken care to send several baroscopes to Barbados, in order to examine, whether they would be of any use for the foretelling the seasons and mutations of the weather as they are found to do in England especially concerning hurricanes.—The president inquiring what experiments were designed for the next meeting, Mr. Hooke undertook to have the hydrostatical experiment ready; as also a farther improvement of the microscope. It being late the Society rose, and waited on the president to his own house.

December 7, 1664. It being suggested, that there were several persons of the society, whose genius was very proper and inclined to improve the English tongue and particularly for philosophical purposes; it was voted that there be a committee for improving the English language; and that they meet at Sir Peter Wyche's lodgings in Gray's-Inn.

December 8, 1670. Monsr. Andreas Monceaux, a French gentleman and a great traveller, son to Monsr. Monceaux, counsellor to the most Christian King, and great audiencier of France was proposed candidate.

December 9, 1663. The experiment of trying the force of powder by weight in the new powder engine contrived by Mr. Hooke was made twice, but without success both times; once by reason that the barrel broke in pieces; the second time, because the cover of the barrel bent. It was referred to Mr. Hooke to think of a way to prevent the inconveniencies.

1667. Sir Anthony Morgan and Mr. Hoskyns reported concerning the legal validity of the obligation subscribed by the fellows of the society; that the statutes had already specified the penalty for non-observance, viz., expulsion; and that thereby other penalties were excluded.

1669. Mr. Hooke produced another specimen of staining with yellow, red, green, blue and purple colours; which he said would endure washing with warm water and soap.

1675. There was produced a manuscript of Mr. Newton, touching his theory of light and colours, containing partly an hypothesis to explain the properties of light, partly the principal phenomena of the various colours exhibited by thin plates or bubbles, esteemed by him to be of a more difficult consideration.

December 10, 1662. The experiment of purging water from air, to see whether it subsides, according to the Torricellian experiment was deferred till the next meeting, because the engine was not tight.—Dr. Croune brought in some account of the breaking of wires; the experiment whereof appearing as yet very uncertain, he was desired to prosecute the same by trying several wires of different matter, and the same size, to see, whether the proportion of toughness in different metals may be found.

1668. A letter of Dr. Wallis contained an answer to some queries of Mr. Neile, viz., 1. Whether quiescent matter have any resistance to motion. 2. Whether motion may pass out of one subject into another. 3. Whether no motion in the world perish. 4. Whether different motions meeting destroy one another. Ordered to be entered.

December 12, 1678. Mr. Povey presented to the Society for their library a small stitched book in 4to. containing an history of Chelsea College.—He presented likewise, the claw of a West India spider, very much resembling the claw of a lobster or crab; given him by the Lord Willoughby of Parham as a present remedy against the tooth-ache.

Societies and Academies.

LONDON.

Optical Society, November 13.—T. **Smith**: (1) The theory of neutralisation. According to the new theory which is propounded, the test should be made with the lenses midway between the test object and the observer's eye, and the connexion between the vertex powers of the lenses when neutralisation is exact involves the distance of the test object and the order in which the lenses are placed. The simple law of the zero sum for the vertex powers is attained with simple accuracy as a mean result, the combination of high-powered lenses of equal and opposite vertex powers appearing as a positive lens from one side and negative from the other. The theory leads to the suggestion that in practice plano-lenses should be tested with their plane, not their curved, surfaces in contact. (2) The back vertex power of a combination of lenses. The general relations between the constants of a compound instrument and those of its components are obtained when the imagery is collinear. From these relations the expression for the vertex power of a compound instrument is built up in the form convenient for application in spectacle and other calculations.—R. **Kingslake**: A new type of nephelometer. The instrument provides an accurate optical method of measuring a minute amount of precipitate by means of the turbidity it produces in solution. Light is passed into the end of a tube containing the solution, and the intensity of the scattered light is measured by a special form of wedge-photometer.—A. **Pollard**: A note on nephelometry. The nephelometer described above is capable of measuring such minute quantities as the amounts of the oxides of nitrogen evolved from explosives in unit time under normal temperature and pressure.

Physical Society, November 14.—W. H. **Eccles** and C. F. A. **Wagstaffe**: An electrical method of producing vowel sounds and its application to wireless telegraphy. Apparatus has been devised to test a proposed method of communication in which the electric waves transmitted could produce easily recognisable chords at a suitably equipped receiving station. It was thought that chords would be more easily recognised than simple tones, and that vowel sounds would be the most easily recognised of chords. The ideal aimed at in this method of communication is that an operator at one side of the ocean should converse with an operator at the other side by means of a language made up of vowel sounds (somewhat like the Hawaiian language), the sounds being produced by pressing keys. Any ordinary language could be converted immediately into this telegraphic language by a code wherein each consonant was represented by a definite pair of vowel sounds.—D. W. **Dye** and L. **Hartshorn**: The dielectric properties of mica. Practically all samples of muscovite (potassium mica) have the same dielectric constant, the most probable value being 7·0. The presence of inclusions has no great effect on this value. The samples of phlogopite (magnesium mica)—*i.e.* the amber micas—have rather lower dielectric constants, about 6·0 for normal amber mica, and 5·0 for the silver amber variety. For the clear micas (muscovite) the power factor may be so low as 0·0003, and possibly less. The effect of inclusions is to increase it considerably. The power factor of the amber micas is greater than that of the muscovite variety—about 0·02 for the clear amber and 0·05 for the silver amber variety. The samples were all about 8 cm. square and 0·1 mm. thick, and the measurements were all made on the Carey Foster bridge at a frequency of 800 cycles per

second.—L. **Simons**: The X-ray emission of electrons from metal films, with special reference to the region of the absorption limit. Barkla and Miss Dallas have shown how the total energy of the β-rays from silver (as measured by the ionisation produced in H_2) varies with wave-length as the region of the K absorption limit is crossed. The author has now determined directly the aggregate number of β-rays of all types emitted over the same range; no selective change in the average energy occurs when the K fluorescent spectrum is excited. This is brought about by a re-grouping amongst the numbers and energies of the β-rays constituents, together with the addition of the K group of minimum individual energy. The experimental work has necessitated the separation of the β-rays from the secondary effects they produce, the chief of which is the production of δ-rays of very low energy. The δ-rays seem to be impact electrons the most frequent energy of which is little greater than 3·5 volts; this seems to be independent of the wave-length producing them, and of the substance from which they come. There are indications that they are influenced, at the moment of their departure from the surface, by the scattered X-rays.

PARIS.

Academy of Sciences, November 10.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: Remarks on the dissogenites, with reference to Colorado evergreenite.—G. **Bigourdan**: Observation of the occultation of Mars by the moon on November 5, 1924. The times of the second and fourth contacts are given. The sky was clear, but the atmospheric conditions were not good.—Armand **Cahen**: Developments proceeding according to f functions indefinitely superposed and arranged in descending chain.—A. **Bloch**: Functions taking several times the values 0 and 1 in a circle.—E. F. **Collingwood**: Some theorems of M. R. Nevanlinna.—Arnaud **Denjoy**: The singularities of series of rational fractions.—M. **Lyot**: The polarisation of the planet Saturn. It has been shown in earlier communications that light from the moon, Mars, and Mercury is polarised; the polarisation caused by Venus appears to be due to clouds, whilst that of Jupiter is partly due to clouds and partly to an atmosphere. Observations on Saturn made in May and June 1922, April, May, and June 1923 and 1924. The ring and the planet showed different polarisation phenomena, and the results are shown separately on a graphical representation of the results.— — **Giacobini** and — **Fatou**: Observations of Baade's planet, made at the Paris Observatory. Four positions are given on November 6, 7, and 8, together with the positions of the comparison stars. At present this planet is of 9·3 magnitude.—Ferdinando **Gazzoni**: An attempt at the quantitative estimation of thorium-X. In the presence of thorium, after precipitation by hydrogen peroxide, the filtrate contains thorium-X and its active deposit: in the presence of aluminium, after precipitation by ammonia, only thorium-X is found in the filtrate.—Paul **Pascal**: The definition and preparation of the hexametaphosphates. On the basis of cryoscopic and electrical conductivity measurements, and in view of the existence of a sodium lead salt $(Pb.Na_4(PO_3)_6)_2$, Graham's salt is regarded as a complex hexametaphosphate of the constitution $Na_2(Na_4(PO_3)_6)$.—E. **Burlot**: The determination of the theoretical energy and the co-volume of explosives.—Henry **Le Chatelier**: Observations on the preceding communication of E. Burlot. In experiments made forty years ago (with Mallard) the authors calculated some specific heats. The experiments in the preceding paper show the necessity of modifying these figures, which were probably 10 per cent. too high.—Claude **Fromageot** and René **Wurmser**: The comparative adsorption of some organic acids and their sodium salts. The adsorption by charcoal of formic, acetic, propionic, oxalic, succinic, citric and pyruvic acids from aqueous solutions was determined and compared with the adsorption of their sodium salts from solutions of the same concentration. No simple relation was found between the adsorption of the different groups and the dissociation constant of the acids to which they belonged. The salts are always less adsorbed than the corresponding acids.—L. J. **Simon**: The conditions of application of the technique for the estimation of carbon by the argentosulphochromic method. Experiments showing the relation between the amount of silver bichromate used in the analysis and the time required for complete combustion are recorded.— — **Tiffeneau**, A. **Orékhoff**, and Mlle. J. **Levy**: The isomerisation of the ethylene oxides with migration. The mechanism of molecular transpositions. Trisubstituted ethylene oxides of the type $Ar.CH.C(RR)$ (O) can be isomerised under the influence of heat, giving rise to the corresponding aldehydes $Ar.C(RR').CHO$. It is certain that in this case the migration of the aromatic group cannot be the initial change.—Marcel **Delépine**: The structural relations between the pinenes and the terpineols or the limonenes derived from them.—J. **Barthoux**: The pyrites of Maïdan-Peck (Serbia).—Mme. A. **Hée**: The frequency of earthquakes in Algeria during the ten years 1911-1920.—Marcel **Mirande**: The optical properties of the sterinoplasts and of the phytosterin of the bulbs of the white lily.—René **Souèges**: The embryogeny of the Euphorbiaceæ. The development of the embryo in *Euphorbia Esula*.—Marc **Bridel**: The hydrolysis of monotropitine by a ferment. The production of primeverose. The products of hydrolysis of monotropitine (extracted from *Betula lenta*) by an enzyme extracted from *Monotropa hypopitys* were methyl salicylate and the reducing sugar, primeverose. The latter was obtained crystallised and was proved to be identical with the primeverose obtained from gentiacauline and from the glucosides of *Primula officinalis*.—J. **Beauverie**: The germination of the uredospores of the rust of wheat.—E. **Leblanc**: The orbital muscles of reptiles. Study of the muscles in *Chameleo vulgaris*.—M. **Javillier**, P. **Bauer**, and Mlle. S. **Levy-Lajeunesse**: Attempts at the identification of the factor A. The factor A and phytol. The unsaponifiable fraction of chlorophyll, consisting mainly of phytol, has many properties in common with the liposoluble factor A, but experiments on rats proved that phytol has not the action of factor A.

COPENHAGEN.

Royal Danish Academy of Science and Letters, October 17.—C. **Wesenberg-Lund**: Contributions to the anatomy and biology of the genus Zoothamnium. The biology and anatomy of Z. *geniculatum* has been studied during two years. Special attention has been paid to the so-called macrogonidia, their origin and their significance for the formation of new colonies.

October 31.—Johannes **Fibiger**: Vilhelm Ellermann. His life and scientific work.—Niels **Nielsen**: Note on Lagrange's series. The name of Bürmann has been given to some series of Lagrange, but the supposed memoir of Bürmann does not exist. Research on a new series of Lagrange.

VIENNA.

Academy of Sciences, June 12.—F. **Werner**: Scientific results of the Treitl bequest zoological expedition to the Anglo-Egyptian Sudan, Kordofan, 1914. Odonata, compiled by F. Ris, including descriptions of two new species.—H. **Spandl**: Freshwater amphipodes, especially those of the Baikal and Caspian Seas, and the relation of the Caspian Sea fauna to that of the Arctic and Baltic.—V. **Brehm**: Descriptions of new Entomostraca from the Handel-Mazzetti expedition to China.—E. **Dittler** and A. **Köhler**: Experiments on potassium-sodium felspars. Perthite was heated at temperatures below the melting-points of its components. Thin sections about 0·02 mm. in thickness were used; an alteration of optical constants as seen through the microscope proved diffusion in the solid state. An electrical resistance furnace allowed a temperature of about 1000° C. to be maintained for 500 hours. Albite and orthoclase can diffuse into each other forming mixed crystals.

June 20.—F. **Kerner-Marilaun**: The solar-climatic temperatures of antiquity.—H. **Handel-Mazzetti**: New Chinese plants described, including species and varieties of Juniperus, Camellia, Schima, Lobelia, Leontopodium.—L. **Kölbl**: Tectonic of the granite peaks in the High Tauern.

June 26.—R. **Kremann** and R. Gruber-**Rehenburg**: Electrolytic conduction in fused metal alloys, copper-zinc, copper-tin, copper-silver, and copper-aluminium.—R. **Kremann** and O. **Benda**: The electrolysis of silver-lead alloys.—R. **Kremann** and H. **Drazel**: On the influence of substitution in the components of binary solution equilibria. Equilibrium diagrams for benzhydrol with phenols and amines.—E. **Müller**: Calculating with fold-products as applied to three-dimensional objects of the second order.

July 3.—E. **Lohr**: Continuum theory of Röntgen ray propagation in crystals.—H. **Handel-Mazzetti**: New Chinese plants.—I. **Pia**: The diplopores in the Trias of Southern Dalmatia.—E. **Hofmann**: Plant remains from the lake-dwellings of Mondsee.

July 10.—E. **Philippi** and R. **Seka**: On the di-naphth-anthracene series. VI. Condensation of pyromellithic acid anhydride with decaline and tetraline. VII. Sulphonation of di-naphth-anthracene-di-chinon. VIII. Substituted derivatives of pyromellithic acid. Some aliphatic polycarbon acids.—J. **Korczyn**: On the irregularities in the β-radiation of freshly crystallised uranyl nitrate.—G. **Ortner** and H. **Pettersson**: On the preparation of radium C II.—G. **Kirsch** and H. **Pettersson**: On the disintegration of atoms by α-rays (II.). A method for observing atomic fragments of short range.—H. **Pettersson**: On the disintegration of atoms by α-rays (III.). The disintegration of carbon. Bombardment by α-radiation gives H- and α-particles, the latter with a range of about 10·5 cm. The ranges of the H-particles at right angles to, and in the direction of, the primary radiation were 16 cm. and 8 cm. The results were in agreement with an explosive mechanism for atomic disintegration.—G. **Kirsch**: On the disintegration of atoms by α-rays (IV.). Disintegration of nitrogen and oxygen; helium a product. When fast α-rays traverse nitrogen, both H-particles and secondary α-rays arise. $\grave{\alpha}$-particles were also obtained from oxygen. The collisions of swift α-particles with light atoms yield hydrogen and helium as disintegration products.—H. **Handel-Mazzetti**: New Chinese plants. The descriptions of new Chinese Primulas collected by the Handel-Mazzetti expedition are continued. Six new primulas are described, some from 10,000 feet and higher in the mountains of the provinces Yunnan and Setschwan.—F. M. **Exner**: Monthly anomalies of atmospheric temperature and pressure on the earth; correlation of the pressure in Iceland with the pressure in other places.—O. **Dafert** and J. **Höfinger**: Chemical investigations of the deposits from the Dragon Cave near Mixnitz in Styria.—R. **Kremann** and J. **Dellacher**: Electrolytic conduction in fused metal alloys (IX.), tin-aluminium alloys.—M. **Kohn** and M. **Weissberg**: On *m*-bromophenol (VII.).—G. **Weissenberger** and L. **Piatti**: Molecular compounds of phenols (II.). The behaviour of cresols with aromatic hydrocarbons.—G. **Weissenberger** and H. **Waldmann**: On absorption from viscous fluids by charcoal.—R. **Seka**: On 8-amido-chinolin and derivatives.—F. **Kautsky**: The more recent folding in the eastern Alps and its expression in the gravity diagram.—L. **Moser** and R. **Lessnig**: The identification and separation of rare metals from other metals (V.). The separation of zirconium and hafnium from titanium, cerium, and thorium.—A. **Brukl**: The preparation of metallic tellurides from tellurium hydride and metallic salt solutions.

October 9.—H. **Kurtz**: A revision of the genera Lernæogiraffa and Doryphorus, parasitic copepods inhabiting the gills of a fish Heterotis in the river Nile.—F. **Querner**: The head and mouth parts of the African fly, *Diopsis apicalis*.

October 16.—A. **Tauber**: Some properties of algebraic functions.—E. **Dittler** and A. **Köhler**: The behaviour of felspars at high temperatures. Continued investigations of perthite.—G. **Weissenberger** and F. **Schuster**: Molecular compounds of phenols (III.). The behaviour of binary systems with hydrated phenols.—A. **Kailan** and H. **Raupenstrauch**: The esterification of fatty acids in glycerin, with a formula for the coefficient of velocity.—F. **Hochstetter**: On cases of total absence of septum pellucidum in man.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 10, No. 9, September).—H. **Bateman** and P. **Ehrenfest**: The derivation of electromagnetic fields from a basic wave-function.—Alice H. **Armstrong**, W. **Duane** and W. W. **Stifler**: The influence on secondary X-ray spectra of placing the tube and radiator in a box. The X-ray tube and secondary radiator were placed inside a lead-lined wooden box, the back of which could be removed. Evidence was obtained of scattered radiation due to the Kα doublet of the molybdenum, but on removing the back of the box the form of the spectrum changed. It is suggested that the secondary and tertiary radiation inside the box may mask completely the effect of the secondary radiator under examination.—S. K. **Allison**, G. L. **Clark** and W. **Duane**: The influence on secondary X-ray spectra of placing the tube and radiator in a box. In these experiments a wooden box was used. Radiation with increased wave-length was obtained, agreeing with Compton's observations and also with the suggested tertiary radiation, but of carbon and oxygen. Removing the secondary radiator (a plate of sulphur), but retaining the wooden box, decreased the intensity of the spectrum without changing its character. If the box was removed and the secondary radiator retained, the character of the spectra changed.—B. **Davis** and R. von **Nardroff**: Further experiments on the refraction of X-rays in pyrites. In earlier experiments the characteristic K radiation of molybdenum was used; the K characteristic radiation from copper is now employed and as before (NATURE, April 26, p. 627) the results are in good accord with figures derived from the Lorentz dispersion formula. This formula seems to be valid for X-radiation.—K. K. **Smith** and L. I. **Bockstahler**:

An improved method of measuring the specific heats of metals at high temperature. A positively charged molybdenum cylinder surrounds a tungsten filament which acts as a thermionic emitter, and the whole is heated in a furnace. The changes in the thermionic current are measured by an oscillograph. The specific heat of tungsten at 2375°-2475° K is 0·045 cal. per gm. and the atomic heat 8·3 cal. per gram-atom.—C. E. **St. John** and H. D. **Babcock**: Note on the pressure and currents in the sun's atmosphere. Gathering up the observations of different workers during the past few years, a chart is constructed showing a scheme for the distribution of factors in the sun's atmosphere according to level.—C. E. **St. John** and W. S. **Adams**: Convection currents in stellar atmospheres. High dispersion spectrograms of Sirius, Procyon, Arcturus and the sun show close agreement between the differences enhanced minus arc lines and high- minus low-level lines, both differences being apparently due to variation in convection currents with level. Convection currents seem to increase with temperature. The pressures in the atmospheres of all these stars are low and of the same order.—E. B. **Wilson** and W. J. **Luyten**: A statistical discussion of sets of precise astronomical measurements (III.); masses of the stars. The distribution of the logarithm of the mass of the stars is very close to normal—closer than might be expected from the meagre data. Systems with unusually big masses are not included.—T. R. **Hogness** and E. G. **Lunn**: The ionisation potentials of hydrogen as interpreted by positive ray analysis. Hydrogen is ionised by impact electrons from a tungsten filament, and the positive ions are drawn into a magnetic field where they are analysed. Three positive ions were found, H^+, H_2^+ and H_3^+, the H_2^+ ions predominating; no negative ions were detected. To determine the ionisation potentials, the voltage of the impact electrons was decreased by steps from a maximum until no ions were detected. The values obtained were: H^+, 16·6 volts; H_2^+, 15·7 volts; H_3^+, 16·7 volts.—G. E. M. **Jauncey** and H. E. **Stauss**: The polarising angle for X-rays scattered by paraffin. A shift of the polarising angle was observed according qualitatively with Jauncey's equations for a corpuscular quantum theory of the scattering of polarised X-rays.—R. G. **Dickinson**: The combination of hydrogen and oxygen in the presence of activated mercury. Hydrogen and oxygen in a quartz reaction tube were exposed to a blast of air from a mercury lamp; the pressure decreased steadily, apparently owing to the formation of water.

Official Publications Received.

Smithsonian Miscellaneous Collections. Vol. 75, No. 2: Cambrian Geology and Paleontology, V. No. 2: Cambrian and Lower Ozarkian Trilobites. By Charles D. Walcott. (Publication 2788.) Pp. 53-66. Vol. 76, No. 11: The Freshfield Glacier, Canadian Rockies. By Howard Palmer. (Publication 2757.) Pp. 16+9 plates. Vol. 77, No. 1: A Chapter in the History of Zoological Nomenclature. By Leonhard Steineger. (Publication 2789.) Pp. 21. (Washington: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 3: An Evaluation of Kindergarten-Primary Courses of Study in Teacher-Training Institutions. By Nina C. Vandewalker. Pp. iii+44. (Washington: Government Printing Office.) 5 cents.

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1924. 90e année. Pp. 450+9 planches. (Bruxelles: Maurice Lamertin.) n.p.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 489: Primary Radio-frequency Standardization by Use of the Cathode-Ray Oscillograph. By Grace Hazen and Frieda Kenyon. Pp. 445-461. (Washington: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 244: Tides; a Manual of the Harmonic Analysis and Prediction of Tides. By Paul Schureman. (Special Publication No. 98.) Pp. x+416+9 plates. (Washington: Government Printing Office.) 1 dollar.

Bulletin of the National Research Council. Vol. 8, Part 5, No. 47: Classified List of Published Bibliographies in Physics, 1910-1922. Compiled for Research Information Service by Karl K. Darrow. Pp. v+102. (Washington: National Academy of Sciences.) 2 dollars.

Journal de la Société des Américanistes de Paris. (Reconnue d'utilité publique.) Nouvelle Série, Tome 16. Pp. xxx+552. (Paris: 61 rue de Buffon.)

Proceedings of the Royal Society of Edinburgh, Session 1923-1924. Vol. 44, Part 3, No. 22: The Theory of Circulants from 1900 to 1920. By Sir Thomas Muir. Pp. 218-241. 2s. Vol. 44, Part 3, No. 23: On a Class of Partial Differential Equations. By Dr. E. L. Ince. Pp. 242-247. 9d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1923-24. Pp. 16. (Leeds.)

Memoirs of the Archæological Survey of India. No. 18: Hindu Astronomy. By G. R. Kaye. Pp. v+134. (Calcutta: Government of India Central Publication Branch.) 3 rupees; 4s. 8d.

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Twenty-eighth Session adopted at the Annual Meeting of Governors held on the 21st October 1924. Pp. 79. (Glasgow.)

Suomen Geodeettisen Laitoksen Julkaisuja: Veröffentlichungen des Finnischen Geodätischen Institutes. No. 3: Die Beobachtungsergebnisse der Südfinnischen Triangulation in den Jahren 1920-1923. Pp. iii+235. No. 4: Untersuchungen über Schwerkraft und Isostasie. Von W. Heiskanen. Pp. iv+96. (Helsinki.)

Mysore Government: Meteorological Department. Report on Rainfall Registration in Mysore for 1923. By C. Seshachar. Pp. xvii+35+2 plates+2 maps. (Bangalore: Government Press.)

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 8, Nos. 5, 6, 7, 8 and 9. No. 5: Papers on Indian Tabanidæ; i. A Practical and Simple Method for rearing Tabanid larvæ; ii. The Number of Moults in Tabanid larvæ; iii. The Life History of *Tabanus crassus*, Walker, and the Identity of the Female of the Species; by P. V. Isaac. No. 6: Two Drosophilidæ from Coimbatore; and No. 7: A New Aphidiphagous Fly; by J. R. Malloch. No. 8: Notes on Indian Odonata in the Pusa Collection; by Major F. C. Fraser. No. 9: On New and Old Oriental Cicindelidæ; by Dr. Walther Horn. Pp. 53-91. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 1.4 rupees; 2s.

Publications of the South African Institute for Medical Research. No. 17: The Value of the Konimeter; being an Investigation into the Methods and Results of Dust-Sampling as at present practised in the Mines of the Witwatersrand. By A. Mavrogordato, with the Collaboration of J. Boyd, J. Innes, E. MacEwen, A. Pulford, L. G. Ray, G. D. Maynard, J. Moir, E. Cluver. Pp. 71+11 plates. (Johannesburg.) 5s.

Union of South Africa: Department of Agriculture. Science Bulletin No. 30 (Division of Chemistry Series No. 31): An Investigation into some Physical and Chemical Changes occurring in Grapes during Ripening. By P. R. v. d. R. Copeman. Pp. 38. (Pretoria: Government Printing and Stationery Office.) 3d.

Institut International d'Agriculture. Service de la statistique générale. Annuaire International de statistique agricole, 1923: International Yearbook of Agricultural Statistics for 1923. Pp. xcv+471. (Rome.) 30 francs; 8s.

Animal Breeding Research Department, The University, Edinburgh. Report of the Director for the Period from 1st July 1923 to 31st March 1924. Pp. 12. (Edinburgh.)

U.S. Department of Agriculture: Weather Bureau. Monthly Weather Review Supplement No. 24: West Indian Hurricanes and other Tropical Cyclones of the North Atlantic Ocean. By Charles L. Mitchell. Pp. iii+47+11 plates. (Washington: Government Printing Office.) 25 cents.

Proceedings of the Cambridge Philosophical Society. Biological Sciences. Vol. 1, No. 3, October. Pp. 139-218. (Cambridge: At the University Press.) 12s. 6d. net.

Bergens Museum. Aarsberetning, 1923-1924. Pp. 82. (Bergen: A/S John Griegs Boktryckkeri.)

Bergens Museum Aarbok, 1923-1924. Hefte 1. Naturvidenskabelig Række. Pp. 166. Hefte 2. Naturvidenskabelig Række. Pp. 262. (Bergen: A/S John Griegs Boktryckkeri.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 27: Fossil Plants of the Calamopitys Type, from the Carboniferous Rocks of Scotland. By D. H. Scott. Pp. 569-596+6 plates. 6s. Vol. 53, Part 3, No. 28: On the Presence of Tetrads of Resistant Spores in the Tissue of *Sporocarpon furcatum* Dawson from the Upper Devonian of America. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 597-601+1 plate. 1s. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Diary of Societies.

SATURDAY, DECEMBER 6.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10 A.M.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—E. W. H. Piper: Durham Cathedral (Lecture).

INSTITUTE OF BRITISH FOUNDRYMEN (at Chamber of Commerce, Birmingham), at 4.—D. Wilkinson: Malleable Iron.

MONDAY, DECEMBER 8.

ROYAL IRISH ACADEMY, at 4.15.

VICTORIA INSTITUTE, at 4.30.—Prof. T. G. Pinches: The Worship of Idols in Assyrian History in Relation to Bible References.

CAMBRIDGE PHILOSOPHICAL SOCIETY (at Cavendish Laboratory), at 4.30.—C. T. R. Wilson and Prof. G. I. Taylor: The Bursting of Soap-bubbles in a Uniform Electric Field.—Prof. E. A. Milne: Dissociative Equilibrium in an External Field of Force.—Dr. T. M. Cherry: Some Examples of Trajectories Defined by Differential Equations of a Generalised Dynamical Type.—J. Brill: Note on the Lorentz Group.—E. H. Neville: Note on the Harmonic Conic.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—D. Fairweather: The Electrolysis of Salts of Alkyloxyacids.—W. West and E. B. Ludlam: The Ionisation of Iodine Vapour by Ultra-violet Light.—W. O. Kermack and W. T. H. Williamson: The Stability of Suspensions, I. The Rate of Precipitation of Kaolin Suspensions by Salts at Varying Hydrogen Ion Concentrations.—P. MacCallum and W. O. Kermack: The Influence of Gelatin on the Stability of a Colloidal Solution of Cholesterol, and on the Charge of the Particles.—W. O. Kermack and C. I. B. Voge: The Action of Salts with Multivalent Cations on Colloidal Solutions of Gold and Gum Benzoin.—A. O. Curle: Obituary Notice of the Rt. Hon. Lord Abercromby.—Dr. A. Lauder: Obituary Notice of Sir J. J. Dobbie.

BIOCHEMICAL SOCIETY (at Imperial College of Science and Technology), at 5.—E. Watchorn: The Magnesium of Human Serum.—M. E. Robinson and R. A. McCance: The Oxidation of Amino Acids by Fungus Tyrosinase.—H. W. Buston, H. N. Mukherjee, and S. B. Schryver: The Isolation of a Hydrolysis Product of the Proteins, hitherto undescribed.—H. Martin and S. B. Schryver: Some Transformations of Casein.—Dorothy Griffiths and S. B. Schryver: The Separation of the Proteins of Egg-white in an Electrical Field.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—A. V. Williamson: The Irrigation of the Indo-Gangetic Plain.

SOCIETY OF ENGINEERS (at 17 Victoria Street, S.W.), at 6.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—G. M. Clark and others: Discussion on the Pretoria Power Station.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—S. E. Flack: Ships' Propellers.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Modern Colour Problems (III.) (Cantor Lectures).

SURVEYORS' INSTITUTION, at 8.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. G. Graham, Prof. H. Maclean, and others: Discussion on The Present Position of the Treatment of Diabetes by Insulin.

BIOCHEMICAL SOCIETY (at Imperial College of Science).

TUESDAY, DECEMBER 9.

FARADAY SOCIETY (at Chemical Society), at 4.30.—Discussion on Base Exchange in Soils. Chairman: Sir Daniel Hall.—Dr. D. J. Hissink: Base Exchange in Soils.—Prof. N. M. Comber: The Rôle of the Electronegative Ions in the Reaction between Soils and Electrolytes.—H. J. Page and W. Williams: Studies on Base Exchange in Rothamsted Soils.—Prof. G. W. Robinson and R. Williams: Base Exchange in Relation to Soil Acidity.—S. J. Saint: The Relation between the P_H Value, the Lime Requirement, and the Thiocyanate Colour of Soils.—E. A. Fisher: Some Secondary Aspects of Base Exchange in Soils.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Prof. W. E. Dixon and Dr. F. H. A. Marshall: The Influence of the Ovary on Parturition.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group), at 6.—Conference on the Standardisation of Plate Testing Methods.—The Light Source, Primary and Secondary. Spectral composition of the light source with special reference to colour sensitive plates; daylight correction filters, etc. Opening paper by J. W. T. Walsh.—The Exposure Mechanism. (*a*) Intermittent or continuous exposure; (*b*) Relative merits of wedge and sector wheel; (*c*) Other methods. Opening paper by S. O. Rawling.—Development. (*a*) Methods of development; (*b*) Effect of varying composition of the developer with the same emulsion; (*c*) Effects of temperature variation; (*d*) A standard developer. Opening paper by Dr. W. Clark.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. C. M. MacLagan: The Sliding Cylinder, Double-acting, Two-cycle Diesel Engine.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Centre) (at Town Hall, Leicester) at 6.45.—T. Hall: Domestic Applications of Electricity.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—D. R. Nanji and W. S. Shaw: The Rôle of Silica in Plant Growth, its Assimilation and Physiological Relation to Phosphoric Acid.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—T. Martin: The Microscope in the Study of Alloys.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Coventry).

SOCIETY OF DYERS AND COLOURISTS (Leeds Junior Branch) (at Leeds).—P. G. Marshall: The Tinctorial and Antiseptic Properties of Certain Types of Quinoline Dyestuffs.

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Section) (at Swansea).

WEDNESDAY, DECEMBER 10.

ROYAL SOCIETY OF ARTS, at 5.—N. Thomson: Colombia as a Field for Development.

ROYAL SOCIETY OF MEDICINE (Otology, Laryngology, Medicine, Neurology Sections), at 5.—Dr. H. Thursfield, Sir William Milligan, Dr. W. Drought and Dr. J. G. Greenfield, W. M. Mollison, and others: Discussion on the Causes, Early Recognition, and Treatment of Non-tubercular Meningitis.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 7.—E. Latham: Suitable Fendering for Tidal Berths.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—R. J. Welsh: Some Factors affecting Vacuum in Surface Condensers.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Miss Eleanor F. Rathbone: Family Endowment and Birth Control.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Mechanical Engineers), at 8.—A. J. V. Underwood: The Natural Soda Deposits of East Africa.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (Informal Meeting, at Manchester).

THURSDAY, DECEMBER 11.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Capt. H. Riall Sankey: Standards of Comparison in connexion with the Thermal Efficiency of Steam Engines.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.

INSTITUTE OF CHEMISTRY (jointly with Society of Chemical Industry) (at 36 York Place, Edinburgh), at 7.30.—Lt.-Col. W. G. Liston: Fumigation with Hydrogen Cyanide.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—A. G. Norris and W. H. T. Swire: Industrial Power Supply, a Comparison of Electrical and other Methods of Driving Industrial Machinery.

INSTITUTE OF METALS (London Local Section, Joint Meeting with Institution of British Foundrymen) (at Institute of Marine Engineers), at 7.30.—F. W. Rowe: Present Problems and Developments in Engineering Bronze Foundry Practice.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—J. E. Barnard: Some Problems in Medical Microscopy.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.

ROYAL SOCIETY OF ARTS, at 8.—Senatore G. Marconi: Radio Communications (Inaugural Address).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Prof. W. E. Dixon, Sir Havelock Charles, Sir William Collins, and Dr. Arthur Powell: Discussion on Some Clinical and Scientific Aspects of Drug Addiction in the Tropics.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Section) (at Birmingham).—Vice-Adml. Sir George G. Goodwin: The Trend of Development of Marine Propelling Machinery (Thomas Hawksley Lecture).

FRIDAY, DECEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. J. Lunt: Large Line-displacements in the Spectra of Germanium and Chlorine under Different Conditions of Temperature.—Prof. E. A. Milne: The Equilibrium of the Calcium Chromosphere.—T. Allison: Squaring-on Newtonian Mirrors.—S. D. Tscherny: Occultation of B.D. −18°·6078 by Mars, observed 1924, September 5, at the Astronomical Observatory, Kiew.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Capt. A. Egerton: Numerical Values of Chemical Constants and Frequencies of the Elements.—J. H. Powell: The Sensibility of Circular Diaphragms for the Reception of Sounds in Water.—A. Campbell, with Demonstration by W. H. Lawes: A Direct-reading Frequency Meter of Long Range.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Cheese: A Winter Holiday in Greece.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—F. Hill and others: Discussion on the Design of Furnaces for Annealing and Heat Treatment.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. G. Bouly: Fluid Transmission Gears.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.—S. B. Freeman: Fuel Oil for Marine Internal-Combustion and Steam Engines.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—O. S. Hillman, E. Apperly, and others: Discussion on Splanchnic Analgesia with Record of Cases.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Section).—Prof. G. F. Charnock: Some Fallacies concerning Invention.

SATURDAY, DECEMBER 13.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at King's College), at 3.15.—Dr. C. S. Myers: A New Theory of Sensory Adaptation.—Prof. C. G. Seligman: The Psychology of the Unconscious in Relation to Anthropology.

PHYSIOLOGICAL SOCIETY (at Middlesex Hospital).

PUBLIC LECTURES.

SATURDAY, DECEMBER 6.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Eggs of Animals.

TUESDAY, DECEMBER 9.

KING'S COLLEGE, at 5.30.—M. Kaye: F. H. Bradley—The Passage to the Absolute.

WEDNESDAY, DECEMBER 10.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir Robert Jones: The Problem of the Cripple Child.

UNIVERSITY COLLEGE, at 5.30.—A. Gomme: Technical and Scientific Libraries.

THURSDAY, DECEMBER 11.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—F. W. Twort: Modern Bacteriological Technique. (Succeeding Lectures on December 12, 15, 16, 17.)

FRIDAY, DECEMBER 12.

KING'S COLLEGE, at 5.30.—Prof. A. V. Hill: Scientific Method.

SATURDAY, DECEMBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Glory that was Thebes.