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The Severn Barrage Scheme*

THE long awaited report on the practicability of the proposal for the establishment of a great hydro-electric power generating installation near the mouth of the Severn, to be actuated by the tidal waters of the estuary in conjunction with an impounding dam, generally known as the Severn Barrage Scheme, has, at last, appeared. Interest in the matter may be expected to revive with the publication of the report and especially when the Cabinet pronounces its decision thereon, but much of the keen attention which was excited by the original promulgation of the project has died down during recent years. It was put forward in 1920, in unusually glowing terms, by the Ministry of Transport, and advocated as a means of opening up a "vista little short of a revolution in the industrial life of the West and Midlands of England" and of bringing "within the reach of all classes of the community the blessings of light, purity and power". In political and labour circles, with an enthusiasm, which neglected, perhaps, to take into account the limitations and delays inherent in the realisation of constructional undertakings of great magnitude, it was hailed as a heaven-sent inspiration for the immediate absorption of a large bulk of unemployed labour. These highly coloured expectations have given place to a more sober and reflective outlook.

In the intervening period, the scheme has been receiving careful and painstaking investigation by a Committee of the Economic Advisory Council, of which Lieut.-Col. J. T. C. Moore-Brabazon, M.P., is chairman. The technical features of the project not unnaturally presented a number of complex problems, some of them of quite a novel character. It is claimed in the report that this is the first tidal power scheme of any magnitude to be investigated in any part of the world in which a solution of the problems has been indicated. No reliable judgment, therefore, could be formed on the feasibility of the project, until the whole of the physical conditions and the constructional details had been examined from a strictly scientific and economic point of view. The results of the execution of the work were bound to be too far-reaching and drastic in their repercussions on a variety of important interests for it to be treated otherwise than with the most serious attention. The professional men associated with the deliberations and conclusions of the Committee

* Economic Advisory Council. Severn Barrage Committee Report. Pp. 28. (London : H.M. Stationery Office, 1933.) 6*d*. net.

were Sir John Snell, Sir Basil Mott, Sir H. P. Douglas, Prof. A. H. Gibson, and Mr. T. Shirley Hawkins: these names are a sufficient guarantee that this duty has been faithfully and consistently performed. Theoretical calculations have been supplemented by the operation of models and experimental apparatus of a very elaborate character in an endeavour to arrive at a true picture of the results.

As the outcome of its labours, the Committee has issued a carefully considered verdict on the technical side of the undertaking. Following the lines of the interim report of 1929, the Committee finds that there are no insuperable difficulties, geological or otherwise, in the way of the construction of a barrage, and it indicates a suitable site for the structure at the English Stones, on a line approximately parallel to the existing Severn Tunnel. It states, however, that a power station at the barrage, dependent entirely on tidal action, would not produce electrical energy at a cost which could compete economically with energy generated at selected coal-fired stations. On the other hand, with an auxiliary scheme of water storage, which the Committee has examined for a suggested site in the Wye Valley and finds to be quite practicable, it is considered possible to produce a supply of electrical energy, somewhat less, it is true, than that obtainable from the barrage alone, but still of considerable proportions and adequate to meet one thirteenth of the total likely requirements of the whole country in 1941 (estimated at 21,000 million units) at a cost which would be only two-thirds of that due to generation at equivalent coal-fired stations. This would mean the substantial saving of between a million and a million and a quarter pounds per annum.

The capital sum required for the realisation of this outstanding enterprise is of correspondingly colossal dimensions, remarkable even in these days of Brobdingnagian finance. With auxiliary features—roads, railways and harbour facilities—it is estimated to run to over fifty millions sterling. Moreover, the scheme cannot be conjured into existence by the stroke of a magician's wand: it will take fifteen years of steady and persistent effort, during which it is estimated that the number of men employed on construction and manufacture will increase gradually from 2,000 in the first year to 12,000 in the tenth, thereafter rising rapidly to a maximum of 27,800 in the thirteenth year. The Committee does not anticipate that the work could be commenced before 1937, consequently no effective operation would be realised before 1942. In cases of all major engineering works, a great deal depends on the accuracy of the forecasts of time and outlay. In the present instance, the premises for these forecasts are attended by rather greater uncertainty than usual, and it is of interest to note that the allowance for contingencies in the expenditure is 12½ per cent. Moreover, the rate of interest for loans has been calculated at 4 per cent, although the present market rate for Government guaranteed loans is about 3½ per cent. The Committee wisely emphasises the risk of unforeseen difficulties and the danger that the estimates may prove inadequate.

Not the least important consideration in the investigation, apart from the main object of the scheme—the generation of cheap supplies of electricity—has been the probable physical effect of the construction of a solid barrier across the Severn estuary and the consequent interference with the established regimen of the tidal region and the upland water discharge—an interference which may bring about changes affecting in greater or less degree the navigable approaches to the docks at Avonmouth and the port of Bristol in the seaward portion and the transportation conditions to and from the port of Gloucester above the barrage. This aspect of the matter has been carefully investigated by Prof. A. H. Gibson with the aid of a large scale tidal model in an extended series of experiments, from which it would appear "that a barrage would not injuriously affect navigation *below* the barrage", while, "even without dredging, a barrage would not seriously affect navigation *above* the barrage at any time of the tide, and would appreciably improve it at low water". How far this pronouncement, founded as it is on relatively minute movements of silt-laden salt water in a model on a distorted scale, will go to alleviate or dispel the apprehensions entertained by the authorities of the ports of Bristol and Gloucester, it is difficult to say, but they will undoubtedly require to be convinced in no uncertain way that their important trade interests are not likely to be prejudicially affected by the proposed undertaking. A strong point in support of the general reliability of the model experiments is that they have satisfactorily reproduced the main conditions in the estuary at the present time after a period of operation representing seventy-eight years of past history.

Another matter of public concern is the question

of floods, which, in the upper reaches of the Severn, are often of a serious character. Fears have been expressed that control of these visitations would be rendered more difficult by the existence of a barrage. The report states that, on the contrary, the model experiments show that a barrage would provide a means of reducing inundations in times of flood. Prof. Gibson's reports on the operation of the model do not accompany the Committee's Report; they will be awaited with interest for the additional light they will throw on the methods by which these important conclusions have been reached.

Sanitation has not been overlooked, and it is satisfactory to have the assurance that the barrage would not seriously affect the question of sewage disposal. With reference to the auxiliary features of the scheme (docks, roads, railways and other transport facilities), it is pointed out that, in combination with a supply of cheap electricity, they may lead to the establishment of new industrial centres, which, as potential sources of trade, offer the prospect of financial return on the outlay.

The foregoing is a necessarily brief review of the principal conclusions arrived at by the Barrage Committee as a result of prolonged and praiseworthy researches. After pronouncing a favourable opinion on the practicability of the scheme from a technical point of view which is sure to command general professional assent, the Committee is careful with judicial impartiality to direct attention to other considerations of a non-technical character "such as the social, economic and industrial reactions of the scheme upon the district", which lay outside the terms of reference and therefore did not concern the Committee in drawing up its report. These considerations are admittedly of the highest importance and will have to be carefully taken into account before the country can commit itself to an outlay of the magnitude suggested. The prospect of a great augmentation of power at favourable rates of generation is undoubtedly attractive, especially to a community like our own, which is dependent on its industrial output for its livelihood and prosperity, and faced nowadays with the fierce competition of other nationalities. None the less, it is essential to exercise due circumspection before the country embarks on an enterprise which, for good or evil, will leave a permanent impression on its surface and an indelible record in its history.

B. C.

International Economics

The Means to Prosperity. By John Maynard Keynes. Pp. 37. (London: Macmillan and Co., Ltd., 1933.) 1*s*. net.

NOTABLE in themselves, and doubly notable for their appearance in the *Times*, Mr. Keynes's recent articles on "The Means to Prosperity" have now been rounded off by a short introduction and conclusion and republished. Mr. Keynes's thesis in essence is the familiar argument that schemes of capital development or, as he terms it, loan-expenditure, are the only available means for creating employment, stimulating demand, raising prices, and so extricating the world from the present depression. Since loan-expenditure by public and semi-public bodies for housing, transport and similar capital works normally absorbs a large proportion of the activity of the capital goods industries, and since private business will not enlarge its demand for capital goods until *after* prices and turnover have increased and profits have become reasonably assured, Mr. Keynes urges that the loan-expenditure which the present situation demands should be embarked on by Government, first through reversal of the contractionist policy which has prevailed for the past year and a half, and then through the launching of new schemes of needed development.

Such schemes, Mr. Keynes argues, by reducing outlay on the dole and increasing the national income and therefore the yield of taxation, will benefit the Exchequer and stimulate industry generally. Since, however, no country by single-handed efforts can increase the volume of employment sufficiently, and since contradictory policies in various countries would cancel the advantages of expansionist efforts, in order to bring about world recovery fresh loan-expenditure must be undertaken simultaneously in all important countries by international agreement. The difficulties and fears of central banks, and the shortage, outside France and the United States, of internationally acceptable means of payment, would however prevent the expansion of credit which must accompany reviving trade. In order to solve this problem, Mr. Keynes advocates the issue by an international authority of gold notes to a total of 5,000,000,000 dollars which, allocated to each country in appropriate proportions against corresponding gold bonds, would

give elbow-room for the growth of credit and the revival of activity.

The framing of an agreed scheme along these lines Mr. Keynes regards as the chief task of the World Economic Conference and the only hope of trade revival; and provided that such agreement can be reached, and that the essential subsidiary measures and steps are taken to end exchange restrictions, lower tariff barriers and generally encourage trade, Mr. Keynes would be prepared to see concurrently a qualified *de facto* return to a controlled gold standard. Mr. Keynes is always on the side of the angels, and once again he offers the inspiriting example of clear scientific thinking in a bemused world. Certain details of his argument—notably the probable cost of providing employment for an unemployed man—may perhaps be questioned. The general soundness of his thesis commands wide assent alike in official and technical circles and amongst the general public; and though before recovery can be finally assured, there must be an international political settlement which will abate fear and restore confidence, a vigorous expansionist policy would itself contribute to a political settlement as well as hasten the revival which must come soon if industrial civilisation is not to crash finally and disintegrate.

War and Post-War Explosives

Explosives: their History, Manufacture, Properties and Tests. By Arthur Marshall. Second edition. Vol. 3. Pp. xiv+286. (London: J. and A. Churchill, 1932.) 42*s*.

MARSHALL'S "Explosives" was first published in 1915 at a time when interest in the subject had been stimulated by the necessity for the production of service explosives on a scale unprecedented in the history of the world. Republished in a second edition in 1917, the addition of new matter, particularly on nitro-aromatic compounds, necessitated its expansion to two volumes. The treatment of the subject suffered from the unavoidable restrictions imposed by the necessity of maintaining secrecy concerning the composition, manufacture, and applications of many of those materials in use as service explosives, which precluded the publication of information obtained during the early years of the War.

In the years immediately following the War, many publications relating to the production of explosives and to investigations of their properties were released from Government and other sources. Foremost among these are "Technical Records of Explosives Supply", compiled by W. McNab, and a number of papers from the Research Department, Woolwich, under the ægis of Sir Robert Robertson. The same was true of Germany, France, and the United States, all publishing information hitherto withheld for military reasons.

The new volume under review embodies a large proportion of this information, also the results of work carried out in the intervening years. It must be regarded as a supplementary volume to the first two, and not as complete in itself. The subject matter is arranged in twelve parts and two appendixes corresponding to those in the first two volumes, the paragraphs having marginal references to the relevant pages in that edition.

The whole work forms a valuable summary of the manufacture and properties of explosives, and has been kept within due bounds by the omission of information concerning those raw materials of the industry, details of which are to be found in other works of reference. It is suggested that the three volumes could with advantage be combined in a single volume printed on a thinner and tougher paper, the supplementary paragraphs being inserted in their appropriate places. Possibly the author and publisher will consider this when a new edition becomes necessary.

The first two parts of the new volume deal with the early development of shell and black powder, the latter formerly of prime importance as a service explosive, but now of minor application, its place having been taken by the modern smokeless propellants and high explosives. In the industrial field, it still survives in various forms as a blasting explosive for use in quarrying and mining operations. It is interesting to note that picric acid in the form of its potassium salt was first prepared by Glauber early in the seventeenth century, but the application of the acid to military purposes was delayed until late in the nineteenth century, when it was adopted in the British service as a high explosive shell-filling under the name of 'lyddite'.

Parts 3–7 are concerned with the chemistry and manufacture of modern types of explosive and of their raw materials, based for the most part on the nitric esters of cellulose and glycerine, and on aromatic nitro-compounds. The manufacture of the acids necessary for the nitration processes has

undergone great development since 1914 ; in Great Britain a rapid expansion took place in the production of 'oleum' by the various modifications of the contact process, and in the manufacture of nitric acid by the traditional method using Chile saltpetre as raw material. In Germany the supplies of sulphur, pyrites, and Chile saltpetre were restricted, and intensive development of alternative raw materials and processes was effected ; large quantities of sulphuric acid were made by the decomposition of sulphates such as gypsum and kieserite ; nitric acid was produced by the oxidation of ammonia synthesised by the Haber and cyanamide processes. Only in post-War years were synthetic methods of production developed in Great Britain at Billingham. For the concentration of weak sulphuric acid, a product of nitration operations, the Gaillard tower proved to be the most efficient type of plant for handling large and continuous tonnage, but for the intermittent and smaller demands of normal production, the Kessler concentrator still holds its own.

The chemistry of cellulose has undergone considerable revision in the light of X-ray spectrography, and of the work of Haworth and others. The supply of cotton cellulose for the manufacture of 'nitro-cotton' presented no insuperable problem to the Allies during the War, but in the case of the Central Powers early recourse was had to wood as an alternative raw material. Some difficulty was experienced in both cases in obtaining a cellulose of suitable chemical and physical properties, but this was largely overcome by the adoption of controlled methods of preparation in place of the cruder methods formerly used. The nitration and stabilisation processes for the most part followed well-tried methods, which are still in use in slightly modified form. Nitric esters derived from other carbohydrates have been prepared and examined, but on grounds of high cost or poor stability have not displaced those of cellulose and glycerine to any great extent.

In the case of glycerine, an interesting application was made of Pasteur's fermentation process, many thousands of tons of glycerine being produced. Some progress has been made in recent years in the continuous nitration of glycerine, in which greater safety is attained owing to the much smaller quantities of explosive present in the nitrator at any one time as compared with the usual batch-nitration method.

Large quantities of glycol were nitrated during the War in order to conserve glycerine, but only latterly has this become an economic process owing to the fall in the price of glycol. 'Nitroglycol' is now largely used as an ingredient of 'non-freezing' explosives.

Previous to the War, the usual filling for high explosive shell was picric acid, but soon after the outbreak of war it was seen that the supply available was quite inadequate. This led to the adoption of T.N.T. and of mixtures of T.N.T. with ammonium nitrate (amatols) as the main types of filling, and called for the development of new methods of large-scale manufacture. The results of preliminary experiments at the Research Department, Woolwich, were embodied in the design of large factories at Queensferry and elsewhere, the production of T.N.T. finally rising to nearly 100,000 tons per annum. Many improvements were introduced, particularly in the method of purifying the crude explosive. The manufacture of picric acid was also continued and expanded, increased efficiency being obtained by the adoption of continuous methods.

In Germany other nitro-compounds such as hexanitro-diphenylamine and picryl sulphide were used in addition to T.N.T. and picric acid.

The enormous propellant requirements of the army led in Great Britain to the introduction of a new type of cordite designated R.D.B. (Research Department 'B') in which acetone was replaced by a mixture of ether and alcohol as a solvent in manufacture, the raw material for the latter being more readily available than acetone. More recently, propellants have been made in which the use of a volatile solvent is dispensed with, thus eliminating the dangerous and slow process of drying from manufacture.

Part 8 deals with blasting explosives, which are increasingly numerous. During the War large use was made of chlorates and perchlorates to take the place of nitrates. The latter in the form of sodium and ammonium salts are largely used in this type of explosive.

The evolution of methods for the determination of the physical and chemical properties of explosives has made great strides during and since the War ; noteworthy among these are the application of Sir J. J. Thomson's piezo-electric method to the measurement of the pressure of explosion, of Hopkinson's pressure bar to the measurement of the pressure and violence of detonation, and of the condenser discharge method to the measurement of the velocity of detonation. On the chemical side, much has been done in devising

tests for the detection and measurement of instability, notably the gas evolution test of Farmer, and a number of tests for the measurement of the acidity of the products of instability by the use of electrometric methods, or of suitable indicators.

The final section of the book deals with revised methods for the examination of raw and finished materials, and thermochemical data additional to those in vol. 2 are given in an appendix.

The book is well printed, well indexed, contains few errors or misprints, and can be confidently recommended to all those who are interested in explosives, professionally or otherwise.

R. C. Gale.

The Rayon Industry

Cellulose Acetate: its Manufacture and Applications. By A. G. Lipscomb. Pp. xii + 304. (London: Ernest Benn, Ltd., 1933.) 21*s.* net.

It is difficult to keep closely in touch with the development in those branches of industry which become successful and popular at a particular time, because the technical discoveries are either obscured in the form of patents or explained in special journals which are seen only by the few. Hence it is not until some expert considers it advisable to disclose his knowledge in book form that a general perspective of the subject can be obtained by the outsider. This is particularly true of the cellulose acetate industry and its applications in the form of rayon and elsewhere, and Mr. Lipscomb's effort is sure of a receptive public. It is written from a dual point of view, aiming both at giving a complete account of the manufacture of cellulose acetate from its raw materials, including a full account of the up-to-date methods of making these, and also at summarising the very considerable patent literature: a list of these patents is included in a special index.

The rayon industry has not yet made up its mind whether it should properly belong to the textile or to the chemical industry, or to both. It would be rational merely to make the acetate and spin it, but, on one hand, the processes involved in the recovery for re-use of the chemicals required make it attractive to make these chemicals as well, whilst on the other, there is the temptation to dye and do much else with the rayon, even to the making of dyestuffs. In some quarters the view is gaining ground that it is more economic in this and analogous industries to restrict the number of operations than to enter too far into the chemical industry, except on a large scale.

The book follows normal lines in the treatment: commencing with an historical section, a description of modern views of the structure of cellulose and its acetate follows, after which the practical side is stressed. The details are sufficient to be of material help in initiating and running a factory, the chapter under this heading being clearly written. Nothing that is of interest in connexion with cellulose acetate is omitted, so far as we have been able to judge, and the latest plant for special purposes, such as active carbon for solvent recovery and the Suida process for acetic acid recovery, are adequately described. The book should be of immediate use to all who are active or seek for information in this field.

Some Ancestral Fossil Mammals

British Museum (Natural History). Catalogue of the Pontian Carnivora of Europe in the Department of Geology. By Dr. Guy Ellcock Pilgrim. Pp. vi + 174 + 2 plates. (London: British Museum (Natural History), 1931.) 15*s.*

At the time of publication of Darwin's "Origin of Species", Prof. Albert Gaudry, of Paris, was collecting and studying a large series of remains of fossil mammals from an Upper Miocene or Lower Pliocene freshwater deposit at Pikermi, near Athens, in Greece. He soon recognised that, although the animals represented by his fossils were closely similar to those inhabiting the warmer parts of the Old World at the present day, they differed in several small respects and seemed to include some links between animals which are now very distinct, and others which might be the ancestors of our modern animals. Between 1862 and 1867 he published his results in a classic volume entitled "Animaux fossiles et géologie de l'Attique", which was the first attempt on a large scale to describe and arrange extinct animals from the point of view of an evolutionist. Since Gaudry's pioneer work, nearly similar groups of fossil mammals have been found in Spain, Hungary, Macedonia, the Black Sea region, Persia, Mongolia, eastern China, and India; while apparently contemporaneous deposits in North America have yielded several closely allied genera and species. These mammals constitute the fauna which is now generally known as Pontian, and they include

especially numerous individuals of the three-toed horse, *Hipparion*.

For many years Dr. G. E. Pilgrim has studied the Pontian and later fossil mammals in India, and he is at present preparing a descriptive catalogue of the large collections of similar fossils from Pikermi, the island of Samos, and other European localities, which are brought together in the British Museum. The first volume, on the Bovidæ. was published in 1928, and the second volume, on the Carnivora, is now before us.

Dr. Pilgrim's descriptions, of course, are entirely technical, but they are extended by many interesting comparisons which help to make the new facts useful for science. They are illustrated by some good text-figures and two plates. The first section relates to the primitive forerunners of the dogs and bears, which are important among the fossils from Pikermi. The next long section is on the mustelines and otters, which are less differentiated in the Pontian fauna than they are at the present day. Then follow more annectant forms between viverrines and hyænas, besides both ancestral hyænas and true hyænas. The well-known *Hyœna eximia*, from Pikermi and Samos, is represented by many fine specimens, which seem to show that it belongs to the same genus as the spotted hyæna, usually named *Crocuta*. This genus is now known to have ranged as far as eastern China, and it is difficult to determine where it originated. True cats of the genus *Felis* occur, and with them are remains of *Machœrodus* and other members of the sabre-toothed group.

Dr. Pilgrim's valuable catalogue is unfortunately marred a little by inadequate editing. There are more misprints than might be expected in a publication of the British Museum; and the statement on p. 142 that in 1857 the Bavarian Academy published its *Abhandlungen* in Vienna is inaccurate. There are several ungrammatical and inelegant expressions, and the text would have been much improved by the omission of redundant words and circumlocutions.

A. S. W.

Short Reviews

The Theory of Knowledge and Existence. By Dr. W. T. Stace. Pp. xii + 456. (Oxford: Clarendon Press; London: Oxford University Press, 1932.) 18*s*. net.

This comprehensive attempt to determine the characteristics and purpose of knowledge deserves careful reading. We believe that the author is right in stressing the empirical value of epistemology, though we fail to see why transcendental issues are altogether outside the horizon of the theory of knowledge proper. Adopting the well-known method of building up the world with some primitive elements, Dr. Stace characterises first the universe of the solitary mind, then gives shape to the external world, and finally describes what happens when the solitary mind discovers other minds. After concluding this part of his inquiry, he discusses space-time, mathematics, logic, the categories, and scientific knowledge. Though he purposely avoids the technicalities of these subjects, the author has many pertinent reflections about the issues they imply. To give but one example, in discussing the epistemological aspect of the new theories of matter, he points out that the earlier concept of the nuclear atom, though beyond any possible perception, is not itself unreal, as we can make a logical model of it by means of data supplied from other sources of perceptual knowledge. But the new concept of the 'wavicle' which purports to combine the characteristics of a particle with those of a wave, cannot possibly have any sort of existence, as it possesses contradictory properties. Also, he rightly assumes that when any type of knowledge clashes with logic, it is not logic but our scientific assumptions which must be changed somehow.

The author's views on the character of mathematics are of a more controversial character; for him, mathematical propositions are a necessity derived from logic. The truth or falsity of mathematics means something more than self-consistency; it refers them to reality outside mathematics; and therefore mathematics cannot exist in a world of its own, cut off from concrete things. Mathematics, like all other kinds of knowledge, is tied by the 'given'.

T. G.

Pétroles naturels et artificiels. Par J.-J. Chartrou. (Collection Armand Colin: Section de Chimie, No. 124.) Pp. 206. (Paris: Armand Colin, 1931.) 10.50 francs.

In view of the rapidly growing importance of petroleum in modern life, M. Chartrou attempts to acquaint the public with the main features of the technique of the industry, which in France has only recently come into prominence. An interesting and readable account is given of the composition and properties of the natural deposits, the character of the soil and geological strata in which they occur, theories as to their origin, methods used in the exploitation, storage, transport, refining and analysis of the different products, their application to industry, together with brief summaries of geographical distribution, regulations imposed by different governments and the

dangers associated with the operations. In the last chapter new processes are described which are being developed for the production of synthetic liquid fuels and petroleum substitutes.

A glance through the bibliography shows that the author has consulted mainly French works, though Redwood's treatise and several English and American journals are included. Much information of interest to the general reader has been compressed into a small compass and the result is an attractive volume, well illustrated with clear diagrams of apparatus and plant. The chapter on analysis summarises the methods used in the determination of chemical and physical properties of products, empirical formulæ being given for the calculation of constants. The book should appeal not only to technologists but also to a wider public.

Differential Equations from the Algebraic Standpoint. By Prof. J. F. Ritt. (American Mathematical Society, Colloquium Publications, Vol. 14.) Pp. x + 172. (New York: American Mathematical Society; Cambridge: Bowes and Bowes; Berlin: Hirschwaldsche Buchhandlung; Paris: Albert Blanchard; Milano: Nicola Zanichelli, 1932.) 2.50 dollars.

This book gives a connected account of the author's researches on the algebraic side of the theory of differential equations and forms a welcome addition to the literature of the subject, for this aspect of the theory has received little attention hitherto. About four-fifths of the space is devoted to ordinary and the remainder to partial algebraic differential equations, the treatment broadly speaking following the lines laid down by Kronecker and his successors in the theory of algebraic elimination and the general theory of algebraic manifolds, transcendental equations being excluded from consideration.

The first chapter is devoted to the decomposition of a system of ordinary algebraic differential equations into irreducible systems, and the second to the precise formulation of the notion of the general solution of a differential equation and its use in determining the manifold of an irreducible system. The succeeding chapters apply and develop these results, the last two extending them to systems of partial differential equations. The novelty of the point of view adopted and the importance of the results obtained render the book well worthy of the attention of all interested in the theory of differential equations.

First Principles of Television. By A. Dinsdale. Pp. xv + 241 + 38 plates. (London: Chapman and Hall, Ltd., 1932.) 12*s.* 6*d.* net.

It is no easy matter to write a book on a subject like television which is making rapid progress. There is always the risk that when the work is on the eve of publication some new invention will render part of it antiquated. Something of this nature has occurred in this case. Only a few days before writing the preface, the author attended a demonstration in New York given by U. A. Sanabria, a young experimenter from Chicago, who presented 'close up' pictures on a screen six feet square which were better than anything he had ever seen before. By special neon arcs, special arrangements of holes in the discs and a special amplifier, Sanabria can produce pictures which show an almost complete absence of flicker and the detail of which is quite as good as that provided by the average home cinema. Seaming lines also are very little in evidence. We think it was wise to include in the preface what appears at first sight to be a technical afterthought. Anyone possessing some knowledge of electricity and radio can easily understand this book. We can recommend it to everyone who wants a general knowledge of the first principles of television given in an interesting and easily intelligible form.

Webster's Collegiate Dictionary. Fourth edition of the Merriam Series. Pp. xl + 1222. (London: G. Bell and Sons, Ltd.; Springfield, Mass.: G. and C. Merriam Co., 1932.) 21*s.* net.

From the point of view of students of science, technology, etc., we cannot think of a better book of general reference. Besides the normal English words to be expected in a dictionary of this size, there are many scientific, technical, and mythological names which they may have occasion to verify, and most of them are included. In this respect the volume is surprisingly up to date, though there are a few omissions. For example, isotopes and stomates (instead of the older term, stomata), are now familiar terms, yet they do not appear. Also protein has been substituted for proteid, yet the latter term takes precedence in this dictionary and is used throughout, in definitions. These, however, are minor points in an extremely useful reference volume which has clearly involved much care and labour. The book is well bound; but we think a cheaper edition is desirable.

Mental Deficiency Practice: the Procedure for the Ascertainment and Disposal of the Mentally Defective. By Dr. F. C. Shrubsall and A. C. Williams. Pp. vii + 352. (London: University of London Press, Ltd., 1932.) 12*s.* 6*d.* net.

The subject of mental defect is very slow in coming before the public. So many individuals prefer to repress the subject and not admit its existence. It is, however, a very serious problem and one which so many local authorities have shirked and left in a disgraceful condition. Dr. Shrubsall, who is lecturer in mental deficiency in the University of London, and Dr. Williams, have given us a very useful and practical book in which the procedures for ascertainment and disposal of the mental defective in our midst are set out in a very sensible and clear manner.

The pages devoted to specimen forms and their use should be most helpful to those who may have doubts and difficulties.

Light and Life*

By PROF. N. BOHR, For.Mem.R.S.

THIS revision of the foundations of mechanics, extending to the very question of what may be meant by a physical explanation, has not only been essential, however, for the elucidation of the situation in atomic theory, but has also created a new background for the discussion of the relation of physics to the problems of biology. This must certainly not be taken to mean that in actual atomic phenomena we meet with features which show a closer resemblance to the properties of living organisms than do ordinary physical effects. At first sight, the essentially statistical character of atomic mechanics might even seem difficult to reconcile with an explanation of the marvellously refined organisation, which every living being possesses, and which permits it to implant all the characteristics of its species into a minute germ cell.

We must not forget, however, that the regularities peculiar to atomic processes, which are foreign to causal mechanics and find their place only within the complementary mode of description, are at least as important for the account of the behaviour of living organisms as for the explanation of the specific properties of inorganic matter. Thus, in the carbon assimilation of plants, on which depends largely also the nourishment of animals, we are dealing with a phenomenon for the understanding of which the individuality of photo-chemical processes must undoubtedly be taken into consideration. Likewise, the peculiar stability of atomic structures is clearly exhibited in the characteristic properties of such highly complicated chemical compounds as chlorophyll or hæmoglobin, which play fundamental rôles in plant assimilation and animal respiration.

However, analogies from chemical experience will not, of course, any more than the ancient comparison of life with fire, give a better explanation of living organisms than will the resemblance, often mentioned, between living organisms and such purely mechanical contrivances as clockworks. An understanding of the essential characteristics of living beings must be sought, no doubt, in their peculiar organisation, in which features that may be analysed by the usual mechanics are interwoven with typically atomistic traits in a manner having no counterpart in inorganic matter.

An instructive illustration of the refinement to which this organisation is developed has been obtained through the study of the construction and function of the eye, for which the simplicity of the phenomena of light has again been most helpful. I need not go into details here, but shall just recall how ophthalmology has revealed to us the ideal properties of the human eye as an optical instrument. Indeed, the dimensions of the interference patterns, which on account of the wave nature of light set the limit for the image formation in the eye, practically coincide with the size of such partitions of the retina which have separate nervous connexion with the brain. Moreover, since the absorption of a few light quanta, or perhaps of only a single quantum, on such a retinal partition is sufficient to produce a sight impression, the sensitiveness of the eye may even be said to have reached the limit imposed by the atomic character of the light effects. In both respects, the efficiency of the eye is the same as that of a good telescope or microscope, connected with a suitable amplifier so as to make the individual processes observable. It is true that it is possible by such instruments essentially to increase our powers of observation, but, owing to the very limits imposed by the properties of light, no instrument is imaginable which is more efficient for its purpose than the eye. Now, this ideal refinement of the eye, fully recognised only through the recent development of physics, suggests that other organs also, whether they serve for the reception of information from the surroundings or for the reaction to sense impressions, will exhibit a similar adaptation to their purpose, and that also in these cases the feature of individuality symbolised by the quantum of action, together with some amplifying mechanism, is of decisive importance. That it has not yet been possible to trace the limit in organs other than the eye, depends solely upon the simplicity of light as compared with other physical phenomena.

The recognition of the essential importance of fundamentally atomistic features in the functions of living organisms is by no means sufficient, however, for a comprehensive explanation of biological phenomena. The question at issue, therefore, is whether some fundamental traits are still missing in the analysis of natural phenomena, before we can reach an understanding of life on the basis of physical experience. Quite apart from the practically inexhaustible abundance of biological phenomena, an answer to this question can scarcely be given without an examination of what we may understand by a physical explanation, still more penetrating than that to which the discovery of the quantum of action has already forced us. On one hand, the wonderful features which are constantly revealed in physiological investigations and differ so strikingly from what is known of inorganic matter, have led many biologists to doubt that a real understanding of the nature of life is possible on a purely physical basis. On the other hand, this view, often known as vitalism, scarcely finds its proper expression in the old supposition that a peculiar vital force, quite

* Continued from p. 423

unknown to physics, governs all organic life. I think we all agree with Newton that the real basis of science is the conviction that Nature under the same conditions will always exhibit the same regularities. Therefore, if we were able to push the analysis of the mechanism of living organisms as far as that of atomic phenomena, we should scarcely expect to find any features differing from the properties of inorganic matter.

With this dilemma before us, we must keep in mind, however, that the conditions holding for biological and physical researches are not directly comparable, since the necessity of keeping the object of investigation alive imposes a restriction on the former, which finds no counterpart in the latter. Thus, we should doubtless kill an animal if we tried to carry the investigation of its organs so far that we could describe the rôle played by single atoms in vital functions. In every experiment on living organisms, there must remain an uncertainty as regards the physical conditions to which they are subjected, and the idea suggests itself that the minimal freedom we must allow the organism in this respect is just large enough to permit it, so to say, to hide its ultimate secrets from us. On this view, the existence of life must be considered as an elementary fact that cannot be explained, but must be taken as a starting point in biology, in a similar way as the quantum of action, which appears as an irrational element from the point of view of classical mechanical physics, taken together with the existence of the elementary particles, forms the foundation of atomic physics. The asserted impossibility of a physical or chemical explanation of the function peculiar to life would in this sense be analogous to the insufficiency of the mechanical analysis for the understanding of the stability of atoms.

In tracing this analogy further, however, we must not forget that the problems present essentially different aspects in physics and in biology. While in atomic physics we are primarily interested in the properties of matter in its simplest forms, the complexity of the material systems with which we are concerned in biology is of fundamental significance, since even the most primitive organisms contain a large number of atoms. It is true that the wide field of application of classical mechanics, including our account of the measuring instruments used in atomic physics, depends on the possibility of disregarding largely the complementarity, entailed by the quantum of action, in the description of bodies containing very many atoms. It is typical of biological researches, however, that the external conditions to which any separate atom is subjected can never be controlled in the same manner as in the fundamental experiments of atomic physics. In fact, we cannot even tell which atoms really belong to a living organism, since any vital function is accompanied by an exchange of material, whereby atoms are constantly taken up into and expelled from the organisation which constitutes the living being.

This fundamental difference between physical and biological investigations implies that no well-defined limit can be drawn for the applicability of physical ideas to the phenomena of life, which would correspond to the distinction between the field of causal mechanical description and the proper quantum phenomena in atomic mechanics. However, the limitation which this fact would seem to impose upon the analogy considered will depend essentially upon how we choose to use such words as physics and mechanics. On one hand, the question of the limitation of physics within biology would, of course, lose any meaning, if, in accordance with the original meaning of the word physics, we should understand by it any description of natural phenomena. On the other hand, such a term as atomic mechanics would be misleading, if, as in common language, we should apply the word mechanics only to denote an unambiguous causal description of the phenomena.

I shall not here enter further into these purely logical points, but will only add that the essence of the analogy considered is the typical relation of complementarity existing between the subdivision required by a physical analysis and such characteristic biological phenomena as the self-preservation and the propagation of individuals. It is due to this situation, in fact, that the concept of purpose, which is foreign to mechanical analysis, finds a certain field of application in problems where regard must be taken of the nature of life. In this respect, the rôle which teleological arguments play in biology reminds one of the endeavours, formulated in the correspondence argument, to take the quantum of action into account in a rational manner in atomic physics.

In our discussion of the applicability of mechanical concepts in describing living organisms, we have considered these just as other material objects. I need scarcely emphasise, however, that this attitude, which is characteristic of physiological research, involves no disregard whatsoever of the psychological aspects of life. The recognition of the limitation of mechanical ideas in atomic physics would much rather seem suited to conciliate the apparently contrasting points of view which mark physiology and psychology. Indeed, the necessity of considering the interaction between the measuring instruments and the object under investigation in atomic mechanics corresponds closely to the peculiar difficulties, met with in psychological analyses, which arise from the fact that the mental content is invariably altered when the attention is concentrated on any single feature of it.

It will carry us too far from our subject to enlarge upon this analogy which, when due regard is taken to the special character of biological problems, offers a new starting point for an elucidation of the so-called psycho-physical parallelism. However, in this connexion, I should like to emphasise that the considerations referred

to here differ entirely from all attempts at viewing new possibilities for a direct spiritual influence on material phenomena in the limitation set for the causal mode of description in the analysis of atomic phenomena. For example, when it has been suggested that the will might have as its field of activity the regulation of certain atomic processes within the organism, for which on the atomic theory only probability calculations may be set up, we are dealing with a view that is incompatible with the interpretation of the psycho-physical parallelism here indicated. Indeed, from our point of view, the feeling of the freedom of the will must be considered as a trait peculiar to conscious life, the material parallel of which must be sought in organic functions, which permit neither a causal mechanical description nor a physical investigation sufficiently thorough-going for a well-defined application of the statistical laws of atomic mechanics. Without entering into metaphysical speculations, I may perhaps add that any analysis of the very concept of an explanation would, naturally, begin and end with a renunciation as to explaining our own conscious activity.

In conclusion, I wish to emphasise that in none of my remarks have I intended to express any kind of scepticism as to the future development of physical and biological sciences. Such scepticism would, indeed, be far from the mind of a physicist at a time when the very recognition of the limited character of our most fundamental concepts has resulted in such far-reaching developments of our science. Neither has the necessary renunciation as regards an explanation of life itself been a hindrance to the wonderful advances which have been made in recent times in all branches of biology and have, not least, proved so beneficial in the art of medicine. Even if we cannot make a sharp distinction on a physical basis between health and disease, there is, in particular, no room for scepticism as regards the solution of the important problems which occupy this Congress, as long as one does not leave the highroad of progress, that has been followed with so great success ever since the pioneer work of Finsen, and which has as its distinguishing mark the most intimate combination of the study of the medical effects of light treatment with the investigation of its physical aspects.

Food Storage at Low Temperature

SOME of the problems involved in the preservation of food for transport and storage have been discussed by Sir William Hardy in two recent lectures*. The abandonment of the earlier agricultural civilisation by many races for an urban culture required the transportation for long distances of foodstuffs destined for the peoples of the cities. Non-perishable foods such as oil, honey and grain required no special treatment; meat and fish, however, were preserved by drying or curing with salt, and root vegetables for winter use as jams made with honey. It was not until the eighteenth century that the growth of winter vegetables was developed and another hundred years passed before low temperature began to be employed to preserve perishable food in the fresh condition.

The modern period began about fifty years ago, when the first cargo of meat was successfully brought from Australia in the frozen condition. That was made possible by mechanical refrigeration, and, at first, research and invention were occupied in perfecting the machinery, the insulation and the design of cold stores, in wagons or in ships. The properties of the material to be stored were, on the whole, neglected until more recently, when the importance of defining the exact conditions under which the stored foodstuffs survived for the longest time was realised and the science of biological engineering became differentiated from mechanical engineering.

The heavily insulated rooms at the Low Temperature Research Station at Cambridge are cooled by pipe grids through which cold calcium chloride brine is pumped. The first approximation to the required temperature is arrived at by regulating the temperature and rate of flow of the brine. The fine adjustment is made by treating the chamber as an electrically controlled thermostat.

Stored foodstuffs undergo changes in cold storage, the nature of which must be fully understood if the food is to be stored at the optimum temperature and if the store is to function efficiently. Fruit, for example, is alive, consuming oxygen and giving off carbon dioxide and heat. The heat production is greater the higher the temperature and is also increased by disease, for example, fungus rot. A rise of temperature in the store thus sets up vicious circles, with shortening of the storage life of the fruit. In addition to removal of heat from the store, the engineering problems involve the maintenance therein of an atmosphere with a constant content of oxygen, carbon dioxide and water vapour.

A further complication arises from the fact that storage life also varies, under the same conditions, with the earlier history of the fruit. The following variables have been found to affect the storage life of apples: variety, rootstock and age of tree, maturity of fruit on tree, its size and position on the inflorescence, the soil, manuring and climate, and finally orchard sanitation.

The rate of output of carbon dioxide on storage varies with the temperature, but the curves at different temperatures all have the same shape. The output falls continuously while the apple is growing and maturing on the tree. It then rises for a short time after picking and again decreases

* The Hurter memorial lecture before the Liverpool Section of the Society of Chemical Industry on November 18, 1932 (*Chem. and Ind.*, 52, 45; 1933). The Sir William Trueman Wood lecture before the Royal Society of Arts on February 22, 1933.

during the remainder of storage life. The similarity of the curves of output at different temperatures suggests that it must be governed by one factor only. This may be the rate of diffusion of oxygen —not of carbonic acid because it diffuses so much more rapidly—or the semi-permeability of the skin of the fruit to the respiratory gases. During the earlier period of storage the apple is peculiarly susceptible to the injury of internal breakdown; during the later period it is only slightly susceptible to internal breakdown but increasingly liable to attack by fungi. For Bramley's Seedling it has been found that minimum wastage from both these factors occurs at 3° C. which is therefore the optimum temperature for storage of this variety.

Another aspect which must be considered is the fact that apples give off vapours or emanations in minute amounts, which are poisonous to other fruit, one part in about fifty thousand being a toxic dose. The phenomenon has a commercial interest since the emanation tends to quicken the ripening of young apples, so that a colony of apples tends to ripen at the same time.

Meat and fish may be either chilled or frozen. Fruit, of course, unless intended for some secondary process such as jam-making, must not be frozen. Chilling will only delay the growth of moulds or bacteria long enough to give the material a storage life of about 30–40 days. If it cannot be marketed within this time, it is necessary to freeze it. Freezing, however, alters the physical state of the tissues and yet does not abolish all chemical change. Moulds, for example, can grow down to −7° C. and bacteria down to −3° C. Freezing results in the separation of ice within the tissue. It acts therefore as a drying agent by withdrawing water. The proteins of muscle become increasingly insoluble when meat is stored in the frozen state, so that on thawing the product is tough and unpalatable. The rate of change has been found to be greatest at about −3° C. The change is entirely due to freezing and does not occur when the tissue is merely overcooled to this or even a lower temperature.

Detailed study of the changes occurring in muscle in the cold has shown that overcooling to −4° C. does not prevent return to the normal state on thawing. Freezing at this temperature kills the muscle, which becomes opaque, shortened and acid due to the formation of lactic acid. This acid is produced and accumulates even in the frozen state, the rate of accumulation rising to a maximum at about −2° C. The temperature of −1·6° C. is critical. When frozen at a higher temperature the muscle can get rid of the excess lactic acid and revert to normal on thawing. Muscles frozen at a lower temperature have lost this power; they are dead on thawing and the acid increases in them as in *rigor mortis*. Thus at −1·6° C. the catalysts responsible for the re-synthesis of the lactic acid to glycogen are destroyed. It has also been found that the catalysts responsible for the synthesis of phosphagen are permanently lost at −2·5° C. and those concerned in the oxidation of lactic acid at −3·2° C.

In conclusion, Sir William Hardy referred to the difficulty of assessing the dietetic value of different foodstuffs. Experiments with human beings, which are costly and difficult, will no doubt give an answer in digestible calories which will be quite decisive, but there is little doubt that the answer in terms of human wellbeing will be indecisive. There are certain properties of foodstuffs, hard to define, which yet play their part in the assessment of the suitability of these foods for human consumption. 'Bloom' in meat is a case in point: it appears to have no obvious relation to digestibility, yet it is inadvisable to dismiss the judgment of the trade expert as devoid of physiological meaning. It is never safe to dismiss the tradition of the practical man as having no scientific basis.

Obituary

Dr. H. O. Forbes

DR. HENRY OGG FORBES, who died at Selsey on October 27, 1932, was well known among travellers and naturalists in the latter part of the last century, but his activities had been for many years cut short by constant ill-health and consequent seclusion. The second son of the Rev. Alexander Forbes of Dunblade, Aberdeenshire, he was born on January 30, 1851, and educated at Aberdeen Grammar School and afterwards at the Universities of Aberdeen and Edinburgh. He proposed to enter the medical profession, but owing to the accidental loss of an eye, he abandoned this career, although he had almost completed the necessary examinations.

Forbes's earliest travels were in Portugal where he made biological and geological investigations; but in 1878 he embarked on an expedition to the Far East where he spent five years wandering among the Dutch islands—Java, Sumatra, Banda, Amboina, Timor-Laut, Buru and Timor—making observations and collecting zoological and other material. After his return to England, he published in 1885 his well-known volume: "A Naturalist'sWanderings in the Eastern Archipelago: a Narrative of Travel and Exploration from 1878 to 1883." Mrs. Anna Forbes wrote a book "Insulinde" (1887) giving her experiences of this expedition.

Forbes went to British New Guinea in 1885 and early in 1886 made an expedition inland from Port Moresby, hoping to ascend the Owen Stanley Range. Through no fault of his he was unsuccessful, but he made large botanical and other collections and entered into friendly relations with the Sogeri. Mr. John Douglas, the Administrator,

appointed Forbes as the Government representative in the China Straits, and Mr. and Mrs. Forbes arrived at Samarai in June, where they remained until the end of March 1887. Forbes then went to Australia to arrange for another expedition. He left Port Moresby for the interior in October 1887 and again reached the base of the Range, making further geographical and other observations. An account and a map of this unsuccessful attempt to reach the summit of the Owen Stanley Range will be found in the *Scottish Geographical Magazine*, 4, 138, 1888. Sir William Macgregor succeeded in reaching the summit in 1889 and renamed it Mount Victoria; in his account of the expedition he criticised the work of Forbes (*Proc. Roy. Geog. Soc.*, 12, 218; 1898). This led to a reply by Forbes (loc. cit., p. 558), and Coutts Trotter later attempted to reconcile the two accounts (loc. cit., p. 697). Although Forbes visited various parts of New Guinea he did not publish anything about the natives in scientific journals, but he recorded a few notes in his official reports (New Guinea, Further Correspondence, C. 5883, London, 1890).

In 1890, Forbes was appointed director of the Canterbury Museum at Christchurch, New Zealand. During his stay there, he visited the Chatham Islands and made a study of the very interesting extinct birds found in recent deposits in that group. The results of this investigation will be found in a paper published in the *Ibis* for 1893, while his more theoretical views as to the geological history of this island group as deduced by a study of the recent and extinct fauna formed the basis for a paper published in the *Supplementary Papers* of the Royal Geographical Society, for which he received the award of the Gill Memorial.

In 1894, Dr. Forbes was appointed director of the Liverpool Museums, the interests of which he was energetic in promoting, and about this time he made, in company with the late Mr. W. R. Ogilvie-Grant, an expedition to the Island of Socotra, where large collections were made for the British Museum (Natural History) and for the Liverpool Museum; the results of this will be found in the "Natural History of Sokotra and Abd-el-Kuri: a Monograph of the Islands", published in 1903.

Forbes's last expedition was to Peru to investigate the condition of the guano industry and the best means for the conservation of the bird life on which the industry was dependent of the Guano Islands off the coast. This was undertaken on behalf of the Peruvian Government, for which a valuable report was prepared containing a survey of the islands, and suggestions for the most efficient methods of working the deposits.

From the University of Aberdeen, Forbes received an honorary degree of LL.D. He was a fellow of the Royal Geographical Society and of the Zoological Society, as well as of many other learned bodies.

Dr. R. T. A. Innes

Robert Thorburn Ayton Innes was born in Edinburgh and educated in Dublin. In 1879, at the age of seventeen years, he became a fellow of the Royal Astronomical Society. He was married in London and began his career as a double star observer in Sydney, where he soon became of repute among astronomers. Half a dozen years later he deliberately sacrificed his quite considerable material prosperity in order to become temporary clerical assistant to Sir David Gill at the Royal Observatory, Cape of Good Hope, at a salary just one-tenth of his income in New South Wales. No weak, 'Safety First' principle in this sudden plunge but everything he had, wife, family, capital and reputation, risked. In after years it gave Sir David pleasure to record the insatiable appetite of his 'Secretary, Librarian and Accountant' for work, extra work and yet more work.

During these few years Innes used the 18-inch Victoria telescope in an extensive search for double stars, but his main work was in the revision of the Cape Photographic Durchmusterung, in which Gill years earlier had the co-operation of Kapteyn. The importance of the C.P.D. may be judged by the award in 1902 of the gold medal of the Royal Astronomical Society to Kapteyn. In this work and for his observation of variable stars Innes used the 7-inch equatorial by Merz which dated from 1849 and Gill wrote, "This work of Mr. Innes was from first to last a labour of love, carried out by him with conspicuous energy and success." It would be difficult to over-estimate the value of this period of testing when Innes was acquiring the knowledge and experience and habits of methodical industry which procured him in 1903 the unsolicited post of creator of the Transvaal Observatory.

The Boer War emancipated the Dutch of South Africa from the tutelage of President Kruger, and at its conclusion an intellectual awakening demanded the establishment of the Transvaal Observatory, which must surely be regarded as the first fruits of that war. For a time at least, it was intended that this Observatory should be exclusively devoted to meteorology with an indispensable time department. Except as a step-ladder by which to raise himself to higher levels, meteorology, whether theoretical or observational, had no appeal for Innes. "Here," said he, in effect, "is a fine clear sky with steady observational conditions, let me use my telescope without stopping to inquire as to how these conditions arose." His first step upon appointment was the purchase (how, we know not, but probably his family had to endure 'iron rations' for a time) of a 9-inch refractor to be mounted on an equatorial stand borrowed from his benefactor at the Cape. In 1909, after an interval of six years, Innes persuaded the authorities to provide him with funds for a 26-inch refractor—this in itself was a difficult piece of work. It was expected that this worthy instrument would be in use in a couple

or three years at the most but here is the tragedy of the life of Innes. For sixteen years he was fretting and chafing at the delay, for his telescope was not erected complete with the object glass fitted until April 1925, only two years and nine months before his retirement at the age of sixty-six years.

Innes's first communication made to the *Monthly Notices of the Royal Astronomical Society* was to correct a computational slip in Laplace. From Sydney there followed two others on the secular perturbations of the orbit of the earth by Mars and by Venus, and by a third on the methods of Gauss. It was from New South Wales too that he published his first discovery of 26 new double stars using a 6-inch equatorial without circles. This result of thirty hours observation, "will prove what a mine of wealth awaits the diligent double-star observer in the southern hemisphere". Prophetic words, for ultimately his own doubles numbered 1,200. Next at the Cape he observed η Argus and in a few years discovered 285 new doubles and published his catalogue of southern double stars. Besides this work he contributed two papers to the *Monthly Notices* on multiple systems, and a very notable communication on Jacobi's 'Nome' as a means of computing elliptic integrals.

At Johannesburg Innes established his well-known Circulars which contain the records of much of his work—but the *Proceedings of the Royal Society of Edinburgh*, *Astronomische Nachrichten*, and *Astronomical Journal* contain papers of value. His interest in celestial mechanics continued unabated but of necessity other subjects demanded and received due attention—to mention a few: Jupiter's Galilean satellites, galactic co-ordinates, variable rotation of the earth, occultations and their reduction by improved methods, continuation and completion of the work of Franklin-Adams, use of blink microscope, the invariable plane of the solar system, a new catalogue of southern double stars, and comet orbits. It was a proud day for Innes when the University of Leyden gave him the D.Sc. (*honoris causa*) and of all his work perhaps his discovery of Proxima Centauri pleased him most.

Innes was a good friend and the wide extent of his generosity is barely suspected. In spite of his advancement, he remained to the end absolutely simple, approachable and unaffected and apparently unaware of the high regard in which he was held. Deeply interested in the work of others, he himself worked until the day of his sudden and quite unexpected death on Monday, March 13. Frank Robbins.

We regret to announce the following deaths:

Lieut.-Col. A. W. Alcock, C.I.E., F.R.S., professor of anthropology in the London School of Hygiene and Tropical Medicine and professor of medical zoology in the University of London, from 1919 until 1924, formerly superintendent of the Indian Museum and professor of zoology in the Calcutta Medical College, known for his work on Crustacea and deep-water fishes, on March 24, aged seventy-three years.

Mr. James Groves, an authority on the *Charophyta*, on March 20, aged seventy-five years.

Prof. Friedrich Rinne, formerly professor of mineralogy and petrography in the University of Leipzig, author of many works on crystallography, on March 12, aged seventy years.

Prof. Edwin C. Starks, associate professor of zoology in Stanford University, California, who was a corresponding member of the Zoological Society of London, aged sixty-six years.

Prof. J. Millar Thomson, F.R.S., emeritus professor of chemistry at King's College, London, president of the Institute of Chemistry of Great Britain and Ireland in 1900–3, who was known for his work on the chemistry of ancient glasses, chemistry of pigments, etc., on March 22, aged eighty-four years.

News and Views

Early Man in East Africa

While it is no longer possible on the latest interpretation of the evidence to accept the very high antiquity of Oldoway man, there appears elsewhere in this issue of Nature (p. 477) a series of reports on the further evidence collected by Dr. Leakey in the spring of last year (not "autumn" as stated inadvertently in our note last week) which points to the early appearance of *Homo sapiens* in East Africa. We publish in full the reports of four committees, each dealing with one aspect of the evidence, presented to, and adopted by, the Royal Anthropological Institute's conference at Cambridge. The material which the committees had before them was derived from deposits at Kanjera and Kanam, two sites, about three miles apart, near Kendu, at the north-east of Victoria Nyanza, an area of old lake-beds, well-known for its fossiliferous deposits. It comprised a part of a femur and fragments of human skulls of three individuals from Kanjera, of which one group formed a skull-cap, and a second permitted a reconstruction of the skull, and of a small fragment of human mandible from Kanam, fossil animal remains, including a considerable proportion (which has been put so high as fifty per cent) of specimens belonging to extinct forms, and two stone industries, one a pebble industry and the other Chellean. It is to be noted that at Kanjera, while the human bones comprising two groups had been washed out by the rains, two fragments of the third group were found *in situ* in association with fossil animal remains and Chellean tools. Further, the Kanam fragment of mandible was found not far from a pre-Chellean stone implement.

In considering the findings of the committees, it must be borne in mind that the geological evidence, more especially in its stratigraphical aspect, is crucial. Several members of the geological committee have visited the sites personally and concur with Dr. Leakey in his view that after the Kanjera and Kanam deposits had been laid down there was great local tilting and volcanic activity. The committee "does not believe that the [skeletal] fragments can have been introduced into the calcareous deposit at a later date . . . the two fragments said to be found *in situ* belong in fact to the original deposit". The palæontological committee finds that the fragment of human jaw from Kanam was associated with a fossil fauna which justifies its reference to the lower Pleistocene, while the Kanjera fauna "cannot be later than the middle Pleistocene". Thus from these two findings it appears that the human remains are referable on both geological and palæontological grounds to lower and middle Pleistocene dates. As to the character of the human remains, the report of the anatomical committee is not unfavourable to their high antiquity, so far as can be determined by their condition, points out the absence of Neanderthaloid characters, and, while adverting to the abnormal thickness of one of the skulls, sees no feature inconsistent with their inclusion in the type of *Homo sapiens*. On the archæological evidence, the human skeletal remains, thus regarded as within the category of 'modern man', are associated with what for this purpose may be termed a pre-Chellean, and a Chellean industry, which are equated with the cultures of Europe of like character through the Oldoway series. The latter are said to be of equal or somewhat greater antiquity than those with which they are comparable in Western Europe. It is to be noted that, archæologically, the association of the Kanam jaw fragment with a pebble industry assigns it to Oldoway I, a stage earlier than that with which Oldoway man was originally associated—the later phase of Oldoway II.

Control of the Tsetse Fly

One of the most terrible scourges of Africa is the disease known as sleeping sickness, which is caused by a trypanosome, a blood-parasite, carried and spread by two species of tsetse fly. Hence there was a large gathering of the fellows at the meeting of the Zoological Society on March 21 to see the film exhibited by Mr. R. W. Harris, who showed what is being done by the Government entomologists to mitigate, if not terminate, the ravages of this insect. Since this war of extermination has to be carried on over millions of square miles, any such campaign might seem hopeless. But it was made manifest that, in so far as Rhodesia is concerned, a considerable measure of success has been attained. This has been done by the use of an ingenious trap devised by Mr. Harris's father, Mr. R. H. T. P. Harris. The trap is made of canvas; box-like in form, and much wider at the top, it is mounted on four legs, keeping it well off the ground. In bulk it is roughly of the size of, say, a small antelope. The flies are not very discriminating, and on sighting this canvas 'stalking-horse' alight on it, and crawl down according to their habit, to reach the shaded under-side, there to suck the blood of their prospective victim. Their exploration is thorough, but fruitless. But presently, they find a long slit through which daylight appears, entering from a special cage at the top. They at once pass through, and upwards, into what they take to be the daylight and freedom beyond. Passing into this light-filled cage they are unable to escape. Enormous heaps of flies were shown which had been taken from this trap. Yet another trap was shown designed to induce the flies to deposit their larvæ therein. Millions of pupæ are taken in this way.

Dr. Bevan joined with Major Austen, who forcefully reviewed the main results of this work at the end of the paper, by deploring the efforts which have been made to control the tsetse fly by killing off big game animals. More than 15,000 head of game in one year were slaughtered to this end. This takes no account of the numbers which died from wounds, owing to the lack of skill of the natives armed for this purpose. This state of affairs has fortunately been stopped, for a period at least, owing to the need for financial economy. It is the more deplorable because, as Major Austen and others have shown, if the very last of the big game animals of Africa was wiped out, sleeping sickness would still remain, since there are numerous small animals which also act as hosts for the trypanosome concerned. Even now, considerable misapprehension exists as to tsetse flies. Commonly one hears of *the* tsetse fly. As a matter of fact there are twenty species, all of which feed on blood. Only some of these depend for their food on game animals. *Glossina palpalis*, carrying *Trypanosoma gambiense* and *G. morsitans*, carrying *Trypanosoma rhodesiense*, are the most formidable of sleeping sickness disseminators. But, as Duke and Swinnerton have shown, in certain circumstances, *G. swynnertoni*, closely allied to *G. morsitans*, may also cause human trypanosomiasis, or sleeping sickness. Dr. Bevan gave a most helpful and interesting summary of what is being done in the suppression of this scourge, and the methods adopted towards that end. It is devoutly to be hoped that his protest against the wholesale slaughter of game, as a means to that end, will now cease, since all the highest authorities agree that even if successful, it would be a futile measure. More than that, as evidence has already shown, it might lead to an aggravation of the evil.

The Kea Parrot

Whether or not we may be able to boast 'home-bred' keas depends on an experiment about to be made at the Gardens of the Zoological Society of London. An artificial cave is to be made in the parrot-house to induce, if possible, a pair of these birds to breed, and it may well be successful. The kea parrot of New Zealand was years ago to be found in large numbers. Then, unfortunately, it took to attacking sheep, tearing holes in the back to get at the flesh, with fatal results to the sheep. It

was said to do this for the sake of getting at the fat covering the kidneys, but this, obviously, is a statement founded on insufficient knowledge of what this implies. The damage done, as evidence has shown, was grossly exaggerated, and, when inflicted, was due to hunger. It was shown that keas could, and did, exist in numbers, without doing damage in areas where the food supply was constant, although in and around sheep-farms. But be this as it may, the fear and dislike which its presence has engendered, threatens its existence. Hence it is to be hoped the experiment of the Zoological Society will be successful.

Alcohol-Petrol as a Motor Fuel

In connexion with the leading article in Nature of March 11 on the subject of power alcohol, it is of interest to find that an alcohol-petrol mixture has begun to be distributed in Great Britain from garages over a wide and extending area under the name of "Koolmotor Alcohol Blend" at the same price per gallon as No. 1 Petrol. A mixture of alcohol in petrol has been in common use in racing cars for a year or two, but now the ordinary public will have for the first time an opportunity of testing its merits, in particular the absence of knocking. The anti-knock value is said to be equivalent to approximately 85 octane number. An alcohol of 99·9 per cent purity produced in England is being used. It is probable that the use of a fuel of this type in England, with the opportunity it will give for general experimenting, will have an effect on engine design. As the result of motor racing, which has as its real object the improvement of design and not the establishing of speed records, engines of high compression ratios have been introduced which need special fuels if they are to be used to advantage.

A blend of alcohol with ordinary petrol has now been prescribed by law in Czechoslovakia. Science Service of Washington, D.C., gives details of the spirit, 20 per cent alcohol and 80 per cent petrol, which the Government has apparently instigated in order to give a boost to the potato industry. Potato starch yields the desired grade of alcohol by hydrolysis and fermentation and all motor fuel is, apparently, to be treated with the specified percentage of alcohol before retail sale. There is, further, one technical matter which seems to have been solved in this connexion. Alcohol, as produced by economical distillation methods, usually carries with it 4–6 per cent water, which makes it impossible to mix directly with straight-run petrol, particularly of the paraffin base type. Recent research has resulted in a new distillation process, economical on a large scale, which permits dry or 'absolute' alcohol to be made with the aid of benzene. This product is now available under the new Czechoslovakian edict. The somewhat curious corollary to all this is that ordinary petrol will now go on the restricted list in that country, like ethyl and methyl alcohol in Great Britain, and, presumably, only chemists, research laboratories and the like will be able to receive permits to purchase pure petrol.

Darwin's Barometer

The British Association has recently received on loan from the Royal Society the barometer used by Charles Darwin during the voyage of the *Beagle*, and it is now exhibited among the other relics of Darwin in Down House, his home in Kent, now in the custody of the Association. The barometer, made originally by the firm of Newton, has been restored by Messrs. Negretti and Zambra with the advice of the Meteorological Office, the scales have been re-engraved, and it is now in working order as Darwin had it. The instrument is of the straight type, contained in a wooden case three feet long, with a thermometer near the base. The barometer scale reads down to 18·2 in., so it was suitable for use up to fairly high altitudes, and Darwin is known to have carried it when ashore during the voyage. A double mercury cistern and locking arrangement is provided to allow of carrying the instrument without disturbance.

British Polar Year Expedition

The National Polar Year Committee has received a report dated December 31, 1932 from Mr. J. M. Stagg, leader of the British expedition at Fort Rae in Canada. From this it appears that the party had its first taste of winter conditions on October 1, when the first snow fell and the rain recorder was permanently frozen up. The temperature at the date of the report was about −40° F. Difficulties have also been experienced with the clocks. Special low temperature clocks proved useless out of doors, but the party found that by removing all the oil from ordinary clocks, they functioned satisfactorily. The recording pen of the anemograph has also proved troublesome. Sounding balloons have been sent up but none had been recovered, though a cabled message has since reported the recovery of two meteorographs with good records. Communication with the sub-station for auroral photography about twenty miles south-east of Fort Rae was by wireless, but with the onset of winter, a telephone line was taken across the frozen Great Slave Lake. Auroral activity has been poor though some form of aurora can be observed more or less continuously from dusk until dawn. Some four hundred photographs have been taken, using the double station communication to obtain simultaneous exposures at Fort Rae and the sub-station twenty miles distant. The moon is only below the horizon for a short time daily, and during full moon auroral photography becomes almost impracticable. The sub-station is manned by one member of the expedition for a week at a time. The expedition's schedule includes full meteorological records every three hours, hourly cloud observations, and observations of aurora every five minutes and continuously when photography is being done.

Recent Acquisitions of the British Museum (Natural History)

Additions to the study series of mammals in the Zoological Department of the Museum include the skins of a male and female golden cat (*Profelis aurata*) from the Cameroons, presented by Mr. F. W. Carpenter. The specimens illustrate the two colour

phases found in this species, one skin being buff and the other grey. A similar dimorphism exists in the bay cat of Asia, and at one time the buff-coloured specimens were thought to represent a species distinct from the grey ones. The Department of Entomology has received during the past twelve months a further 7,773 insects collected and presented by Mr. Rowland Turner, from South Africa. Most of these are small and little-known wasps, and the proportion new to science is extremely high. The Department of Mineralogy has acquired by exchange fragments of a meteoric stone which fell on August 27, 1931, near Yukan in eastern Kiangsi, China. Although the fall of stones from the sky has been mentioned in Chinese literature since 1808 B.C., none appears to have been preserved with the exception of three stones that have been described scientifically since 1923.

Botanical Acquisitions at the Natural History Museum

HIS MAJESTY THE KING has placed on loan a further collection of Nepal plants presented to him by His Highness the Maharaja of Nepal. The collection contains 182 specimens and was made in central Nepal by Prof. K. N. Sharma. The plants are excellently preserved, and include a fine series of *Primula*, *Gentiana* and *Mecanopsis*. Seeds of most of the plants have been sent for growing in the Royal Parks and Gardens. The British herbarium of the late Mr. Percy Moring has been presented by his widow. Mr. Moring was resident for some time at Dover and the herbarium is rich in plants of the neighbourhood. It also contains the specimens collected round Hampstead during the Hampstead Regional Survey. Many specimens from the London suburbs are valuable records of habitats now lost through building. The Department has purchased Part I of a copy of an edition of Philip Miller's "Figures of Plants described in the Gardener's Dictionary", published in 1798. So far, nothing is known further about this edition. The thirty plates are printed in various colours and are also coloured; the dates have been erased from the blocks and the Linnean system of naming has been adopted.

A British Film Institute

THE joint committee of the Commission on Educational and Cultural Films and the bodies representing the film trade has now reached agreement on a scheme for the setting up of a British Film Institute. The general purpose of this Institute will be to encourage the use and development of the cinematograph as a means of entertainment and instruction. Among its specific objects will be to advise educational institutions and other organisations and persons as to sources and conditions of supply, types of films and apparatus; to promote and undertake research into the various uses of the film and of allied visual and auditory apparatus; and to maintain a national repository of films of permanent value. The Institute will have a membership based on subscription, and its government will be vested in a council representative in equal proportions of the film trade, educational interests and the general public. The membership of the governing council has not yet been completed, but it includes Sir Charles Cleland, Mr. A. C. Cameron and Mr. R. S. Lambert as representing the Commission on Educational and Cultural Films and Mr. Thomas Ormiston, M.P., Mr. C. M. Woolf and Mr. S. Eckman, as representing the film trade.

Underground Lighting in Mines

THE paper on "Underground Lighting in Mines" read to the South Wales Branch of the Association of Mining Engineers by R. H. Campin and published in the *Mining Electrical Engineer* for February is a helpful and useful paper. Special stress is laid on the importance of miners' hand lamps. Mr. Campin points out that most of the hand lamps now in use are virtually of the same type as those developed before 1915. There are approximately 750 thousand hand-lamps in use in Great Britain. About fifty per cent of them are flame safety lamps. The popularity of the flame type is probably due to the fact that it automatically indicates the presence of inflammable gas. Most of the electric lamps in use are of a somewhat antiquated type giving only one candle power and supplied by a two volt battery in a celluloid case. The number of lamps supplied by alkaline batteries is about four per cent. There is no doubt that in many cases improved lighting would considerably increase the output as well as diminish the total number of accidents per annum on which compensation has at present to be paid. The author mentions the case of a German mine where the effect of doubling the illumination was to increase the output per man-shift by about 30 per cent. Doubling the light increased the cost of the lighting from a half-penny to a penny per ton of coal raised. Medical investigations have shown that nystagmus is practically a light deficiency disease. The collieries have to spend £440,000 annually in compensation to sufferers from it. If lights of not less than four candle power were used, the number of cases would be greatly diminished. The author thinks that the illumination of many of our collieries could be tripled or even quadrupled without increasing operating charges. Flood-lighting at localised spots is recommended.

Prehistoric Society of East Anglia

THE contents of the recent issue of the *Proceedings of the Prehistoric Society of East Anglia* (vol. 7, pt. 1) are of exceptional interest. At the head is the presidential address in which Mr. J. Reid Moir surveys the evidence for the culture of Pliocene man which has been collected in the last twenty-five years. This is followed by a description by Mr. J. P. T. Burchell of hand-axes from the north of Ireland, upon which Mr. Reid Moir reports that a certain number are undoubtedly of high antiquity, ranging from eolithic to Clactonian I. Lieut. K. R. W. Todd enumerates stone age sites, mostly palæolithic, from which he has obtained a considerable number of implements, in the neighbourhood of Bombay; and Prof. A. Barnes discusses the mode of prehension of some forms of upper palæolithic implements. The important work

of exploration at Grimes' Graves has been continued and Mr. Leslie Armstrong reports on the examination of five pits, one still unfinished, since the date of the last report in 1926. Two communications deal with different aspects of related problems. Of these, one by Mr. Stuart Piggott and Prof. Gordon Childe describes and discusses the affinities of neolithic pottery from Larne, now in the Ashmolean Museum. The authors conclude that in decoration this pottery is a reflex of the current round the north of the British Isles that is supposed to have brought the passage-grave idea to Denmark, while in form it is the most distinctively Iberian in the whole Windmill industry. In the second communication, Mr. J. G. D. Clark examines the distribution of the curved flint sickle blade in Britain, and deriving it from the Nordic culture area, thinks it is to be associated with the Peterborough pottery folk, while it is probable that the Windmill Hill people used a composite sickle. In addition to other communications, there are some useful notes and references.

Barrages on the Niger

One of the most important irrigation schemes in the African Sudan is being carried out in the Upper Senegal district of French West Africa, where the project is to irrigate the Macina district from the flood waters of the Niger. A few details are given in *Terre Air Mer* for February. At Bamako the Sotuba barrage, 1,340 yards long, irrigates about 15,000 acres on the right bank. The chief barrage, however, is in course of construction below Segu about 200 miles farther downstream at Diamarabougu. This will be about 1,300 yards long and will feed a number of canals on the left of the river. Some of these are already cut and embanked. A navigation canal with locks will be built round this barrage. It is estimated that this irrigation scheme will eventually allow the population of the area affected to be increased five-fold with crops of rice, cotton, forage plants and live-stock.

Sir Patrick Geddes

A supplement issued with the recent number of the *Sociological Review* (vol. 24, No. 3) consists of tributes to the late Sir Patrick Geddes by friends, former pupils and fellow-workers, in which his many-sided genius, his fertility in ideas and his gift for inspiring enthusiasm in others are commemorated. Sir D. M. Stevenson, Lord Provost of Glasgow, writes of "the Social Reformer"; Mr. Edward McGegan, writing from the Outlook Tower, Edinburgh, with which the name of Geddes will always be associated, speaks of him as a man of action; Lord Sandwich records his part in the saving and re-erection of Crosby Hall; Dr. R. S. Buist tells of his work at University College, Dundee; while intimate views of his enthusiasms, with which he fired others, are given in accounts of his schemes for forming a university students' quarter in London, of his work in town planning in India and in Palestine and his Collège des Ecossais at Montpellier, by writers who were closely associated with him in these undertakings.

Moles Storing Worms

Referring to notes in our Calendar of Nature Topics of Feb. 25, Mr. Lionel E. Adams, Wheatley, Shide Cross, Newport, I.O.W., who contributed a valuable paper entitled "Observations on a Captive Mole" to the *Proceedings of the Manchester Literary and Philosophical Society* of May 31, 1906, and later, an illustrated article entitled "Moles and Molehills" to Nature of March 10, 1910, p. 37, writes: "A farmer on whose land I was trapping moles, informed me that while digging out a 'fortress' he came across a mass of dead worms in the nest cavity close to the nest. He described the quantity as 'three spadefuls'. I have frequently watched captive moles bury worms when their hunger was satisfied. The mole would bite the worm with quick bites along its whole length and then cram it into the earth and scratch the earth over it with his fore paws."

Australian Entomology

Amongst many valuable references to papers in all branches of science, *Australian Science Abstracts* (No. 4, Nov. 1932) records a "Bibliography of Australian Entomology, 1775–1930", published by the Royal Zoological Society of New South Wales (1932, pp. 1–380). In the list of papers and works touching on Australian insects during that period are references to scientific expeditions which have visited Australia and information concerning authors, collectors and collections. Invaluable to entomologists, the work will be found useful also by zoologists and botanists. An index classifies papers written on various orders of insects, as well as papers on economic, medical and veterinary entomology, and on Australian fossil insects.

The Faraday House Journal

The part played by the Faraday House Electrical Engineering College in providing Great Britain with electrical engineers has been a very important one. Its old students are found occupying many of the highest positions in the electrical industry, and the recent issue of the *Faraday House Journal* states that more than 2,000 students have passed through the College. The virtual founder of the College was Robert Hammond, who in 1882 opened the Hammond Electrical Engineering College. In one of the notes in the *Journal* reference is made to the attempt to light Cockermouth with electricity in 1881, the opening function being attended by Hammond. That same year Godalming was lighted by electricity, but whereas this proved successful the scheme at Cockermouth failed. The *West Cumberland Times*, however, looking ahead, said that electricity would revolutionise the world, that the maturing of fruits and vegetables would be speeded up by its use and that the dynamo would be as common on the farm as the threshing machine.

The Ray Society

At the annual general meeting of the Ray Society, held on March 22, the following officers were re-elected: *President*, Sir Sidney Harmer; *Treasurer*, Sir David Prain; *Secretary*, Dr. W. T. Calman.

Mr. Charles Oldham was elected a vice-president and Mr. D. J. Scourfield, Mr. J. Spedan Lewis and Mr. David Bryce were elected new members of council. It was announced that the third volume of Dr. Gurney's "British Freshwater Copepoda" is in the press, and will form the issue for the current year. For future issue, in addition to the second volume of Prof. Stephenson's "British Sea Anemones", the Council has provisionally accepted works on British Neuroptera by Mr. F. J. Killington, on British Psocoptera by Mr. J. V. Pearman, and on British Freshwater Planarians by Mr. Philip Ullyott, all of which are in active preparation.

Announcements

AT the annual general meeting of the Institute of Metals, the following officers were elected for the year 1933–34: *President:* Sir Henry Fowler; *Vice-Presidents:* Prof. C. H. Desch and Prof. R. S. Hutton; *Members of Council:* Eng. Vice-Admiral Sir Robert Dixon, Mr. Wesley Lambert, Mr. H. C. Lancaster, Mr. A. H. Mundey, Mr. A. J. G. Smout, Mr. F. Tomlinson. The silver Jubilee meeting of the Institute will be held in Birmingham on September 18–21. It was in Birmingham that the first general meeting of the Institute was held in the autumn of 1908, under the presidency of the late Sir William White.

THE Institute of Physics announces that the B.O.I.M.A. Prize for the best paper published in the *Journal of Scientific Instruments* during the year 1932 has been awarded to Mr. E. Lancaster-Jones, of the Science Museum, for his paper on "The Principles and Practice of the Gravity Gradiometer", and the Institute of Physics prize for the best contribution to the Laboratory and Workshop Notes in the *Journal* has been awarded to Dr. J. L. Miller and Mr. J. E. L. Robinson of Messrs. Ferranti, Ltd., for their joint note entitled "A Three-Dimensional Adjustment of an Electrode in Vacuo".

A SPECIAL exhibition in commemoration of the death, on April 22, 1833, of Richard Trevithick, the great advocate of the high-pressure steam engine and the 'father' of the railway locomotive, is being held in the Main Hall of the Science Museum, South Kensington, from March 31 until the end of June. The exhibition includes examples of engines, etc., designed by him as well as numerous other objects relating to him and his work.

THE fourth annual exhibition of television and photoelectric apparatus arranged by the Television Society will be held at the Imperial College of Science and Technology, South Kensington, S.W.7 on April 5 at 6–9 p.m. and April 6 at 3–9 p.m. The exhibition catalogue (price 6*d.*, or post paid, 7*d.*) can be obtained on about April 3 from the exhibition secretary, Mr. W. G. W. Mitchell, "Lynton", Newbury, Berks. Further information and cards of admission can be obtained from the honorary business secretary of the Television Society, Mr. J. J. Denton, 25, Lisburne Road, Hampstead, N.W.3.

WE have received from British Glues and Chemicals Ltd., Imperial House, 15, 17, 19 Kingsway, London, W.C.2, a pamphlet containing particulars of an international competition organised with the object of promoting interest and research in the development of the uses of bone glue. Provision has been made for prizes to the total value of 20,000 Swiss francs and a further sum of 10,000 Swiss francs is held in reserve to be employed in special cases set out in the rules. A copy of the pamphlet containing the rules and any further information may be obtained at the above address (Department I/S).

IN the review of Dr. W. N. Bond's "Numerical Examples in Physics" in NATURE of March 4, the reviewer suggested that it was a slip on the part of the author to express the mass of the sun as 1·47 kilometres, and to specify a piece of glass as having a refractive index of 1·961. Lord Holden has written to point out that the former is a statement in terms of units that Eddington has found it convenient to use. It may therefore be regarded as correct but rather cryptic. As regards the second statement, glass has been made of such a large refractive index as is given in the question, though it is not very satisfactory in use, turning yellow with age. The high value of the refractive index was intended by Dr. Bond to add point to the numerical example.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Three junior assistants in the Chief Engineer's Department of the Metropolitan Water Board—The Chief Engineer, Offices of the Board, 173, Rosebery Avenue, E.C.1 (April 6). A temporary principal technical assistant in the Shellfish Services Staff and an assistant naturalist in the Fisheries Department of the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W.1 (April 10). Examiners in botany and mathematics in the matriculation and General School examination of the University of London—The Secretary to the Matriculation and School Examination's Council, University of London, South Kensington, S.W.7 (April 18). A professor of physiology in the University of Sheffield—The Registrar (April 20). A senior pathologist in the Department of Preventive Medicine of the University of Bristol—The Secretary (April 20). A scientific assistant in the Imperial Bureau of Plant Genetics: Herbage Plants, Agricultural Buildings, Aberystwyth, Wales—The Director (April 21). A demonstrator in the Department of Zoology at Bedford College for Women, Regent's Park, N.W.1—The Secretary (April 29). An inspector of installations (heating, ventilating, electrical, sanitary, etc.) for the new buildings of the Société des Nations—Le Bureau du Personnel, Secrétariat Société des Nations, Geneva (April 30). A lecturer in helminthology in the Department of Zoology and the Royal (Dick) Veterinary College (University of Edinburgh)—The Secretary of the University (May 24).

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.*]

Protective Inoculation against a Plant Virus

THE *X* virus of the potato, first described by Kenneth Smith[1], is capable of considerable variation in virulence, as shown by its clinical expression on several of the Solanaceæ. If tobacco plants be inoculated from the potato and the virus maintained by *passage* over a long period, the clinical expression may pass from a more or less mild mottling of pale and dark green, to a stage in which the pale areas are bright yellow, ending in one in which the lesions become extensively necrotic. Inoculation with the virus in this latter stage causes young tobacco plants to remain in a dwarfed and crippled condition.

Some four months ago, a series of experiments was instituted in which segments of about 2 mm. diameter were punched out of the green and yellow areas respectively of a leaf of a somewhat severely affected *X*-infected tobacco plant of the White Burley variety, and inoculated by needle into young and healthy seedlings of the same variety. It was at once evident that two distinct clinical conditions had ensued. From the green areas there resulted an exceedingly mild disease we may designate the *G* type of *X*, from the yellow areas a severe disease with large bright yellow patches on a pale green background accompanied by dwarfing; we may designate this the *L* type of *X*. So far, no further development of virulence has occurred in this type, although the *G* strain has, by selective sub-culture, been reduced to one giving an almost imperceptible reaction. Mixing the *G* and *L* tissue extracts in varying proportions *in vitro*, and inoculating tobacco seedlings with the same, has shown that a mixture of 1 *L* : 9 *G* produces a preponderantly *G* reaction, whilst mixtures with less of the *G* element call forth a reaction like that of *L*. Although plants infected with a 1 *L* : 9 *G*, or a 1 *L* : 19 *G* mixture behave, in general, like *G* infections, yet small areas of bright yellow, such as is common in the *L* type, do appear scattered on the otherwise almost normal green leaf. Sub-cultures from such yellow and green areas respectively, in these mixed infections, reproduce the original *L* and *G* types. There has been mixture of the two strains, not neutralisation of one strain by the other.

If tobacco plants inoculated with the mildest type of the *G* form of the *X* virus—no matter whether the ensuing reaction is definite enough to be recognised as a mottle, or so slight as merely to arouse a suspicion of its presence—are re-inoculated after nine days, either with the *L* strain or the most virulent necrotic type of *X* we possess, no further reaction ensues. Such plants retain their mild, almost imperceptible, *G* type of reaction, and present a solid immunity against the further attack of the *X* virus however virulent it may be. Later experiments have shown that this protection against the virulent strains of *X* is developed on the fifth day after the preliminary inoculation, and some four to five days before any systemic response to *G* is apparent. When from such doubly inoculated plants sub-cultures are made, only the *G* type of the *X* virus is obtained; the secondarily inoculated and severer type has failed to gain an entry. It would appear that once the plant cell has formed a symbiotic union with the non-virulent form, it has no capacity to enter into relations with any other virus elements of the same generic type.

The reactions recorded above have been repeated on *Datura strammonium*: in this species both the *L* and the necrotic forms of *X* produce a deadly effect. It is, however, only necessary to give the *Datura* plants a preliminary dose of the *G* form of the *X* virus, which induces but a mild mottle with little or no hindrance to growth, and subsequent inoculation a week later with the most severe *X* virus is without effect.

The protection afforded by the *G* strain holds good also for Miss Hamilton's[2] Hy IV, an *X* type of virus discovered in field crops of *Hyoscyamus*, but it is powerless against the *Y* potato virus of Kenneth Smith[1], as well as against that of the common tobacco mosaic, Johnson's No. 1.

The green 'veinbanding' islets, a late development on the leaves of tobaccos infected with the *Y* virus, have been examined by the same methods but with different results. Here neither evidence of a mild or symptomless *G* form, nor that of any adequate protective mechanism, has as yet been found. Indeed the central portions of such green islets appear to be free of virus. A similar condition was shown by Storey and McClean[3] to exist in streak-infected maize. How such green areas, surrounded by a solid mass of heavily infected cells, retain their freedom from virus, is a problem distinct from that of the corresponding areas in the *X*-infected plant.

Within the limits of this communication it is not possible to do more than refer very briefly to the results of others. McKinney[4] differentiated green and yellow strains in rosette disease of wheat, as has been done here with the *X* virus. Both Price[5] and Thung[6] have recorded observations which suggest a similar type of immunity. The phenomenon here described is, however, distinct from theirs, inasmuch as the protection afforded is achieved by a preliminary inoculation of a virus with an almost subliminal virulence, with the result that neither protective nor subsequent inoculation has any appreciable effect on the health of the plant.

REDCLIFFE N. SALAMAN.
Potato Virus Research Institute,
Cambridge.
March 6.

[1] Smith, Kenneth M., *Proc. Roy. Soc.*, B, **109**, 251; 1931.
[2] Hamilton, M., *Ann. App. Biol.*, **19**, 550; 1932.
[3] Storey and McClean, *Ann. App. Biol.*, **17**, 691; 1930.
[4] McKinney, H., *Science*, N.S., **73**, 650; 1931.
[5] Price, W., Contrib. of the Boyce Thompson Institute, **4**, 359; 1932.
[6] Thung, T. H., reviewed in R. A. M., **11**, 750; 1931.

Experimental Rickets as a Phosphorus Deficiency Disease

ALTHOUGH both prophylactic and curative technique against rickets is now highly developed, the pathogenesis of the disease is still far from being adequately understood. Recent experimental findings —some having already been published[1], others to be published shortly—are briefly summarised here since they afford, it would seem, strong support for the view that, whilst other factors play a part, and it would be idle to endeavour to dissociate phosphorus

from calcium metabolism, yet nevertheless *a chronic defect of phosphorus uptake from the diet* is the most important single factor in the production of experimental rickets in rats. This is very probably true in a large proportion of cases of human rickets also, vitamin D being of importance in the rat or human dietary only in so far as its presence enables the organism to increase the net intestinal absorption of phosphorus from the food. Our findings also throw a little light, it is believed, on the part played by the bone enzyme in this disease.

(*a*) We have found that on a normal stock diet, (Bills's[2]) with or without extra vitamin D in the form of irradiated ergosterol or cod liver oil, very severe rickets, demonstrated by X-ray photographs, by the histological appearance of sections of the long bones and by bone ash and plasma phosphate analyses, may be brought about in growing rats by the simple expedient of adding 0·5 per cent of *beryllium carbonate* to this normal diet. With smaller quantities of the carbonate down to 0·1 per cent or even less, a milder rickets may be produced, amenable in some degree to therapy with the usual antirachitic agents. The addition of an equivalent quantity of beryllium *phosphate* to the Bills's diet has no such effect, and the rats continue to grow normally.

Beryllium is peculiar in forming a phosphate which is highly insoluble even in fairly acid solutions (*p*H4 or less). Its rachitogenic effect is almost certainly bound up with this property, the beryllium dissolved in the gastric juice precipitating quantitatively in the intestine with any free phosphate found there, whether derived from the food or from the intestinal secretions, and removing it in the insoluble form in the fæces.

The possibility has not been overlooked that beryllium may be taken up from the food, and have a specific toxic effect on the growing bone. That this is probably not the case is indicated not only by the experiments just mentioned, in which beryllium *phosphate* added to the diet permitted of strictly normal growth, but also by the absence, histologically, of any evidence of toxic disturbance of the bone or cartilage cells. Moreover, qualitative chemical analysis of the ash of the bones and other tissues of the experimental animals has so far failed to reveal any recognisable quantities of beryllium, using a method sensitive to the presence of 1 part of beryllium in 100 parts of calcium.

(*b*) In the 'beryllium rickets' described above, and also in rickets produced in rats by the rachitogenic diet McCollum 3143 or Steenbock 2965, we have found that in addition to a very low plasma inorganic phosphate (in beryllium rickets values so low as 0·4 mgm. phosphorus per 100 c.c. plasma have been found), there is also a marked diminution in the *phosphoric ester content of the red blood cells*. Assuming the correctness of Robison's theory[3] of the function of the bone phosphatase in the deposition of bone salts, and that the phosphoric esters of the red cells form an important substrate for the activity of this enzyme, it would appear that rickets is explicable as the result, on the physico-chemical mechanism of bone deposition, of a two-fold handicap, first the low inorganic phosphate in the plasma, and secondly the low phosphoric ester content of the circulating blood. If vitamin D be added to the McCollum or the Steenbock diet of such rachitic animals, during the time the rickets is disappearing the phosphoric ester content of the red cells is increasing towards normal.

The above findings fit in very satisfactorily with the recent work of Shohl and collaborators[4] on rat rickets, of Theiler and Green[5] on the production of rickets and osteomalacia in herbivorous animals, and of Bodansky and his co-workers[6] on human rickets. The accumulated evidence may now be sufficient to support the corollary that the most important, if not the essential, effect of vitamin D in physiological quantities is to increase directly the intestinal absorption of phosphate (which normally implies increased uptake of calcium also) from the diet. It seems likely that, in the human, the functional efficiency of the intestine in the taking up of phosphate may vary markedly from one normal individual to another, the diet being the same. In certain stubborn cases of infantile rickets or adult rickets (osteomalacia) we may be dealing, essentially, with individuals in whom, as the result of an inborn or acquired functional defect of the intestine, this ability to take up phosphate from the contents of the gut is abnormally low, rather than with individuals in whom there is a deep-seated metabolic error or an essential deficiency in the process of bone formation itself. Their cure (if the intestinal absorptive mechanism had not degenerated too far) by the addition of generous quantities of vitamin D to the diet would then be explicable by the action of the vitamin not *directly* on the deposition of bone, but indirectly in stimulating phosphate uptake through the defective intestinal wall, a suggestion which, though not new, has hitherto been somewhat lacking in experimental support.

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[2] Bills, *et al.*, *J. Biol. Chem.*, **90**, 619; 1931.
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[5] Theiler and Green, *Nutrition Abstracts and Reviews*, **1**, 359; 1932.
[6] Bakwin, Bodansky and Turner, *Proc. Soc. Exp. Biol. and Med.*, **29**, 1238; 1932.

Estimation and Distribution of Ascorbic Acid (Vitamin C) and Glutathione in Animal Tissues

MOST of the recorded measurements of the reduced glutathione content of tissues have been made by Tunnicliffe's method of titration with iodine on the assumption that the trichloracetic extracts of tissue contain little else but glutathione capable of reducing iodine in acid solution. A method depending upon a different principle was introduced by Mason, who found that the reduced glutathione content of liver, kidney and yeast extracts determined by titration against iodine is 120–200 per cent of the true value. His method has however been neglected, and the iodine method has been used almost exclusively. Recently, Bierich has evolved a third method for the estimation of reduced glutathione and has also obtained values much lower than those obtained by iodine titration. Ever since the discovery of ascorbic acid, it has been evident (as is mentioned by these workers) that where ascorbic acid occurs in the tissues, it will be estimated as glutathione in the iodine titration; but it has been assumed without any evidence that ascorbic acid occurs only in traces except in the suprarenal cortex.

Using the indophenol titration method of Tillmans as modified in this laboratory for the estimation of

ascorbic acid, we have found that ascorbic acid occurs in a number of organs in amounts comparable with that of glutathione, and that in organs other than the suprarenal cortex, up to 40 per cent of the iodine titre ('glutathione') may be accounted for by the ascorbic acid. Figures are given for blood, voluntary muscle, liver, kidney and the lens of the eye in the accompanying table. In view of this finding, data relating to the glutathione content of tissues, and factors influencing it, will require a thorough re-examination.

Tissue	Ascorbic acid (mgm. per gm.)	N/100 I_2 required for ascorbic acid present (c.c.)	Total N/100 I_2 required per gm. tissue (c.c.)	Per cent of I_2 titre due to ascorbic acid
Rat blood	<0·02	<0·023	0·197	<12
„ muscle	0·06	0·068	0·232	29
„ liver	0·15	0·188	1·14	16
„ kidney	0·22	0·25	0·910	27
Sheep liver	0·45	0·512	1·51	34
„ eye lens	0·46	0·52	1·64	32
Pig liver	0·38	0·432	1·44	30
Rabbit liver	0·40	0·455	1·33	34
„ kidney	0·25	0·285	0·655	43
Guinea pig liver, scorbutic	0·09	0·102	1·16	9
„ „ „ normal	0·30	0·34	0·97	35
Ox suprarenal cortex	1·62	1·85	2·40	77

From the data collected in the table, it will be seen that those tissues known to be rich in glutathione also have a high ascorbic acid content, and this coincident occurrence of the two substances has led us to formulate the working hypothesis that ascorbic acid and glutathione may be two linked factors in one system of oxidation in the animal cell. This has already led to the discovery of a thermolabile agent which is a catalyst for the dehydrogenation of ascorbic acid.

It must be borne in mind that although glutathione does not reduce 2–6 dichlorphenolindophenol under the conditions employed, there may be other unsuspected substances in the tissue extracts which will reduce the reagent, and therefore will be included in the estimation as ascorbic acid, causing too high a figure to be obtained. Fortunately, the ascorbic acid content as determined by the titration method can be checked by measuring the antiscorbutic activity of the tissue, and experiments with this object are already in progress.

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Action of Proteolytic Enzymes on the Oxytocic Principle of the Pituitary Gland

For more than a year we have been engaged in a study of the inactivation by enzymes of purified preparations[1] of the oxytocic principle of the pituitary gland. The stimulating action of the hormone on smooth muscle is slowly destroyed by aminopolypeptidase preparations from English brewers' yeast, and is rapidly destroyed by dipeptidase and proteinase preparations from the same source. Preparations of dipeptidase and aminopolypeptidase, with which Dr. Grassmann of Munich kindly presented us, also inactivated the hormone. None of the enzymes mentioned above is responsible for this inactivation. It is apparently due to an additional enzyme, present in these preparations, which has a *p*H optimum at 7·4.

Recently Freudenberg, Weiss and Eyer[2] stated that "die Wirkung der Substanz [the oxytocic hormone] von Pepsin und Erepsin nicht verändert, von Trypsin und Papain (auch wenn dieses nicht aktiviert ist) aber zerstört wird. Das Hormon ist entweder hochmolekular oder an einem hochmolekularen Träger der Eiweissgruppe gebunden. Offenbar gehört es dem Typus des Insulins an". We concur that papain preparations destroy the hormone rapidly, even more rapidly than do dipeptidase preparations, but the *p*H-optimum and *p*H-activity curve of the enzyme causing this destruction are the same as those of the yeast enzyme mentioned above. It is improbable, therefore, that the destruction of the oxytocic hormone is caused by a papainase, and we suggest that it is due to the presence in the papain preparations of an enzyme identical with, or similar to, the enzyme which we have detected in yeast.

Our experiments with the yeast enzyme and papain preparations will shortly be published *in extenso*. Experiments are in progress to identify the enzyme which destroys the oxytocic hormone, and we have been occupied for some time in investigating the constitution of the hormone by studying its behaviour with other enzymes and with chemical reagents. The results of an investigation of the action of nitrous acid and other reagents on the hormone have already been published[3].

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[1] Gulland and Newton, *Biochem. J.*, **26**, 337; 1932.
[2] Freudenberg, Weiss and Eyer, *Naturwiss.*, **20**, 658; 1932.
[3] Gulland, *Chemistry and Industry*, **52**, 160; 1933.

Predissociation and Pressure Effects in the Band Spectrum of Aluminium Hydride

By the aid of graphical methods[1], we have constructed the potential curves $V_J(r)$ for different rotational states of $^1\Pi$ in aluminium hydride. From estimations on the line width of the diffuse lines in the $^1\Pi \rightarrow {}^1\Sigma$ band system, we were able to extend our constructions to wide nuclear spacing ($r \sim 3 \times 10^{-8}$ cm.) as shown in Fig. 1. Reproducing the curve $V_0(r)$ for $J = 0$ $\left[V_J(r) = V_0(r) + \frac{h}{8\pi^2\mu r^2} J(J+1)\right]$ we found, that even now a potential barrier remains in $^1\Pi$, the height of which is ~ 400 cm.$^{-1}$, as related to the limit of dissociation. This result appears somewhat surprising, as in the few cases hitherto investigated (hydrogen, mercury hydride, etc.) a smooth approach of the potential curves to the limit of dissociation has been assumed. We are not in the position to distinguish between the alternatives, whether this barrier is a feature of the $^1\Pi$–state itself or produced by the intersection of some unknown and repulsive $^1\Pi^*$–state, as suggested in Fig. 1. In the latter case, the actual $^1\Pi$–curve should be correlated to some excited state in the Al atom as already suggested by Kronig[2], although for other reasons. In any event, by this construction the level scheme

of AlH has been related to that of the Al atom, the position of the level $v = 0$, $J = 0$ in $^1\Pi$ situated 1400 ± 50 cm.$^{-1}$ below the limit of dissociation. Incidentally, it may be mentioned that some interesting cases of perturbations and predissociations in the excited $^1\Sigma'$ and $^1\Sigma''$ states[4] are readily explained hereby.

The transparency of the potential barrier to the de Broglie waves is a well-known effect[3], which has been applied especially to the problems of the disintegration of atomic nuclei and molecules. Generally, the effect of transparency is given by an expression $\frac{\omega}{\pi} e^{-\beta_J}$, where $\beta_J = \frac{4\pi}{h} \int_{r_1}^{r_2} \sqrt{2\mu\,[V_J\,(r) - E]}\, dr$. In the special case here considered, the life of molecules in $^1\Pi$ is thereby reduced from 10^{-8} sec. to $\sim 10^{-13}$ sec. in the most excited rotational states observed. In addition, we wish to point out a reciprocal effect, which comes into play when we consider the problem of molecular

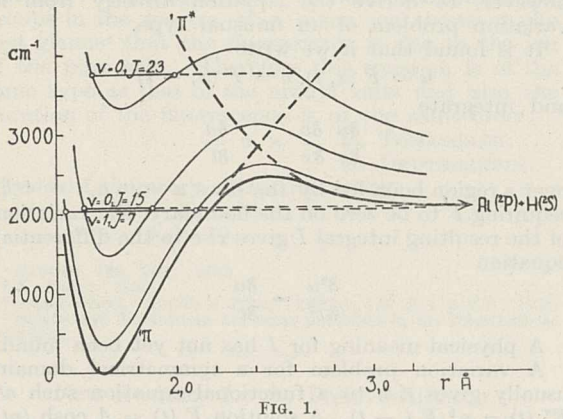

FIG. 1.

formation. In cases of resonance between the system of free atoms and the molecule formed, the probability of capture per collision is determined by an expression $\sim e^{+\beta_J}$. Apparently, this resonance effect plays an important rôle, influencing the processes of exchange between atomic and molecular states [Al + H ⟷ AlH] in favour of molecular formation. To speak more figuratively, the barrier acts as if perforated by a system (J, v) of narrow channels, by which the molecular formation and dissociation takes place.

Applying these considerations to the case of AlH, we expect an excess in the number of molecules of those rotational levels which are situated close above the limit of dissociation in $^1\Pi$, an effect clear enough to be distinguished from those determined by the thermal and electronic activation of the molecules. From a close examination of the intensity distribution in the bands of $^1\Pi \rightarrow {}^1\Sigma$, emitted by an aluminium arc burning in pure hydrogen of one atmosphere pressure, we found that the lines originating from the rotational levels $J = 15$ in $v = 0$ and $J = 7$ in $v = 1$ exhibit distinct peaks on the smooth curves of intensity, given by the expression $ie^{-\frac{E}{kT}}$. It must be emphasised that these lines still belong to the type of sharp band lines, the disintegration of the molecule in the initial state being protected by an almost impenetrable potential barrier.

At low pressure (~ 10 mm. mercury) in the arc, the exciting conditions are mainly due to electronic activation of the molecules. In the states of predissociation, by increasing pressure, this effect is superposed by the effect of molecular formation. The sensible influence observed[4] of the hydrogen pressure on the intensity of the diffuse lines may be interpreted by the aid of the mechanism of resonance, suggested above. Although somewhat hampered by the damping factor $e^{-2\beta}$, the resonance process must be largely favoured by an increasing number of molecules within the radius of interaction of the individual Al + H process.

Details regarding the investigation will be given later.

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[2] R. de L. Kronig, *Z. Phys.*, **62**, 300; 1930. Regarding the constructions of the potential curves of AlH we made use of a more exact relation between the line width and the potential barrier, recently developed by G. Müller, *Z. Phys.*, **79**, 595; 1932.
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New Experimental Evidence in the Sulphur-Hydrogen Reaction

BODENSTEIN[1] studied this reaction in sealed bulbs containing excess of sulphur, and found a temperature coefficient of 1·34 between 234° and 283°, and 1·77 between 310° and 356°. His work was criticised, by Norrish and Rideal[2], as possibly vitiated by the hydrogen sulphide liberated on the solidification of the residual sulphur, and as leaving uncertain, in view of the variable temperature coefficient, the part played by the walls of the bulbs. These workers employed a dynamic method, and showed that the logarithms of the total reaction velocity—always, however, measured in the presence of nitrogen—when plotted against absolute temperature yielded a curved line. The differences in the velocities obtained, using hydrogen at partial pressures of 0·810 atm. and 0·304 atm., respectively, when suitably plotted gave a straight line which was interpreted as belonging to the gaseous reaction alone, since the surface reaction, common to each series, was assumed, and reasonably so, to be independent of pressure. The velocity of the composite reaction was also shown experimentally to be increased by increasing the glass surface, to which it was stated to be proportional; and to be independent of the amount of sulphur present. Knowing the contribution of the gaseous reaction, data for the surface were deduced, and thus the temperature coefficient of each reaction was obtained: homogeneous 2·19, heterogeneous 1·48.

The assumption, fundamental to their deductions, made by Norrish and Rideal, that nitrogen is without effect on the velocity of the formation of hydrogen sulphide, has not been borne out by our re-examination of the problem. Actually, nitrogen definitely increases the velocity of the gaseous reaction over practically the whole of the temperature range under consideration. Furthermore, we have been unable to obtain any evidence of the heterogeneous reaction, described by them as taking place on the glass

surface of the vessels. A heterogeneous reaction of some magnitude has, however, been observed, but it is confined to the surface of the sulphur, its velocity being proportional to the area thereof.

At 760 mm., in pure hydrogen, when precautions were taken to keep a uniform pool of sulphur in the reaction vessel, the dynamic method, in our hands, gave a practically straight log $d\,[H_2S]/dt$ against $1/T$ plot between 265° and 350° The velocities were unaffected by an increase in the surface/volume ratio of 500 per cent, but were appreciably altered by changes in the area of liquid sulphur; in the latter case, within certain limits, the temperature coefficient of the total reaction was not sensibly changed, provided the particular areas were kept constant throughout the temperature range. The introduction of nitrogen resulted in a curve, similar in form, and close in actual position, to that of Norrish and Rideal, and the velocities were somewhat higher than was warranted by the partial pressure of hydrogen employed.

A study of the gas reaction was made, statically, in bulbs, wherein the amount of sulphur was always more than twenty times that converted to the hydride, but was, nevertheless, insufficient to allow of any liquid being present. The surface/volume ratio and the pressure of hydrogen were varied, and the results showed that the velocity of hydrogen sulphide formation was: (1) proportional to the concentration of hydrogen; (2) proportional to the square root of the concentration of sulphur; (3) independent of the area of the glass surface.

The plot of log $d[H_2S]dt$ against $1/T$ was perfectly straight, and gave a temperature coefficient of 1·94. With the same partial pressure of hydrogen, in the presence of nitrogen, log $d\,[H_2S]dt$ against $1/T$ was decidedly curved, and the velocities were appreciably greater than with pure hydrogen. The difference, brought about by the nitrogen, points to a chain mechanism, and the investigation is proceeding with the substitution of helium for nitrogen, and with the limitation of the space for chain formation. The gaseous reaction proceeds in accordance with the equation,

$$d\,[H_2S]/dt = K\,[H_2] \times \sqrt{[S]}.$$

Two or three forms of chain mechanism suggest themselves, but we hesitate to differentiate between these in the absence of other data which are at present being sought.

By a modification of the shapes of the bulbs, whereby three pools of liquid sulphur, of different sizes, were exposed to the action of hydrogen, the composite reaction, in the presence of known areas of sulphur, was investigated. The velocity of the surface reaction was computed by deducting that of the homogeneous one from the composite figure, and its temperature coefficient was estimated from the results obtained. The reaction at the surface of liquid sulphur proved to be: (1) proportional to the area of the liquid exposed; (2) proportional to the pressure of hydrogen. It gave a straight log $d\,[H_2S]/dt$ against $1/T$ plot, from which a temperature coefficient of 1·85 was calculated. The surface reaction proceeds in accordance with the equation,

$$d\,[H_2S]/dt = K \times \text{area of liquid sulphur} \times [H_2].$$

Although Bodenstein failed to recognise the composite nature of the reaction between hydrogen and sulphur, first suggested by Norrish and Rideal, he evidently believed it to have the characteristics of the gaseous reaction here described, in spite of the fact that his analytical results did not entirely confirm this view. His approximate methods also obscured the effect of the heterogeneous reaction occurring at the sulphur surface and prevented its detection.

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[1] *Z. phys. Chem.*, **29**, 315; 1899.
[2] *J. Chem. Soc.*, **123**, 696; 1923.

Variation Problems for a Symmetrical Region

In a review in Nature[1] it is stated that the equation of conduction of heat can be regarded only as a limiting case of an equation arising in the calculus of variations. A successful attempt has been made, however, to derive the equation directly from a variation problem of an unusual type.

It is found that if we write

$$u = F(x, t), v = F(x, -t)$$

and integrate

$$\frac{\delta u}{\delta x}\frac{\delta v}{\delta x} \times v\,\frac{\delta u}{\delta t}$$

over a region bounded by the lines $x = \pm a, t = \pm b$, requiring F to be zero on the boundary, the variation of the resulting integral I gives rise to the differential equation

$$\frac{\delta^2 u}{\delta x^2} = \frac{\delta u}{\delta t}.$$

A physical meaning for I has not yet been found.

A variation problem for a symmetrical domain usually gives rise to a functional equation such as $F''(t) = n^2 F(-t)$. A solution $F(t) = A \cosh(nt) - B \sin(nt)$ of this equation may be found by splitting $F(t)$ into its even and odd parts, a device that is often useful.

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[1] Nature, **129**, 850, June 11, 1932.

If, in Prof. Bateman's example, we take

$$F(x, t) + F(x, -t) = 2\varphi(x, t),$$
$$F(x, t) - F(x, -t) = 2\psi(x, t),$$

then φ and ψ may be regarded as independent of each other, and the variational equations are

$$\frac{\delta\varphi}{\delta x^2} = \frac{\delta\psi}{\delta t}, \qquad \frac{\delta^2\psi}{\delta x^2} = \frac{\delta\varphi}{\delta t}.$$

It is true that the equation $\frac{\delta^2 u}{\delta x^2} = \frac{\delta u}{\delta t}$ can be derived by adding these two equations, but it represents only a *part* of the variational system: the *whole* set consists of the above two equations, which when we eliminate ψ give

$$\frac{\delta^4\varphi}{\delta x^4} = \frac{\delta^2\varphi}{\delta t^2},$$

and I regard this as the true differential equation arising in Prof. Bateman's problem.

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Fluorescence of Pure Salts of the Rare Earths

INVESTIGATING the connexion between the emission spectra in colourless materials[1] and the absorption spectra of the ions of the rare earths[2] we have found that the pure salts of the rare earths can also exhibit a fluorescence of a surprising brightness. Up to the present, this fact was still very doubtful[3]. Under excitation with violet and ultra-violet light, europium sulphate in particular shows a brilliant red fluorescence. Terbium sulphate fluoresces also very strongly with a pale greenish colour. The luminosity of the sulphates of samarium and dysprosium is weaker. Our samples of the sulphates of holmium and erbium showed no perceptible emission. The spectra emitted are very sharp, especially at lower temperatures.

Conclusive proof that the emission is to be ascribed to the pure salts and not to any impurities is given by comparing these spectra with the phosphorescence spectra, when the same ion (in a small amount of about 0·1 per cent) is embedded in a colourless salt by heating. The agreement between the particular groups in the spectra of a given ion shows at the first glance[4] that the fluorescence is due to the ion of the pure salt. Therefore this emission is of the same type as that of the uranyl salts and also the duration of the fluorescence is of the same order.

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[1] NATURE, **130**, 740; 1932.
[2] *Z. Phys.*; 1933.
[3] Geiger-Scheel, "Handb. d. Phys.", 2nd ed., vol. 23, 1, p. 276; 1933.
[4] Details and illustrations are being published in the *Physikalische Zeitschrift*.

New Evidence for the Positive Electron

THE experiments of Anderson[1] and of Blackett and Occhialini[2] on the effects produced in an expansion chamber by the penetrating radiation strongly suggest the existence of positive electrons—particles of about the same mass as an electron but carrying a positive charge.

Some observations of the effects produced by the passage of neutrons through matter, and the experiments of Curie and Joliot[3] in which they observed retrograde electron tracks in an expansion chamber, led us to consider the possibility that positive electrons might be produced in the interaction of neutrons and matter, and we have recently obtained evidence which can be interpreted in this way.

A capsule containing a polonium source and a piece of beryllium was placed close to the wall of an expansion chamber. On the inside of the wall was fixed a target of lead about 2·5 cm. square and 2 mm. thick. This lead target was thus exposed to the action of the radiation, consisting of γ-rays and neutrons, emitted from the beryllium. Expansion photographs were taken by means of a stereoscopic pair of cameras. A magnetic field was applied during the expansion, its magnitude being usually about 800 gauss.

Most of the tracks recorded in the photographs were, from the sense of their curvature, clearly due to negative electrons, but many examples were found of tracks which had one end in or near the lead target and showed a curvature in the opposite sense. Either these were due to particles carrying a positive charge or they were due to negative electrons ejected in remote parts of the chamber and bent by the magnetic field so as to end on the lead target. Statistical examination of the results supports the view that the tracks began in the target and therefore carried a positive charge.

Strong evidence for this hypothesis was acquired by placing a metal plate across the expansion chamber so as to intercept the paths of the particles. Only a few good photographs have so far been obtained in which a positively curved track passes through the plate and remains in focus throughout its path, but these leave no doubt that the particles had their origin in or near the lead target and were therefore positively charged. In one case the track had a curvature on the target side of the plate, a sheet of copper 0·25 mm. thick, corresponding to a value of $H\rho$ of 12,700; on the other side the curvature gave a value $H\rho = 10{,}000$. This indicates that the particle travelled from the target through the copper plate, losing a certain amount of energy in the plate. The change in the value of $H\rho$ in passing through the copper is roughly the same as for a negative electron under similar conditions. The ionising power of the particle is also about the same as that for the negative electron. These observations are consistent with the assumption that the mass and magnitude of the charge of the positive particle are the same as for the negative electron.

The manner in which these positive electrons are produced is not yet clear, nor whether they arise from the action of the neutron emitted by the beryllium or from the action of the accompanying γ-radiation. It is hoped that further experiments now in progress will decide these questions.

Our thanks are due to Mr. Gilbert for his help in the experiments.

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[1] Anderson, *Science*, **76**, 238; 1932.
[2] Blackett and Occhialini, *Proc. Roy. Soc.*, A, **139**, 699; 1933.
[3] Curie and Joliot. "L'Existence du Neutron". Hermann et Cie, Paris.

Summer Thunderstorms

THE annual record of thunderstorms occurring in the six summer months is being continued during 1933.

A note of the place, date and time of the occurrence of thunder, lightning or hail, in any part of the British Isles, between April 1 and September 30, with the direction in which the lightning was seen, especially at night, will be extremely useful. In the case of actual thunderstorms, information as to the time of first observation of thunder or lightning, time of commencement of very heavy rain or hail, or approximate time of nearest approach of storm, and approximate time of final observation of thunder or lightning will be valuable.

It is essential that the position from which the observation is made should be specified, and that the standard of time used should be stated. More data are particularly required from rural and moorland districts and from thinly populated areas generally.

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Research Items

Iron-working in the Bahr el Ghazal. Mr. T. C. Crawhall in *Man* for March describes the processes of iron-working and forging as practised by the Jur of the Sudanese province of Bahr el Ghazal, which are illustrated by some exhibits recently acquired by the Science Museum through Capt. J. F. Cumming, district commissioner. The ore is smelted in a clay furnace, 5 ft. high, with four clay tubes inserted in the side of the furnace near the bottom for ventilation, and a hole at the bottom of the furnace, which is sealed with clay during the period of smelting, for the extraction of the iron. There is no forced draught. The iron ore is broken into small pieces, about one inch cube, and separated into two kinds, known as the male and female elements. Both, it is believed, must be present before iron can be produced. Sixteen baskets of hardwood charcoal are used to three baskets of ore. One such charge, taking about twenty-two hours for smelting, produces only enough iron to make eight or ten spearheads. The iron collects at the bottom of the furnace and is removed by long poles pointed at the ends, pulled along the ground by native-made rope, and then quenched with water. It is then broken into small pieces for treatment at the forge. The forge is situated in a grass hut, mainly to prevent the sun from shining on the iron. Should this happen, it would be impossible to work it. Great deference is paid to the smith, and oaths sworn on his anvil, a rough piece of iron driven into a palm-tree buried in the ground, are inviolable. The charcoal is raised to the temperature necessary to soften the iron by two rows of bellows, of which the chief interest is that they exactly resemble the bellows used in ancient Egypt and shown on a drawing from a tomb at Thebes of about 1500 B.C. They are made of clay covered with goatskin, and have no valves. The nozzles, therefore, do not enter the fire, but each pair rests in a clay junction unit which has one end in the fire and the other open to the air to admit the inward draught.

Hawaiian Tradition. An interesting document has recently come into the possession of the Bernice P. Bishop Museum, Honolulu, and is edited under the title "Kepelino's Traditions of Hawaii" by Martha Warren Beckwith (Bulletin 95). The manuscript was for some years in the possession of the Roman Catholic Mission of Honolulu, for which it was composed by Kepelino, a descendant of the priestly race of Paao, born in Hawaii about 1830, and transcribed by Bishop Maigret. Although Christian influence is present, the record bears the mark of authenticity and sincerity. Of the gods it is said that three classes of gods were recognised in the history of Hawaii : the great gods, the class of spirits who were created and of men, that is the guardian spirits, and thirdly the class of things without souls. The great gods were male gods ; they had no source ; they made all things and all power was theirs. These gods made many gods to serve them and they made man and all things. In the second class there were many gods and these were subdivided into three kinds : the spirits without a body, the *aumakua* of day, and secondly the *aumakua* of night, the dead, and in the third class, district chiefs. The last are put in the class of gods because, as ruling chiefs, they had great power and also because of the *tapu* observed towards them, a thing to be dreaded. Also they had the power of life and death. They were called "gods that could be seen". They were sometimes worshipped. The *tapu* of the gods covers all men and all chiefs, while the *tapu* of the chiefs covers only the commoners with the exception of the *kahuna* and his people. The chief's *tapu* had many laws of death, such as that if one did not prostrate oneself when the chief came forth or sit when the chief's bathing water went by, or if one walked about when the chief's name was chanted, the penalty was death.

Indian Microlepidoptera. Scientific Monograph No. 2 of the Imperial Council of Agricultural Research (India) entitled "Life-Histories of Indian Microlepidoptera" has recently come to hand. In this memoir, Mr. T. Bainbrigge Fletcher, Imperial entomologist, has continued his studies of these small moths. The present contribution deals with the life-histories of a number of species belonging to the groups Alucitidæ, Tortricina and Gelechiadæ the transformations of which, in many cases, are figured on the accompanying plates. Notwithstanding their small size, certain of these insects have a very extensive geographical range and included among them are destructive species of great economic importance. Students of the groups concerned will find many hitherto unknown life-histories described. The monograph is issued by the Government Publication Branch, Calcutta (Rs. 3–4 or 5*s*. 6*d*.).

Culture of Snail's Tissue. J. Brontë Gatenby and E. S. Duthie have recorded (*J. Roy. Micr. Soc.*, 52, pt. 4 ; 1932) observations on the histology of the wall of the pulmonary cavity in *Helix aspersa*. They describe the normal regeneration of the wall after cutting in the living snail, and give a preliminary account of the behaviour of small pieces of the wall when cultivated in hanging drops of the snail's blood. In the process of normal regeneration no mitotic divisions were seen, while figures suggestive of amitosis were extremely common. In no case have the authors seen mitoses in the cultures where cell multiplication is rapidly taking place, but even a few minutes after the tissue has been placed in blood, and put under the microscope, constriction and separation of cells by the amitotic method has been observed. It is concluded therefore that in culture and in normal regeneration, and probably also in normal growth, the cells of the snail multiply by amitosis. The paper is illustrated by thirteen figures. (See also NATURE, **130**, 668, Oct. 22, 1932.)

Fluorescence in Ryegrasses. Rapid developments are taking place in the application of Gentner's screened ultra-violet light test for *multiflorum* characters in *Lolium*. The use of the test has passed into routine practice in a number of seed-testing and herbage research stations and new directions in which it is of service are multiplying. In view of the somewhat expensive nature of mercury vapour and other ultra-violet ray lamps, it is satisfactory to find that filtered daylight may be successfully employed. Linehan and Mercer record (*Proc. Internat. Seed Testing Assoc.*, 4, No. 2 ; 1932) efficient performance of a Dutch instrument for daylight use. A similar instrument of British manufacture is now available. In a recent communication to the Editor, Messrs.

E. W. Hullett and J. W. Calder, of Canterbury Agricultural College, New Zealand, point out that evidently only the longer wave part of the ultra-violet light spectrum is necessary, since ordinary laboratory glass does not markedly reduce the intensity of the fluorescence. These authors report success with several types of ultra-violet ray generator and with daylight passed through a Wood's filter. The fundamental physiological causes of the fluorescence phenomenon remain obscure, and merit biochemical and physical research in view of their probable importance to plant physiology generally. It is interesting to note, however (Linehan and Mercer, NATURE, 131, 202, Feb. 11, 1933), that despite apparent complexity of these causes, fluorescence behaves, in hybridisation, as a simple Mendelian dominant.

Migration of Oil and Natural Gas. Most geologies of petroleum devote considerable space to problems of oil migration within the earth's crust in an attempt to explain how it is that petroleum makes its way into the reservoirs from which it is at the present time produced. Ever since the inception of theories of origin and accumulation of oil, attempts have been made to explain the forces which have caused the movement of the oil through the earth's crust and it must be admitted that there has been a good deal of uninspiring repetition of old theories without regard for the results of experimental work or for the records of field technology now available from well-understood oilfields throughout the world. The study of migration has been made a special one by Prof. V. C. Illing for some years past. His paper before the Institution of Petroleum Technologists on March 7 showed clearly that he is not satisfied with mere repetition of theories. Apart from giving results of experimental work carried on for some years past at the Royal School of Mines, he emphasised that migration is bound to be a twofold process: a primary movement of oil and gas from source rocks to reservoir rocks and a secondary movement of segregation within these rocks and thus the ultimate distribution of oil and gas as pools. Primary migration is ascribed to compaction aided by internal or external sources of pressure, in which phase the oil originates. Secondary migration implies separation of gas, oil and water within the coarse rocks, sometimes due to static buoyancy but probably in the main due to flotation in mobile fluids. Such previously accepted theories as buoyancy, capillarity or hydraulic currents as being responsible, are, the author contends, inadequate, and even Munn's theory fails to explain the retention of oil in coarser rocks.

Photoconductive Effect in Carborundum Crystals. In a communication to the Editor, Prof. Kamienski, of the Institute of Physical Chemistry and Electro-Chemistry, Jagellonian University, Cracow, has observed that some carborundum crystals exhibit a photoconductive effect. A Lindemann electrometer connected across a xylol-alcohol resistance in series with the crystal and a small battery were used to investigate the phenomenon. In a typical case the crystal had an area of 2·5 sq. mm., the xylol-alcohol resistance was of rather less than one tenth the resistance of the crystal in the dark, and a 4-volt battery was used. A small lamp carrying 0·25 amp. at 2·5 volts was used: when it was 1 cm. from the crystal the electrometer indicated 2·2 volts, at 5 cm. it indicated 0·7 volt, and at 10 cm. it indicated 0·4 volt. In contrast with selenium cells, these crystals give very steady and reproducible results. Prof. Kamienski states that the inertia is low; when the crystal is illuminated, the electrometer needle shows immediately a deflection nearly as great as the ultimate equilibrium value, which is attained in 2–4 minutes. Some crystals show a different photo-sensitivity according to the direction the current is flowing; others have an almost equal sensitivity for both directions. Messrs. Adam Hilger Ltd. have carried out experiments on one of these crystals and have confirmed these results. They also found that the range of sensitivity of the crystal was about 3000–5500 A., and that it was most sensitive to light of wave-length about 4000 A.

Photographic Sensitisers for the Infra-Red. In the *Journal of the Chemical Society* for February, Miss N. I. Fisher and Miss F. M. Hamer publish an account of the syntheses of several tricarbocyanines. These dyes are photographic sensitisers for the infra-red between 7000 A. and 10000 A.

New Lens of High Rapidity for Cinematography. Messrs. Carl Zeiss of Jena have placed upon the market a new cinematograph camera lens with an aperture of *F* 0·85. The lens is known as the 'R-Biotar'. It has already proved very successful in providing an X-ray cinematograph record of the pulsating organs of the body. Actually, of course, the fluorescence image produced on a screen was photographed; the great rapidity of the new lens makes this work much more satisfactory than was previously possible. We are informed that the price of the lens in Great Britain is about £48.

Electrostatic Production of High Voltages. Van de Graaf, Compton and Van Atta, working at the Massachusetts Institute of Technology, have developed a very direct method for the production of high direct current potentials (*Phys. Rev.*, Feb. 1). Electric charges are sprayed by point discharge on to the surface of a moving insulating belt which carries them into the interior of a large insulating sphere. The charges are removed from the belt by a point-collector system inside the sphere and the latter becomes charged to a high potential. The charge conveyed by the belt is limited by the electrostatic intensity in the air at the surface of the belt, and the maximum potential is limited by leakage and discharge from the sphere. In a model generator with a pair of 24-inch spheres 25 microamperes was obtained at about 1,500 kilovolts, and this generator was simple and cheap to construct. A very large generator is now being constructed with 15-foot spheres supported on 24-foot towers of shellac insulating compound, inside which the belts are to run. Each of the two spheres will form a laboratory room and a discharge tube will be supported between the two spheres. Simultaneously with the development of the high voltage generator, a discharge tube has been evolved consisting of an insulating fibre (shellac compound) tube with flat metal ends. The electric field around the cylinder is made uniform by providing a spiral indian-ink leak round the outside of the tube. About 300 kv. was applied to a tube of this type without puncture, the voltage being limited by discharge and the current capacity of the electrostatic generator.

Viscosity of Aqueous Solutions. Grinnell Jones and S. K. Talley (*J. Amer. Chem. Soc.*, Feb.) describe some very accurate experiments on the viscosities of

aqueous solutions of six salts and also sucrose and urea at 25°. The Ostwald type viscometer was of quartz, internally ground and polished, and the transit of the meniscus was timed automatically by means of a photoelectric cell. The viscosities confirm the prediction made by Jones and Dole on the basis of the Debye theory of interionic attraction that all salts will increase the viscosity of water if measured at sufficiently low concentration. This is the case even for those salts which produce a diminution in viscosity at higher concentrations, including potassium chloride, chlorate and nitrate, ammonium chloride and cæsium nitrate. The viscosity-concentration curves for these salts go through a minimum. Jones and Dole had shown that the fluidity of a salt solution should be related to the concentration by an equation of the form $\varphi = 1 + A\sqrt{c} + B\,c$, where A and B are constants. A should be negative for all electrolytes but zero for non-electrolytes, whilst B may be either positive or negative. This equation, based on the Debye-Hückel theory, is found to hold, and the results also confirm the equation of Falkenhagen and Vernon, in which the value of the constant A is calculated in terms of the mobilities of the two ions. In the case of the two non-electrolytes, the square root term was absent, as it should be when no ions are present in the solution.

Oxidation and the Lubricating Properties of Oil. In a paper in the *Proceedings of the Royal Society* for February, R. O. King describes experiments on lubrication by oil in a state of strong oxidation. A blended mineral oil was circulated through a journal bearing, the temperature of the bearing was artificially raised by a gas-burner, and the the oxidation of the oil was promoted by blowing air through the hot oil. It was found that as the trial of a sample of oil proceeded, the viscosity increased slightly, but the bearing friction at high temperatures decreased and the temperature of seizing was pushed up to very high values. In one case, for example, the coefficient of friction had the very low value of 0·00045 with the bearing running at about 250°. The lubrication of a bearing of this kind under ordinary conditions is of the 'fluid friction' type, but the friction observed under the oxidation conditions is too low to be explained in this way, and the author suggests that the 'oxidation lubrication' is of a quite different type in which activated molecules formed in the initial stages of oxidation become attached to the surfaces and build up a boundary layer. The conditions are then something like those of 'boundary lubrication' described by Hardy but the special nature of the activated molecular film permits a surface of very free slip to be formed.

Astronomical Topics

Astronomical Notes for April. Mercury is in elongation as a morning star on April 20, but is not well placed for northern observers. Jupiter and Mars continue to be well placed, in Leo. Mars is stationary on April 13, not far from Regulus; after this it will approach Jupiter until the evening of June 4, when they are only 15′ apart. Neptune is also in Leo. Venus and Uranus are too near the sun for observation; the former becomes an evening star on April 21, but will not be easily observable until June.

An occultation of Regulus is visible in the southern portion of England on the evening of April 6; the northern limit runs roughly from Liverpool to Dover. Many observers are making expeditions to the limiting line, in the hope of locating this with precision. At Greenwich, disappearance occurs at 8.57 p.m., and reappearance at 9.10 p.m., 24° east of the north point. The smallest instrument will suffice for the observation. Other disappearances of faint stars occur in London on April 1 at 10.10 p.m., on April 29 at 10.42 p.m. and on April 30 at 11.30 p.m. Minima of Algol occur on April 1 at 11.40 p.m. and on April 4 at 8.30 p.m.

Comet Pons-Winnecke should be visible with moderate instruments at the end of April and in May. Search ephemerides are given in B.A.A. Handbook for 1933.

Summer time begins on the morning of April 9, a week earlier than usual, owing to the third Sunday being Easter. Summer time is not used in these notes, and should not be used for astronomical records. After April 9, the times given here need to be increased by one hour to give the summer time.

The Minor Planet Amor. This is the interesting planet discovered by M. Delporte at Uccle a year ago, when it approached the earth within ten million miles. It was observed for nearly three months; *Astronomische Nachrichten* No. 5936 contains a careful discussion of its orbit by Dr. A. Kahrstedt of the Berlin Rechen-Institut.

Epoch 1932 April 6.0 Greenwich Time; mean anomaly 0·45458°; arc from node to perihelion 25·24671°, node 171·13239°, inclination 11·93816°, eccentricity 0·4358886, mean daily motion 1329·6154″, semi-major-axis 1·9239201, period 974·718 days. It is pointed out that the period is to that of the earth as 8 to 3, so that 8 years bring about a recurrence of favourable conditions. Search ephemerides are given for the spring months of 1916 and 1924, in the hope that a re-examination of plates exposed then may disclose some images of the planet; these would be of great use in improving the orbit determination, and facilitating the recovery of the planet. Its motion when near the earth is so rapid that the long trails on plates might have been taken for those of meteors.

Since the least distance of this planet is only two thirds of that of Eros, it may be used for determining the solar parallax and the mass of the moon, as soon as its orbit is accurately known.

Measures of Double Stars at the Union Observatory, Johannesburg. Bulletin 241 of the Astronomical Institute of the Netherlands contains further instalments of the systematic survey of the southern heavens for double stars, which is being carried out by W. H. van den Bos with the 26-inch refractor at the Union Observatory. Accurate measures are given for 158 stars; a considerably longer list contains estimates of positions and magnitudes; in about half the stars of the first list the separation is less than 1″, and several are so small as 0·1″. In four cases, closer companions of previously known pairs have been detected. The primaries are nearly all in the Bonn or Cape Durchmusterung, their reference numbers in these being given.

Early Man in East Africa

To discuss the early human remains recently discovered by the East African Expedition of Dr. L. S. B. Leakey, the Royal Anthropological Institute convened a Conference on March 18 and 19 to examine the material which is now assembled in Cambridge. After hearing Dr. Leakey's exposition of his discoveries, and a general discussion of questions arising therefrom, the conference appointed committees to report respectively on the geological, palæontological, anatomical, and archæological evidence. The reports of these committees were submitted to the conference as follows :—

Geology

The Geological Committee has considered the problems placed before it from the point of view of the material available for examination and of the stratigraphical evidence. (*a*) Material : i. *Kanjera*. The Committee agreed that the fragments of skull picked up from the surface have the same source as those found *in situ*, their state of mineralisation being similar. ii. *Kanam*. So far as can be determined from the tests made, the mineralisation of the Kanam mandible seems to be the same as that of the rhinoceros bone found in the same deposit. (*b*) Stratigraphical. Of the geologists present on the Committee, two have seen the Kanjera deposits, although not with Dr. Leakey. Others have had experience of similar strata in East Africa, and the rest have brought to bear on the question their general experience of stratigraphical problems. From the evidence supplied by Dr. Leakey, the Committee can see no escape from the conclusion that the Kanjera skull fragments occur in the calcareous deposit which yielded the following fauna : *E. antiquus recki*, etc., as in the palæontological report below, and the implements of evolved Chellean type. Further, that the Kanam mandible was derived from the horizon which yielded implements of pebble-tool type only. This horizon also furnished the following fauna : two species of mastodon, two of primitive elephant, a species of deinotherium and a small variety of hippopotamus.

The Committee, after considering the character of the Kanjera deposit, does not believe that the fragments can have been introduced into the calcareous deposit at a later date, and feels clear that the two fragments said to be found *in situ* belong in fact to the original deposit. Also, those members of the Committee who have seen the deposits in question, support Dr. Leakey in his view that the Kanam and Kanjera deposits antedate a period of great local tilting and faulting and of volcanic activity.

Palæontology

The Committee on Palæontology reports that Kanam East and Kanam West exhibit differences only in the relative numbers of the fossils of different groups. With the human jaw at Kanam West were found close relatives of the two types of rhinoceros still living in the region, a small hippopotamus, a pig, an antelope, fragments of mastodon, two teeth of a very large deinotherium and remains of *Trionyx*. In Kanam East the collection consists chiefly of mastodon with a primitive elephant, deinotherium, and a few specimens of hippopotamus, rhinoceros, horse, and a young monkey.

The fossils from Kanjera have a later aspect. One elephant has dental plates as deep as those of *E. antiquus*, and all the remains of elephant are of Asiatic or European type. At least two antelopes, *Hylæochœrus*, *Phacochœrus*, and a large pig distinct from that of Kanam West, have a very modern appearance. A baboon is remarkable for its comparatively short face. One equine upper molar approaches *Hipparion*, if it does not actually belong to that genus. Typical *Equus* also occurs. Fragments of mastodon, rhinoceros, a giraffoid, hippopotamus, and a carnivore have also been found.

The Committee thinks that the Kanam deposit should be referred to the Lower Pleistocene, in which the deinotherium and mastodon are survivals from the Upper Pliocene. It also thinks that the Kanjera fauna cannot be later than the Middle Pleistocene.

Anatomy

The Anatomical Committee reports as follows :—

A. Kanjera No. 3.—(1) These specimens exhibit a condition consistent with great antiquity, and the Committee agrees to the correctness of associating all the fragments in question. (2) In the specimens submitted to them the Committee has observed no characteristics inconsistent with the reference to the type of *Homo sapiens*. (3) The absence of a frontal torus seems to exclude Kanjera No. 3 from association with Neanderthal types. (4) Pending further inquiry, the Committee is not able to cite examples of cranial vaults of the thickness characterising Kanjera No. 3 in non-pathological examples of the modern types of *Homo sapiens :* but it notes the occurrence in Piltdown (*Eoanthropus*) and the Boskop calvaria. (5) The Committee has noted the presence of a transverse occipital suture, which is rare in modern crania. (6) While reconstructions must be to some extent conjectural, yet those submitted agree in indicating a cranial length of 200–209 mm. (7) The Committee has observed no detail in the fragment of femur inconsistent with its inclusion in the type of *Homo sapiens*.

B. Kanjera No. 1.—(1) This specimen has been reconstructed by Dr. Leakey and Mr. McInnes from numerous fragments. The Committee accepts their association but is not able to exclude the possibility of some distortion of the actual specimen being manifested in the reconstruction. (2) The Committee sees no reason to distinguish between Kanjera No. 1 and No. 3, either in regard to the degree of mineralisation, or in regard to antiquity. (3) The Committee notes that Dr. Leakey's reconstruction and his placing of the two main pieces of the specimen provide a maximum length of 200 mm., and that the mid-sagittal contour is strongly suggestive of that which has been accepted by it as reasonably representative of Kanjera No. 3. (4) The Committee remarks that Kanjera No. 1 does not possess the great thickness seen in Kanjera No. 3, also that the transverse diameters seem to be less in No. 1 than in No. 3. (5) On the whole survey, the Committee is prepared to associate Kanjera No. 1 and No. 3 as possibly female (No. 1) and male (No. 3) representatives of the Kanjera type.

C. Kanam.—(1) The Committee, having examined the fragment of mandible, agrees that the appearance of this specimen is not inconsistent with the high antiquity assigned to it. (2) With the possible exceptions of the thickness of the symphysis, the conformation of the anterior internal surface, and what seems to be a large pulp-cavity of the first right molar tooth, the Committee is not able to point to any detail of the specimen that is incompatible with its inclusion in the type of the *Homo sapiens*. (3) In arriving at this conclusion the Committee has had regard to the conformation of the parts about the chin. It has noted that the incisor teeth show signs of crowding but has detected no indication of unusual size in the canine teeth.

Archæology

The Archæological Committee, after examining the material exhibited, submitted the following conclusions :—

At Oldoway, in a continuous stratified deposit, which should henceforth rank as a standard section, a worked pebble industry in Bed I is supplemented in the lower part of II by an early Chellean industry with *coup de poing* and rostroid forms : and the pebble types persist for a while. There are indications of continuity and of a gradually evolving technique between the pebble industry and the Chellean technique. In Bed III the 'later' or 'evolved' Chellean passes on into highly evolved Acheulean industry, which becomes fully evolved in Bed IV. Though scraper types, round butt hand-axes, and flake implements occur, they are not dominant at any point in the series.

At Kanam and Kanjera, stratified deposits include a similar series of industries, and therein the Kanam jaw is associated with the pebble industry, and the Kanjera skull fragments with Chellean implements corresponding with those of the upper part of Oldoway II.

The pebble industry of Oldoway I has no precise counterpart in western Europe, but is certainly anterior to the Early Chellean of Bed II. The Early Chellean culture of Bed II at Oldoway corresponds typologically with the industries of Early Pleistocene deposits in western Europe ; and the uppermost industries of Oldoway IV with those of the Thames valley gravels with Acheulean implements. The types from Zambezi gravels and other deposits in South Africa indicate comparable lapse of time.

There is no reason to doubt that the series from East Africa is of at least equal antiquity with the European, and it may even begin somewhat earlier.

The Conference, after detailed discussion of these reports, and of supplementary information furnished by Dr. Leakey and Mr. McInnes as to the circumstances of their discoveries, accepted the reports ; congratulated Dr. Leakey on the exceptional significance of his discoveries ; and expressed the hope that he may be enabled to undertake further researches, seeing that there is no field of archæological inquiry which offers greater prospects for the future. It especially urged the early organisation of another expedition.

The following were present and concurred in the above conclusions :—Sir Arthur Smith Woodward (chairman), A. L. Armstrong, H. Balfour, Miss D. M. A. Bate, P. G. H. Boswell, M. C. Burkitt, V. G. Childe, L. C. G. Clarke, W. L. H. Duckworth, H. J. Fleure, C. Forster Cooper, V. E. Fuchs, A. C. Haddon, A. T. Hopwood, O. T. Jones, Sir Albert Kitson, L. S. B. Leakey, D. McInnes, E. H. Minns, J. Reid Moir, J. L. Myres, T. G. Mollison, F. Oswald, K. S. Sandford, R. A. Smith, W. J. Sollas, J. D. Solomon, Miss M. L. Tildesley and D. M. S. Watson.

Utilisation of Coal

Mr. H. T. Tizard, rector of the Imperial College of Science and Technology, presided at a symposium on the utilisation of coal arranged by the British Science Guild and held at the Royal Institution on March 27. The large audience, which was representative of coal, coal-gas and oil interests, scientific and technical societies, trade unions and members of Parliament, was addressed by Capt. Bernard Acworth, Mr. Stephen Lacey, Eng. Rear-Admiral W. Scott-Hill, and Mr. A. C. Hardy, after which there was a discussion.

In his opening paper on the "Economic Significance of Coal", Capt. Acworth made special reference to legislative differentiation unfavourable to the expansion of the coal and coal-gas industries. He asserted that the chief consumers of oil fuel are heavily subsidised out of the public purse. The British taxpayer pays most of the cost of maintaining aircraft, passenger and goods traffic : the taxpayer has likewise had to pay £1,600,000,000 to make our roads fit for motor traffic, and part of this vast sum is an indirect subsidy to the oil companies as it is spent on oil residuals. In addition, certain public authorities have made compulsory the use of electricity for lighting and heating purposes in subsidised houses.

Although the demand for fuel has greatly increased during the past twenty years, the output of coal in Great Britain has decreased by 67,000,000 tons a year since 1913, this decrease indicating the extent by which imported oil has replaced coal. This replacement is represented over the period by an unfavourable trade balance of £960,000,000 ; and one million unemployed involving an annual public burden of £65,000,000. These facts, he urged, should be taken into account by our legislators in considering the relative costs and advantages of coal and oil as a fuel.

Mr. Stephen Lacey, who dealt with the "Development of the Use of Gas", claimed that the part played by the gas industry as an instrument in the efficient utilisation of coal is invariably under-rated. The carbonising process in gas and coke-oven works is the most efficient known means of converting coal into smokeless fuel and other convenient forms of heat. One ton of coal carbonised in a gas works will supply the same amount of useful heat as two tons of raw coal used either for direct heating or converted into electric energy, but at present only ten per cent of the total amount of coal used in Great Britain is carbonised in gas works as compared with twenty-five per cent of raw coal burnt for domestic purposes. This is indicative of the conservatism which has to be overcome, but progress is being made.

The use of gas for industrial undertakings is

increasing, more than half the output of some supply companies being thus utilised: and quite recently successful demonstrations have been made in the use of cylinders of compressed gas for mechanical road vehicles, which opens up a new field of enterprise for the gas industry, for gas possesses advantages over petrol, particularly in connexion with engine-starting and completeness of combustion. The present need is for industrialists to overcome their bias in favour of oil and to modernise their plants to enable them to take advantage of the greater heat efficiency and lower cost of carbonised coal and coal-gas.

In his paper on "Coal for Sea Transport", Rear-Admiral Scott-Hill expressed the view that the use of coal for sea transport must be determined by various factors, only one of which is the actual cost per heat unit of coal as compared with oil. The material we import is greater in bulk than that which we export, and therefore a double economy is effected if our ships carry a home-produced fuel as a source of heat or 'bunkers'. This was the factor which led to the supremacy of the British mercantile marine in the nineteenth century, but it was accompanied by standardisation of ship machinery and a reluctance to apply the results of modern science by designers of ship engines. Consequently the first oil-fired ships worked at an advantage over the stoker-fed coal-burning ships, in addition to which the use of oil makes it possible to reduce greatly the number of firemen, it is clean and its 'bunkering' can be carried out more rapidly and without interfering with other work in and about the ship—great advantages for passenger ships and the Navy. For example, at full-speed a first-class battleship would need 600 stokers if raw coal were used against 200 required for an oil-burning ship. Nevertheless, if modern methods of feeding furnaces are adopted by coal-burning ships, if fuller advantage is taken of pulverised coal or mixed fuels, and if the Government encourages the better utilisation of coal, there is still a future for the use of coal in sea transport.

Mr. A. C. Hardy claimed that, if the wish of the back-to-coal enthusiasts were realised, the British mercantile marine would probably be swept out of economic existence by sheer weight of the operating superiority of its rivals. The inference to be drawn from the great increase in oil-burning and motor ships must be that they have advantages for certain purposes over coal-burning ships. Since 1914, the world tonnage of oil ships has grown from $1\frac{1}{2}$ million tons to nearly $20\frac{1}{2}$ million tons: the motor ships from $\frac{1}{4}$ million to 10 million tons. In the past ten years, however, in spite of the fact that the tonnage of oil ships has doubled, that of coal-burning ships has decreased from $45\frac{1}{2}$ million to 40 million tons.

In any event, the ultimate criterion must be the reduction of fuel cost, to which problem both marine coal-steam and marine oil-steam designers are applying themselves with assiduity and success: both of these have also to reckon with the fuel figure of the marine Diesel designers. Coal consumption per horse-power hour has now been reduced to 1 lb. as compared with the best oil-steam figure of about 0·6 lb. and the best Diesel figure of 0·35 lb. Oil now possesses the advantage that oil-filling stations are more numerous than coaling stations, in addition to the advantages over coal of cleanliness in use, quickness of 'bunkering', ease of stowage, small amount used, lower labour costs on board, and the smaller space occupied by oil-using plant. The real question, he suggested, is whether or not Great Britain is justified in creating a handicap against oil in favour of coal. This, he asserted, can only be done at great expense to the taxpayer and to the ultimate disadvantage of our mercantile marine.

In opening the discussion, Dr. E. F. Armstrong suggested that colliery owners on one hand and the Government on the other must be held partly responsible for the replacement of coal by coal-gas, electricity and oil as a heat source: the former by their tardy recognition of the need for modern methods of coal-getting, the cleaning and classification of coal, care in transport, and their acquiescence in wasteful and obsolete methods of distribution of coal for domestic use: the latter by the adoption of the quota system. Another factor in the decline in the use of coal is the attitude of the coal producers towards their natural allies, the gas and electricity supply companies, both of which are charged excessive prices for coal and both of which in turn add to their own costs a disproportionate and unnecessary burden of advertising charges. Finally, he suggested that Capt. Acworth's plea for a back-to-coal movement would be more effective if he supported instead of attacking expenditure on those researches directed towards obtaining oil from coal, including hydrogenation of coal.

Major F. A. Freeth added that if the coal producers had spent only a small fraction of what Imperial Chemical Industries Ltd. had spent on research and organisation they would not be in their present wretched plight.

Mr. H. Pirie, who followed, said that the coal industry has now realised the need for action on the lines suggested by Dr. Armstrong and Major Freeth. The Coal Utilisation Council which he represented was formed for the purpose of promoting the sale of coal, to which end an intensive propaganda campaign is to be launched. An information bureau has been set up from which both producers and consumers can obtain advice and information, including assistance on technical and scientific matters.

Admiral Willmott-Nicholson expressed his sympathy with the views of Capt. Acworth and laid stress on the strategic importance of Great Britain being independent of imports of fuel in the event of war. Among others who contributed to the discussion were Dr. Ormandy, Mr. Hamilton Gibson and Mr. Zulver.

In summing up, Mr. Tizard warned his audience against falling into the error of associating too closely our increasing imports of oil with the decrease in the use of coal and with unemployment among the mining population. The fact that less coal is now used for domestic consumption is obviously not unconnected with increased efficiency in its use, and taking a long view, this is an advantage to the nation. It is a melancholy reflection that whereas ten years ago our economists and politicians attributed our industrial stagnation to the failure of industrialists to apply science to their undertakings, they now attribute our economic depression to the success with which science has been applied in industry. The fact is that our industrial supremacy during the greater part of the nineteenth century was due to the skill and assiduity with which we applied science and invention to then existing conditions. It is useless to bemoan changed conditions: our task is still to apply our best scientific brains to the world as it is to-day.

University and Educational Intelligence

CAMBRIDGE.—Appointments to three University lectureships in mathematics will be made in the Easter term, to take effect from October 1. The initial basic stipend of a University lecturer is £200 a year but the General Board may grant an additional allowance of £150 a year to a lecturer who is not a fellow of a College and may also grant a number of years seniority carrying with it an increased basic stipend. Candidates are requested to send their names with any evidence of qualification to Mr. M. H. A. Newman, secretary to the Faculty Board of Mathematics, St. John's College, Cambridge, on or before May 6.

The subject proposed for the Adams prize for the period 1933–34 is "The Mathematical Representation of Unsteady Flow in Fluids". Recent experimental researches on fluid flow close to a solid surface have revealed new facts of which no mathematical treatment has yet been given. Other aspects of the subject that might be studied include the stability of the flow of viscous fluids, the statistical treatment of turbulence and the conditions behind a body moving in a fluid. Each essay should be accompanied by a full and careful abstract, pointing out the parts which the author considers to be new and indicating the parts which are regarded as of more importance than the rest. The prize is open to the competition of all persons who have at any time been admitted to a degree in the University. The essays must be sent to the Registrary on or before December 31. The value of the prize is about £268 ; the value may be increased when it seems desirable to the adjudicators, on occasions when the prize is divided.

LONDON.—The following appointments have recently been made: chair of civil engineering (Imperial College—City and Guilds College), Prof. A. J. S. Pippard, since 1928 professor of civil engineering in the University of Bristol ; chair of physics (Birkbeck College), Mr. P. M. S. Blackett, since 1930 a University lecturer at the University of Cambridge ; readership in physiology (Guy's Hospital Medical School), Mr. W. R. Spurrell, since 1931 demonstrator of physiology in the University of Leeds ; Cassel lecturer in commerce (London School of Economics), Dr. Vera Anstey, since 1929 lecturer in commerce at the London School of Economics.

ST. ANDREWS.—The Senatus has resolved to confer the honorary degree of LL.D. at the graduation ceremony on June 30 upon the following : The Right Honourable Mabell-Frances-Elizabeth, Dowager Countess of Airlie, Airlie Castle, Kirriemuir ; Mr. W. St. C. Baddeley, Castle Hale, Painswick, Gloucestershire (antiquarian and archæologist) ; Dr. R. W. Chapman, secretary to the Delegates of the Oxford University Press ; The Right Honourable Viscount Chelmsford, formerly Viceroy of India, Warden of All Souls College, Oxford ; Prof. Carl Neuberg, director of the Kaiser Wilhelm Institut für Biochemie, Berlin, and editor of the *Biochemische Zeitschrift* ; Mr. R. S. Pearson, director of the Forest Products Research Laboratory, Princes Risborough ; Mr. Evelyn C. Shaw, secretary to the Royal Commissioners for the Exhibition of 1851, and honorary general secretary of the British School at Rome.

DOCTORATES conferred in the sciences in American universities have increased steadily in number from 330 in 1919–20 to 1241 in 1931–32. The titles of the theses are published annually in the "Reprint and Circular" series of the National Research Council together with tables of comparative statistics for ten years. The tables show that last year the maximum numbers of doctorates conferred in previous years were exceeded or equalled in chemistry (420), zoology (127), physics (113), mathematics (75), bacteriology (46), pathology (43), physiology (46) and anatomy (16). Psychology (104) takes fourth place in the list of subjects, botany (79) fifth and engineering (47) seventh.

HIGHER education in Sweden is known in Great Britain chiefly by its fruits, the character of which argues excellence in the institutions in which it is conducted. A convenient summary account of those institutions has been published by the United States Government Printing Office as Pamphlet No. 32 of 1932 (10 cents). The author, who is the specialist for western Europe in the Foreign School Systems Division of the Federal Office of Education, has attempted to give such particulars as will enable university registrars to estimate the value of academic credentials of Swedish-trained students and has therefore described the various curricula and examination systems in use, both in the secondary schools and in the four universities and some sixteen other (specialist) institutions of university grade. The important reorganisation of the Swedish national scheme of education described some time ago in the Board of Education's Pamphlet No. 81 (H.M. Stationery Office, 1930) is still proceeding. Another useful pamphlet (No. 29 ; 1932) issued from the Foreign School Systems division of the Office of Education is a summary of official certificates, diplomas and degrees granted in France. This includes a graph exhibiting the successive stages of primary, secondary and university instruction.

How schools have been affected by the prevailing economic depression is told in the December issue of *School Life*, the organ of the United States Office of Education. Thanks to the traditional esteem which education enjoys in the United States, school budgets were scarcely affected during the first year of the depression, but they have now begun to feel the pinch of hard times, especially those of the rural schools in which there was but little provision for expenditure on more than the bare necessities. In school budgets of cities with populations of more than 100,000, the effect of the all-pervading financial stringency is seen chiefly in the reduction in the current year by nearly forty per cent in provision for capital outlay, but in most of the States outside the New England group and California, far more drastic curtailments have taken place in rural school budgets. These have involved such measures as the adoption of a shorter term, elimination of some of the school services and even the closing of schools. In one State, 26 schools were closed for want of funds for their maintenance ; in another the closing of schools in 25 counties is expected to throw five thousand teachers out of employment and the average salary paid to elementary teachers was reduced by twelve per cent without counting reductions entailed by shortening the school term ; some counties have dismissed one out of every three teachers.

Calendar of Nature Topics

April Showers

In England, April is proverbially showery. It is the spring month *par excellence*, in which the air is still cool but the sun is already fairly strong. The worst storms of winter are past, and moderate breezes prevail, but the land surface is much warmer than the sea, and the air which crosses our coasts is warmed rapidly by contact with the ground. On a typical April day ascending currents are formed, giving rise to detached cumulus clouds from which showers may fall, but the clouds rarely coalesce to form cumulo-nimbus, for the amount of moisture in the air is insufficient for the development of the more severe thunderstorms which occur under similar conditions in summer. Sometimes in April, showers may be seen to fall from a cloud but evaporate before reaching the ground.

Tornadoes in the United States

April 7.—Tornadoes are violent whirls of air of small diameter; in the United States they are most frequent and most destructive over the great lowlands of the central and upper Mississippi and lower Missouri valleys, where they sometimes cause considerable loss of life. They may occur in any month and at almost any hour, but are most frequent in the afternoons of spring and early summer. Most tornadoes form in the current of warm moist air which blows from the south in front of a cyclonic depression advancing across the continent from the west. Above this warm southerly wind there is often a cool wind from the north, giving an unstable distribution of the air layers. When, in addition, the ground is heated by sunshine, conditions become very favourable for the occurrence of violent readjustments, which are generally associated with severe thunderstorms and in extreme cases take the form of tornadoes.

Immigration of Summer Visiting Birds

An occasional early bird arrives in Britain in February; the chiffchaff, ring-ouzel, wheat-ear, swallow, sand-martin, and garganey duck are all credited with dates in the latter part of the month, although mid-March is their usual time of arrival. Generally speaking, the tide of normal immigration begins with first arrivals in the second week of March, led by the ring-ouzel and the wheat-ear, and in all about fourteen species of summer visitors have put in an appearance before the month is over. But April is the great month of first arrivals and in the third week of the month the greatest number of species appears, about twelve out of the month's total of thirty. The advance guards are followed within a few days by the general immigration of the species, but often a month or more may elapse before the general movement is completed. Amongst the laggards in reaching their breeding haunts in Britain are the red-necked phalarope, which nests in a few localities in Scotland, where it arrives in the third week of May from its winter haunts in the seas of south-western Europe; and the marsh-warbler, which seldom reaches its nesting sites in the southern counties of England until the early days of June.

The mass arrival of the summer visitors amongst birds is associated with the increase of temperature, for it is in April that the great spring change takes place, and the winter type of temperature distribution, in which inland temperatures are relatively low compared with coastal temperatures, is replaced by the summer distribution of high inland and low coastal temperatures, which continues until the autumn.

Order of the Coming of Summer Visitors

When Dr. Eagle Clarke summarised the vast mass of data on migration accumulated for the British Association Committee of 1896, he found that the great majority of British summer birds appeared on the west coast of England some days in advance of their arrival in their eastern haunts. These observations have been amply confirmed, and it has been found, as Dr. Clarke also has pointed out, that the same rule applies to Scotland, where the Solway and Clyde areas receive their first spring migrants some days earlier than the areas of Tweed and Forth. The records and maps of spring migrant isophenes (or lines of equal arrival dates) published in recent years in the Phenological Report of the Royal Meteorological Society, make still more striking the order of the arrival of the summer birds. From south to north the progress is remarkably steady each year. Within a week of the first arrivals in Kent, the birds are at the Humber, three days later they have reached the Tweed, and in approximately three more days they appear in the neighbourhood of Aberdeen.

Another fact, often referred to, is the regularity with which the individuals of a species arrive at the same place year after year, a testimony to the stability of the seasonal impulse of migration the more striking when the enormous distances traversed between the points of setting out and of arrival are kept in mind. A recent example may be quoted from a paper by Witmer Stone in the Year Book of the Academy of Natural Sciences of Philadelphia for 1931 (1932). For many years the Delaware Valley Ornithological Club has recorded the time of arrival of birds at various places within ten miles of Philadelphia; two examples of their records will illustrate the point—in eight consecutive years the wood-thrush has arrived on April 28, May 2, April 30, April 28, April 29, May 1, April 26 and May 1; and the black-and-white warbler on April 27, 26, 25, 27, 27, 27, 25 and 27. Both birds are easily recognisable, one by its song the other by its coloration, so that there is little chance of either being overlooked or mistaken for another species.

The 'March Brown' of the Angler

The 'March brown', now appearing in great quantity in a number of rivers, is widely distributed in Britain. Well known to the angler for more than a century by its common name of 'March brown' and by other names since the middle of the seventeenth century, it is extremely probable that the 'March brown' is referred to in a well-known description in the "Boke of St. Albans" (1496). It is curious that such a familiar insect should so long have remained unknown to the entomologist, and only recently have found its rightful place in the list of British Ephemeroptera. Eaton (1883) identified it with *Ecdyurus venosus*, an ephemerid different in habits, appearing from mid-May to October, the subimago of which closely resembles the March brown. Moseley (*Ann. Mag. Nat. Hist.*, Jan., 1932) showed the 'March brown' of the early spring months to be *Rhithrogena haarupi*, Esb.-Peters., an insect first described from Denmark (Esben-Petersen, 1909).

Societies and Academies

London

Royal Society, March 23. G. I. Finch and A. G. Quarrell: The structure of magnesium, zinc and aluminium films. An electron diffraction camera is described in which the specimen is swept by a diffuse beam of electrons, thereby reducing the risk of injury to the specimen. The beam is then focused electromagnetically. Oxide-free surfaces of magnesium, zinc, and aluminium on a platinum substrate, also vapours of these metals in transit between source and receiver, were obtained and examined by electron diffraction. The oxides of magnesium and zinc formed on the corresponding metal surfaces have also been examined. It is concluded from the results that (1) the abnormal crystal structures are caused by pseudomorphic strain effects whereby the substrate influences the positions taken up by the atoms of the metal or metal oxide layers formed thereon; (2) such pseudomorphic effects are no longer evident at the surface of sufficiently thick films; (3) for aluminium the pseudomorphic strain effects are confined to the two dimensions of the basal planes, because no such effect was to be observed in the third dimension; (4) magnesium, zinc and aluminium vapours are monatomic. E. C. Pollard: Experiments on the protons produced in the artificial disintegration of the nitrogen nucleus. Experiments to determine the manner of entry of the α-particle into the nitrogen nucleus have been made; these indicate that entry is in general over the top of the barrier, and the height of this barrier is fixed as between $4{\cdot}1 \times 10^6$ and $4{\cdot}4 \times 10^6$ electron volts. Further investigation of the absorption curve of the protons confirms the work of Steudel on this element and gives an indication of a second group, which can be ascribed to resonance entry of an α-particle of $3{\cdot}5 \times 10^6$ electron volts energy.

Geological Society, Jan. 11. C. S. Hitchen: The Skiddaw granite and its residual products. The Skiddaw granite occurs as three isolated, though neighbouring exposures of limited size in the fell country to the north-east of Keswick in the English Lake District. The most southerly exposure occurs at Sinen Gill. It is of the nature of a small apophysis and consists of a porphyritic oligoclase-biotite-granite corresponding to a sub-acid alkali-lime type. The granite of this exposure appears to represent a deep-seated term in the Skiddaw suite. The central and largest exposure occupies an area of about half a square mile and is situated in the valley of the River Caldew. It consists of an albite-muscovite-biotite-granite of a more normal alkali (soda-potash) type, the porphyritic character being less distinct than that of the Sinen Gill rock. The northern exposure at Grainsgill is approximately one-eighth of a square mile in area and appears to be a large apophysis. It consists partly of normal granite and partly of a quartz-mica rock or greisen. It is concluded that the greisen was not formed by the consolidation of mother-liquor extruded from the crystallising magma by crustal disturbances, as was formerly supposed, but that it represents normal granite which has undergone alteration by paulopost hydrothermal solutions. L. G. Anniss: The Upper Devonian rocks of the Chudleigh area, South Devon. The Devonian rocks occur as a number of small, scattered inliers in a region mainly occupied by Lower Culm Measures. The outcrops of Massive Limestone are described, and the Upper Frasnian and the Famennian have been zoned by the cephalopod and other faunas. The Dunscombe beds represent the Manticoceras stage and the base of the Cheiloceras stage (zones 1α to 2α of Wedekind), the Lævigites Limestone and shales represent the Lævigites stage (zone 5), and the Entomis Shales are equivalent to the Gattendorfia stage (zone 6). The succession is not complete, there being a non-sequence between the base of the Cheiloceras stage and the Lævigites stage. The region has been subjected to three distinct earth-movements.

Paris

Academy of Sciences, Feb. 13 (*C.R.*, **196**, 449–512). J. Costantin: Historical résumé concerning conceptions on the degenerescence of cultivated plants. E. Mathias: Contribution to the study of fulminating material. The evaluation of the constant ratio which exists between the final volume and the initial volume in the progressive decomposition at atmospheric pressure when the final temperature is identical with the initial temperature. W. Slebodzinski: The complexes of geodesics in a variety V_3. Alfred Rosenblatt: The theorems of M. Picard in the theory of non-linear partial differential equations of the elliptic type. Paul Lévy: The absolute convergence of Fourier's series. E. Kogbetliantz: The determination of the step $D(x_0)$ of $f(x)$. E. Crausse and J. Baubiac: A modification of the chronophotographic method and some applications. Results obtained by the cinematographic method described were compared with those given by two other experimental methods, hot wire and stroboscopic, and also with the theoretical curve obtained by Szymanski. R. Bossuet: The photographic sensibility of the lines of the alkaline metals in the oxyacetylene flame. Rods of magnesium pyrophosphate were impregnated with the solutions examined at increasing dilutions. Two forms of spectrograph were employed (Féry, Bourguel) and data are given for the limiting sensibilities with lithium, sodium, potassium, rubidium and cæsium. G. Déjardin and R. Latarjet: The spectral sensibility of photoelectric cathodes coated with a cæsium oxide film. Details of the method of preparing the coating and curves of emission as a function of the wave-length. Mlle. Quintin: Study of the electromotive force of the chain: copper, copper sulphate, mercurous sulphate, mercury, at 25° C. The experimental values, used to determine the normal potential E_0 by Lewis's method, do not give a satisfactory extrapolation. René Audubert: The differentiation of the electronic effects and the photoelectric effects in photovoltaic elements. The study of the photovoltaic effects for several frequencies allows, by suitable choice of electrolytes, of distinguishing in the action of light on the electrodes the photoelectrochemical effect from a secondary internal electronic effect. H. Muraour and G. Aunis: The laws of combustion of mixtures of (gun-cotton) powders. F. Bourion and Mlle. O. Hun: The cryoscopy of paraldehyde, acetone and ether in solutions of magnesium and ammonium sulphates. René Dufour: The initial electrolytic overvoltage in the disengagement of hydrogen on mercury. The study of the electrolytic overvoltage of mercury, placed under conditions of reversible equilibrium, appears to lead to the result that the initial overvoltage is nil. Jean Bouchard: The quantitative

study of the inhibiting action of some ions on the fluorescent power of uranine. R. RAMBAUD : Trans γ-oxycrotonic acid. The trans form has been obtained by the complete saponification of ethyl acetoxycrotonate by warm aqueous potash solution. It is stable and does not give a lactone on dehydration. G. DARZENS and MAXENCE MEYER : A new general method for the synthesis of aldehydes. The halogen compound RX is treated with the sodium derivative of ethoxymalonic ester, the latter being readily prepared by the method of Wislicenus, followed by saponification, distillation in a vacuum giving the ester $RCH(OC_2H_5)(CO_2H)$. From the latter the aldehyde RCHO is readily obtained by the method already described by Darzens and Lévy. Examples of the generality of the proposed method are given. D. IVANOFF and I. ABDOULOFF : The velocity of disengagement of hydrocarbons produced by the action of indene on fatty organomagnesium derivatives. A method of measuring the strength of linkage of alkyl radicals with the magnesyl group. L. BERTHOIS : The study of contact metamorphism with the aid of heavy minerals. The method proposed has some advantages over the usual method of thin sections owing to the larger quantities used. P. FALLOT : The Xauen massif (Spanish Rif). L. JOLEAUD and J. LOMBARD : Quaternary mammals of Ounianga Kebir (South-eastern Tibesti). MARCEL CHOPIN : The influence of the medium on the baking value of bread. EMILE F. TERROINE, P. MEZINCESCO and MLLE. SIMONE VALLA : Utilisation of sulphur and nitrogen from cystine at the level of endogenous protein metabolism. The addition of cystine to the diet proves that there is no necessary parallelism, in all circumstances, between the metabolism of nitrogen and that of sulphur. The facts cited lend fresh support to the view according to which the protein needs of the organism should be divided into many fractions to a great extent independent. O. V. AMANN and MLLE. GILBERTE MOUROT : The comparative excretion of neutral sulphur in endogenous and exogenous nitrogen metabolisms and its signification. MME. ANDRÉE DRILHON : Glucose and shedding the shell of crustaceans. At the time the shell is being changed there is a marked increase in the proportion of glucose in the blood. J. LAIGRET : The sensibility of certain wild mice to the virus of yellow fever.

GENEVA

Society of Physics and Natural History, Feb. 2. W. SCHOPFER : Biometric researches on the spores of *Mucor*. The measurements carried out on thirteen pairs of strains of *Phycomyces blackesleanus* genetically related between themselves showed that the dimensional characters of the spores (length, coefficient of variability) are not connected with sex. E. FRIEDHEIM : The biological signification of melanogenesis. The biological signification of melanogenesis is not only in its final product, melanine, but also in an intermediate product, the 'red body', which is a reversible oxidation-reduction system in the thermodynamical sense and functions as a catalyst in cell respiration. P. ROSSIER : The influence of the absolute magnitude of a star on the width of the lines of stellar hydrogen. The relative widths of the lines are independent of the absolute magnitude, whilst the total width of the three lines $H\gamma$, H_δ, and $H + H_\varepsilon$ increases with the absolute magnitude. G. TIERCY : Note on the respective phases of ionisation maxima and light maxima in a Cepheid. By the combination of the light curve and the curve of radial velocities (or that of pulsation) the present note tends to justify the view that the phase of maximum ionisation (youngest spectrum) precedes the maximum of light. WAKKER : Gold-bearing strata of the region of St.-Yrieix (Haute-Vienne). The author describes the deposits as well as the geology of the region and suggests an explanation of their genesis. He studies in detail the Fagassière deposits, those of Tournerie and Ladignac, which are constituted of mineralised quartz veins traversing a granite-gneiss complex.

ROME

Royal National Academy of the Lincei, Nov. 20. U. CISOTTI : Translo-circulatory plane current investing an indefinite rectilinear rod : dynamic actions. A. BEMPORAD : Proper motions and orbital motions resulting from the Astrographic Catalogue of Catania. E. ALMANSI : The deformations of elastic plates (1). GIUSEPPINA BIGGIOGERO : Geometric views on tensors. Certain questions of tensorial calculation are considered with the help of hyperspacial geometry. R. CACCIOPPOLI : A principle of inversion for functional correspondences and its applications to equations with partial derivatives (2). B. FINZI : Group velocity for waves associated with phenomena. M. KOURENSKY : Integration of equations to the partial derivatives of the second order with two functions of two independent variables. (2) Systems containing five derivatives of the second order. U. BARBIERI : Astronomical-geodetic station at the trigonometrical apex of the first order of Mount Crea in July 1930. Results are given of determinations of azimuth, longitude, etc. R. ZOJA : Distribution of the tensions in a solid with a rectilinear axis and a rectangular transverse section (4). A particular case is considered in the light of the solutions previously obtained. C. ANTONIANI : Investigations in the phytosterol group. (2) The sterols of rice husk. A laevo-rotatory sterol, $C_{27}H_{46}O$, melting at 143°, has been isolated from rice husk. The sterol fractions described by Anderson and Nebenhauer (1926) as phytosterol *B*, *C*, and *D* are not definite compounds, but mixtures of the sterol now described with the corresponding dihydro-derivative. A. BARONI : Protoselenosulphochloride. This compound, $SeSCl_2$, obtained by the action of selenium on sulphur monochloride, is a deep-red liquid, boiling at 60°–62° under 20 mm. pressure. It exerts a very rapid vulcanising action on rubber and with colza oil or with carbon disulphide and castor oil it causes instantaneous coagulation. Its action on piperidine results in the formation of monothiopiperidine and the separation of selenium ; hence its formula is probably $Se : S : Cl_2$. NICOLETTA SABATUCCI : The toxic action and elimination of nicotine. (1) Toxic action of nicotine and oxynicotine. For a frog weighing 20 gm., the minimum toxic dose of nicotine capable of producing complete paralysis, followed by recovery after a few hours, is 1·2 mgm., and the minimal lethal dose 3 mgm. The lower toxity of oxynicotine, for which the minimal lethal dose is 15 mgm., shows that the toxic action of nicotine depends, at least partly, on the chemical function blocked by the oxygen. (2) Elimination and cutaneous absorption of nicotine and caffeine. If, after administration of nicotine by subcutaneous injection, a frog is immediately placed in 200 c.c. of water, the minimum lethal dose falls, from 3 mgm. with non-immersion, to 1·5 mgm. If,

however, the alkaloid is introduced into 200 c.c. of water, the minimum lethal dose is 3 mgm. Similar results are shown with caffeine. The frog evidently manifests a special affinity for the two alkaloids. M. Mitolo: Avitaminosis and intoxication. (2) Experimental scurvy and chemical intoxication by metals and metalloids. Ingestion, by a guinea-pig suffering from avitaminosis-C, of mixtures of salts of metals and metalloids in doses non-toxic to normal animals, enhances and accelerates the effect of the food-deficiency.

Forthcoming Events

Saturday, April 1

Royal Institution, at 3.—Developments in Cinematography: A Display of Films, (3) Films in Relation to Aeronautical Research.

Monday, April 3

Royal Geographical Society, at 8.30.—Rev. W. H. Murray Walton: "Among the Mountains and Head-Hunters of Formosa".

Tuesday, April 4

Royal Agricultural College, Cirencester.—Conference on: "The Breeding of Dairy Cattle".

Thursday, April 6

Chemical Society, at 8.—Commemoration of the Bicentenary of Priestley. Papers by Prof. A. N. Meldrum, Sir Philip Hartog and Sir Harold Hartley.

Saturday, April 8

Gilbert White Fellowship, at 2.30—(Annual General Meeting in the Hall of the Art-Worker's Guild, 6, Queen Square, W.C.1).—At 3, Sir John Russell: "Modern Trends in Agricultural Science".

Institution of Naval Architects, April 5–7.—(in the Lecture Hall of the Royal Society of Arts, John Street, Adelphi, W.C.2).—Annual Meeting.

Official Publications Received

Great Britain and Ireland

The Science Masters' Association. Report for 1932, with List of Members (correct to January 1, 1933), Statement of Accounts and Report of Business Meeting. Pp. 96. (Eton College.)

Liverpool Observatory and Tidal Institute. Annual Report 1932. Pp. 15. (Liverpool.)

Linen Industry Research Association. Report of the Thirteenth Annual General Meeting, December 12, 1932. Pp. 14. (Lambeg.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 6 (New Series), No. 1, January. Abstracts Nos. 1–193. Pp. 36. (London: H.M. Stationery Office.) 1*s.* 6*d.* net.

London School of Hygiene and Tropical Medicine. Hand-List of Periodicals in the Library. Second edition. Pp. 44. (London.) 1*s.* 3*d.*

Proceedings of the Royal Society. Series A, Vol. 139, No. A839, March 3. Pp. 475–730. (London: Harrison and Sons, Ltd.) 12*s.*

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 72, No. 435, March. Pp. 189–268+xvi. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

University of Bristol. Annual Report of Council to Court, Session 1931–32. Pp. 45. (Bristol.)

The British Mycological Society. Transactions. Edited by J. Ramsbottom, B. F. Barnes and H. Wormald. Vol. 17, Part 4, 18 March. Pp. 237–371. (London: Cambridge University Press.) 7*s.* 6*d.*

Proceedings of the Society for Psychical Research. Part 129, Vol. 41, March. Pp. 121–138+8 plates. (London.) 3*s.*

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board for the Year ended 30th June, 1932; with Report of the Director of Water Pollution Research. Pp. iii+55. (London: H.M. Stationery Office.) 1*s.* net.

Proceedings of the Royal Irish Academy. Vol. 41, Section B, No. 9: Colonization of a Disused Millpond at Hillsborough, Co. Down. By R. H. Common and H. Cairns. Pp. 146–154. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s.*

Annotated Account of Fungi received at the Imperial Mycological Institute. List 2 (Fascicle 2.) By E. W. Mason. Pp. 67. (Kew.) 5*s.* net.

East African Agricultural Research Station, Amani. Fourth Annual Report, 1931–32. (Colonial No. 78.) Pp. 43. (London: H.M. Stationery Office.) 1*s.* net.

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