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Science in Civilisation.

A STIRRING appeal on behalf of "International Thought" is put forward by Mr. John Galsworthy in a pamphlet just published with that title (Cambridge: W. Heffer and Sons, Ltd. Price 6*d.* net); and in it representatives of science, finance, and the Press are urged to combine to save the civilised world from self-destruction. The most potent director of this triumvirate is held to be science, which has placed in the hands of mankind powers with which it is not fit to be entrusted, as the ethical or moral sense has not kept pace with this development of knowledge. "We have made by our science," says Mr. Galsworthy, "a monster that will devour us yet, unless by exchanging international thought we can create a general opinion against the new powers of destruction so strong and so unanimous that no nation will care to face the force which underlies it."

Mr. Galsworthy is not alone in associating science chiefly with agencies of death and destruction, and in pleading for a curb to be placed upon its powers. It is, indeed, common to regard science as a disturbing influence in human affairs, and to sigh for the simple life away from the restless spirit of inquiry into all things visible and invisible in the universe. It is, however, as futile to rail against the progress of science, or to attempt to prevent it, as to use Mrs. Partington's mop to keep back the rising flood of the Atlantic. Knowledge will grow from more to more whatever the attitude of the public may be towards it. During the last fifty years there have been more scientific discoveries and applications than in the whole previous history of the human race; and we may be on the threshold of developments by which forces will be unloosed, and powers acquired, beyond what have hitherto been known to man. Whether these shall be used to promote social well-being and international amity is not a question for science, but for the public and its leaders. While nations look to war as the ultimate means of deciding disputes, they will seek to possess themselves of the most powerful means of imposing their wills upon others. As Prof. Soddy recently remarked, should it be possible ever to release the great store of energy in the atom, the first use that would be made of it would be to construct a new bomb.

It is only by such an international understanding as is suggested by Mr. Galsworthy that this misuse of scientific discovery can be avoided, yet, in spite of the existence of the League of Nations, the signs of the times are not very favourable towards the unity of mankind. Science itself is international, and the results of research are free to all for any purpose. In the hundreds of scientific papers published weekly in the

world, there is scarcely one deliberately concerned with providing any fighting service with more effective means of destruction, and not one scientific worker in a hundred sets himself intentionally to make such a discovery or invention. It is just as impracticable, however, to prevent the wrong use of scientific powers by individuals as it is to prevent literary people from the misuse of their genius for purposes of gain. The facts of science are as free as the words of our language, and in both cases they may be used for the uplifting of mankind or for its degradation.

The truth is, as Mr. Baldwin remarked in his speech at the Guildhall on November 10, the present troubles in the world are largely owing to the fact that while men have learned to control forces of Nature they have not learned to acquire control of themselves. He urged that more pains should be taken to apply the methods of science to human problems, and by that he obviously meant not the development of poison gases and high explosives, but the principle of facing facts honestly and fearlessly, and basing just conclusions upon them. The methods of science should be the methods applied to social problems if sound principles of progress are to be determined. The Labour Party's recent manifesto says nothing of what science has done or may do to improve the world in this way, but asks, "Can the method of science be applied to nothing save the organisation of men for war and their equipment with instruments of destruction?" We have here a paraphrase of Ruskin's assertion that "The advance of science cannot be otherwise recorded than by the invention of instruments to kill and put down noble life"—a view in which distorted vision is combined with the sin of ingratitude.

Modern civilisation is built upon science, and almost all industrial developments had their origin in principles or substances discussed in scientific laboratories by investigators working purely for the advancement of natural knowledge. The principle that a moving magnet can create a current of electricity in a coil of wire near it, discovered by Faraday nearly a century ago, led to the construction of the dynamo, and was the seed from which the great industry of electrical engineering has grown. It is estimated that this industry now represents a capital of more than one thousand million pounds, and it could not have existed without the discovery by Faraday of the fundamental principle of all electro-magnetic machinery. All the pure copper required for this machinery and electrical purposes generally is produced by electrolysis, and here again the principles used were discovered during scientific investigations by Davy and Faraday. Aluminium—that most useful metal, which is destined to compete with iron and steel in its importance—is now manufactured exclusively by electrolysis of a fused mineral containing it.

The electric furnace was first used by the French chemist, Moissan, in scientific research; and now it is employed for the production of hundreds of thousands of tons of steel annually. Calcium carbide, used so extensively in the production of acetylene gas for house lighting and motor lamps, and for oxy-acetylene welding, is entirely manufactured by heating lime and coke together in an electric furnace. The discovery of X-rays was an incidental result of researches into the nature of electricity, and the existence of electric waves, which led to wireless telegraphy and telephony, was first proved in a laboratory. Long before the thermionic valve had made the wonderful achievement of broadcasting possible, the effect upon which it is based was the subject of scientific investigation, and studies of the emission of electrons disclosed the principle upon which it depends.

Nearly a century and a half ago it was shown by Priestley and Cavendish that, when electric sparks are passed through air, some of the nitrogen and oxygen combine to form oxides from which nitric acid or nitrates may be afterwards obtained. This is the principle of the process by which hundreds of thousands of tons of nitrates are now produced annually in Norway for use as agricultural fertilisers in the place of saltpetre from Chile. The process needs, however, a supply of cheap electric power to make it commercially profitable.

When Germany was cut off from natural supplies of nitrates during the War, she had to obtain what she wanted from the nitrogen in the air, and was so successful that more than a million tons were produced in 1918. The method used was based upon the principle of catalysis, whereby chemical combination is promoted by the presence of small quantities of particular elements, which thus act as matrimonial agents. Nitrogen and hydrogen were passed under pressure over finely divided iron, and a certain amount of the two gases combines under these conditions to form ammonia, which, by being passed with oxygen through tubes containing another catalytic agent, may be converted into nitric acid. The hydrogen required for combination with atmospheric nitrogen is obtained by electrolysis of water, or from water-gas and steam by a process depending upon catalysis. The nitrogen is obtained by distilling liquid air. Nitrogen is more volatile than oxygen, so it distils off first and the two gases may thus be separated.

The methods used in the manufacture of liquid air and other gases, and in modern refrigerating machines generally, are based upon scientific experiments by Joule and Kelvin on the phenomena attending the free

expansion of gases. They found that, when air issues from a small orifice, a fall of temperature is experienced amounting to half a degree Fahrenheit for each atmosphere of difference of pressure between the two sides of the orifice. The great refrigerating industry thus had its origin in the discovery of a purely scientific principle.

It is the same with substances as with principles and processes—they are first found as the result of scientific research and are afterwards used, often after a long interval. The metal tungsten used for the filaments of electric bulb lamps and thermionic valves was scarcely known outside scientific laboratories a few years ago. It was discovered about 1785, but its uses were not understood until nearly a century later. It is an essential constituent of high-speed tool-steels, which require to be not only extremely hard but also to maintain their hardness at high temperatures, even at an incipient red-heat. Tungsten steel is also used for the permanent magnets of telephones and the magnetos of every motor car and aeroplane. Manganese was in existence long before it was made an ingredient of the famous Hadfield steels, used for the helmets of British forces during the War, armour-plates, tramway points, and many other purposes. Chromium is used in the making of stainless steel; titanium, molybdenum, nickel, vanadium, and other elements are similarly employed to give special properties to steels, yet all these elements were discovered by scientific investigators without a thought of their practical value. Thorium and cerium, used in the manufacture of incandescent gas mantles, of which about four hundred millions are made annually, were products of the chemical laboratory many years before they gave rise to a large industry; and even the air-burner itself used for such mantles and in all gas fires was first devised and used by Bunsen for laboratory purposes.

Every scientific discovery, however remote it may seem at the moment from the ordinary practical needs of life, may be the seed from which will grow a mighty tree under which man will build his industrial tent. When argon was isolated from the air in 1895, no one regarded the discovery as of any practical importance, yet the gas is now used in half-watt and other gas-filled electric lamps as the most suitable for the purpose. Neon, isolated from the atmosphere a little later, is widely used for the brilliant pink glow lamps of illuminated advertisements, particularly in Paris, where it is a by-product of the manufacture of liquid air. Probably the most remarkable example of this kind is afforded by the gas helium, which was detected in the sun by Lockyer and Janssen in 1868, twenty-six years later was extracted from cleveite by Ramsay, and is now produced to the extent of thousands of cubic feet daily from natural gas wells in the United States for the inflation of dirigibles and other air-ships. As it is non-inflammable and non-explosive, it has decided advantages over hydrogen for this purpose and is only slightly heavier.

Before things can be used in any way they must be discovered, and it is the particular function of science to reveal them. It is the business of the scientific investigator to discover, of the engineer or inventor to recognise and apply the results achieved, of the artisan to employ his skill in making them commercially profitable, and of the community to see that they are used to promote social welfare. If the world has not been made any happier by what science has given to it, the fault is with the human race itself and not with science. Happiness is a relative term, and no two individuals have the same cup with which to measure it. The beast in the field, or the pig in its sty, may be considered by some people as emblems of content, and if these be the standards to use, then modern man may envy the cave-dweller of prehistoric times. We cannot, however, avoid progress, and whether this is accompanied by increased happiness or not depends upon ourselves. We live in a beautiful world, yet how few there are who find delight in it or raise their eyes to the starry heavens above them. The gifts of God are for those to enjoy who will, and the gifts of science may likewise contribute to the uplifting of the human race if they are rightly regarded, or its degradation if they are not. The attitude of civilised man towards new scientific knowledge at this epoch of the world's history is that of a child playing with fire. It is necessary now more than ever to teach him the strength as well as the danger of the element in his hands, and to cultivate the desire to make the noblest use of all things which are granted to him through the achievements of workers for the advancement of natural knowledge. When this spirit prevails, the human race will prove itself worthy of the opportunities which science gives for social and spiritual progress, and man may indeed become but a little lower than the angels.

The Valuation of Mines.

Mineral Valuation. By Prof. Henry Louis. Pp. x+281. (London: C. Griffin and Co., Ltd., 1923.) 15*s.* net.

THE principles underlying the valuation of mines, whether for the purpose of sale or probate, the raising of loans, investment, or taxation, are not so fully comprehended, except by few mining engineers, or so widely known as they should be. Consequently, in the matter of actual valuations, judging from those which have come before us, these principles are

frequently incorrectly applied. In the case of valuations for assessment of Poor Rate the abjuration of principle is, perhaps, most manifest.

Books on the subject of the valuation of mines and minerals are not numerous, and some, like Hoskold's "Engineers' Valuing Assistant," are either out of print or, in some measure, incorrect. We welcome, therefore, the appearance of Prof. Louis's admirable contribution to the subject.

The work covers, in seven chapters, a fairly wide field, treating, as it does, of the principles of valuation, ownership of mineral leases and concessions, sampling, explanation of the formulæ in use, examples in the valuation of coal and metalliferous mines, and valuation for special purposes, *e.g.* rating, etc. Chapter ii., relating to "Mineral Deposits," is perhaps the best in the book, the occurrence of minerals being a subject of which Prof. Louis has had wide experience and on which he has written much. Under this head he describes simply and with lucidity the manner of occurrence of minerals in beds, veins, and masses, indicating the variations in point of value to which they are subject.

His dissertation on the "probability of error" in the determination of the thickness of deposits for computation of the contents (chapter iii.) is of much interest; but the method usually adopted by mining engineers and alluded to by Prof. Louis on p. 50 is, perhaps, as satisfactory as any other method, namely, "after calculating average values as closely as the available data permit . . . to deduct a certain percentage 'for safety.'" The author is insistent, and rightly so, on the impossibility of assigning "to any mineral property an absolutely definite value, but only a most probable value." Whilst this is particularly true of a mineral property, by reason of the variations in regularity of deposits, of selling prices, and the general risks attendant on mining, it is of course true also, to a lesser extent, of other things as well, *e.g.* agricultural land, owing to the risks to crops due to bad seasons, variation in selling prices, etc. To meet the greater uncertainty of mines, valuers allow in the computation of the value of the annuities an unusually high rate of "remunerative" interest.

The debateable subject of subsidence of the surface due to extraction of minerals (as to which a Royal Commission, of which Prof. Louis is a member, is at present inquiring) is touched upon, and the author rightly says (p. 69), "It will be seen that we are still very far from having arrived at anything like an accurate estimate of the requirements in any given case, and it will always be well to be guided by local experience obtainable from previous workings whenever such is available." But the author might, with advantage, have mentioned Fayol's theory of the dome which reconciles so many of the seemingly contradictory results of different observers regarding subsidence, this theory being to the effect that in stratified deposits the zone of subsidence is limited by a sort of dome, which has for its base the area of the excavation; the extent of the movement diminishing the further one goes away from the centre of that area.

The question of depreciation of plant enters into mine valuations; it may, indeed, be an important item: an immense sum is often expended on the plant, for example, of a deep modern colliery. In making the allowance for depreciation, Prof. Louis criticises what he terms the income tax method; "it is charged each year upon the value of the plant less the amount of depreciation written off the previous year." He says, seeing that the plant can never come down to zero, and that, under the method he criticises, the amount written off for depreciation is a maximum when the machinery is new and becomes very small as the machinery gets older, the method is wrong. The value of the plant at the termination of the lease—if the property is leased—of course depends, amongst other things, on whether the minerals in the leasehold are exhausted or not, and on the site of the mine; and, on the second point, at a well-managed mine renewals of machinery and plant are carried out to a considerable extent during a long-termed lease, which to some extent militates against Prof. Louis's criticism, though not entirely.

Chapter v. treats of "Formulas and Calculations." Why, by the way, does Prof. Louis prefer this plural to the one in common use—"formulæ," and, whilst on the subject of grammar, why does he prefer "under these circumstances" to "in these circumstances"? The formulæ are mainly those familiar to students of Hoskold's "Engineers' Valuing Assistant" and King's "Theory of Finance," the latter being the best work, known to the present reviewer, on the doctrine of interest and annuities certain. The exigencies of space forbid a detailed review of this section of the book, but it may be noted that the author directs attention to the necessity of making the proper and necessary deduction for income tax in the calculation for the recovery of capital. Likewise, "if the capital be invested in the purchase of mineral rights . . . it becomes further liable to mineral rights duty in accordance with the Finance (1909–1910) Act," namely, 1*s.* in the pound. It is not generally realised what a difference there is between the gross and net income derivable from the ownership of mineral lands; mineral rights duty being chargeable *after* the deduction of income tax.

On the vexed question of the proper formula to apply for the determination of the present value of a deferred annuity in which two rates of interest are involved, Prof. Louis recommends (p. 101) that which was, we believe, first put forward by Mr. George King, and is accepted by the Inland Revenue in valuations for the purposes of probate. The simplest form in which this can be stated is that given by the reviewer in a work of which he is joint-author, namely, where:

Y.P. = years' purchase.
a = the amount to which 1*l.* per annum accumulates in e years at r per cent.
A = the amount to which 1*l.* per annum accumulates in t years at r per cent.
r = the accumulative low rate of interest.
R = the remunerative high rate of interest.
d = the period of deference.
e = the period of enjoyment.
t = the total period $= d + e$.

Then $$\text{Y.P.} = \frac{a}{1 + \frac{\text{AR}}{100}}.$$

Allusion has been made at the commencement of this review to want of adherence to fundamental principles in valuation of mines for purpose of assessment of rates, the basis of which is, by law, the annual value. There are no less than sixteen different methods of assessment in use in England and Wales, but there can be no doubt that the fairest is that advocated by Sir E. Boyle, namely, to value the surface works and plant as the non-directly productive works of a railway are valued, and the mine on the gross receipts upon coal raised, excluding colliery consumption, and deducting therefrom the expenses incurred in getting and raising the coal, *i.e.* to take as the value the net income derivable from the coal.

All who seek enlightenment on this and other branches of the subject of valuation of minerals cannot do better than study Prof. Louis's admirable and comprehensive work. RICHARD REDMAYNE.

Dutch Potters and their Work.

Old Dutch Pottery and Tiles. By Elisabeth Neurdenburg. Translated with Annotations by Bernard Rackham. Pp. xv + 155 + 59 plates. (London: Benn Bros. Ltd., 1923.) 84*s.* net.

IT is a pleasure to welcome this competent, scholarly, and interesting account of that renowned pottery-work of the Dutch craftsmen and artists which exercised such a profound and quickening influence on the potter's art as it was practised in all the countries of northern and central Europe, especially during the course of the eighteenth century. We already possess, in English, quite a number of small handbooks which treat of this important subject; but here, at last, a volume is presented which may be acclaimed as worthy and complete in its text, and is also so handsomely illustrated as to satisfy every requirement of the collector.

One praiseworthy feature, which immediately arrests attention, is the frank simplicity with which the many troublesome questions concerning the date or even the period of the various types of pottery and tile-work manufactured in the different towns and provinces of Holland are discussed and their origins elucidated. The factories at Delft, most famous of Dutch pottery-towns, are described at length, and we have interesting personal accounts of their proprietors and the principal painters in their employ; though we are still, fortunately, in the time when the proprietor of a pottery was his own principal artist or master-craftsman. The factories at Rotterdam, Haarlem, The Hague, and those in the province of Friesland are not overlooked, though, as is only to be expected, they do not receive the same detailed notice, for their pottery was not of the same importance either in quantity or in technical excellence.

The descriptive account of the native peasant-pottery and tiles, enriched with decorations in "slip" or with more ambitious designs in "sgraffiato," strikes one as somewhat meagre and unilluminating. This is a matter for regret, when we remember the extensive and splendidly decorative use which was made of these simple methods by our English potters of the seventeenth and eighteenth centuries.

Of the famous tin-enamelled wares, with their brilliant and effective painted decoration in blue or in polychrome, the book gives an excellent and convincing account. We are shown, by a documented narrative, how the processes were first introduced into Holland and how the mingled stream of Italian and Spanish influence fertilised the native art of the Dutch potters; either as a result of the incursions of Italian and Spanish pot-painters or from the return of Dutch potters who had travelled abroad for the increase of knowledge. Thus, an account is given of one, Hendrik Vroom, who travelled to the south of Europe to become qualified as a painter in oils but repeatedly earned his living while pursuing his studies by serving as a painter of pottery; working in Seville for an Italian potter and, later on, at a majolica factory in Venice. By such interchanges the art and craftsmanship were both improved, for the Dutchman sharpened himself on the more fiery metal of the South; so that, when he turned in earnest to the reproduction of Oriental designs, borrowed from the fashionable porcelain of the Far East, he was so well equipped that he was able to take full advantage of the lessons taught by the greatest of

all decorative artists. How fully the lesson was learnt has been demonstrated again and again, as when, on close examination, among a set of Chinese vases used for the adornment of a mantel-shelf one will be found to be a Delft-ware copy of a broken original.

The most famous of the Dutch potters and pottery-painters, such as De Keizer, Pijnacker and Frijtom of the seventeenth century and Van Eenhoorn and Fictoor, who were at work early in the eighteenth century, as well as the later painters like Hoppesteyn and Adrien Pijnacker, are fully dealt with and the characteristic details of handling or treatment by which their work may be distinguished are clearly explained. Valuable and interesting as the work is, it is more than a little disconcerting to find the author indulging in such an unwarrantable statement as is contained in the last paragraph, where she states that when the Staffordshire earthenware of Wedgwood and his compeers displaced the tin-enamelled wares by their fine and eminently serviceable qualities, "The wares which had been the pride of Holland, possessing in their soft, pleasant enamel and cheerful, harmonious colouring a charm unequalled even by Chinese porcelain, went under before the output of an industry to which Dutch craftsmen had given its start." One is inclined to rub one's eyes and wonder if the words flow from some ultra-patriotic writer who, not content with the assured position always accorded to the wares of her native country, must needs exalt them above their proper place by challenging the finest pottery known among men.

WILLIAM BURTON.

A Lover of Mountains.

Below the Snow Line. By Douglas W. Freshfield. Pp. viii+270. (London: Constable and Co., Ltd., 1923.) 18*s*. net

MR. FRESHFIELD has been, as he tells us, "as much a traveller as a climber," and he offers these "selections from old records of travel" in the hope that they may "convey to a few kindred spirits suggestions of alternative playgrounds near and far off, accessible at times when the High Alps are practically closed." But neither the title of the book nor the innuendo of these sentences must be taken literally. They do no justice to the scope of Mr. Freshfield's journeys, to the amount of true exploration involved, or the depth of the author's knowledge of mountains and mountain ranges, or his great love for mountain travel. After all, they "half reveal and half conceal the soul within." Perhaps the title was a mere chance repercussion from that of Mr. Clinton Dent's "Above the Snow Line." It serves at least to prove that to the true mountaineer all things fall to be considered in relation to the snow line. The lower slopes have no absolute value, save as they lead to the higher, or, if they have the misfortune to be so situated geographically as to have no higher slopes, they are to be considered as opening a prospect of the great hills, or, if even this be denied, as illustrating them in reminiscence.

There is indeed more in it than that. Mr. Freshfield is in grain a traveller; and, though we can scarcely conceive of him as travelling without a mountain as a goal or as a background, his interest in mountains does not consist solely in getting up and down them. He has, it is true, been engaged in doing so for a period that includes almost the whole of the history of modern mountaineering. Mr. Alfred Wills ascended the Wetterhorn in 1854. Mr. Freshfield published "Thonon to Trent" in 1865. A great many things have happened since then. Trent has changed both its nationality and its name, and a whole system of Alpine theory and technique has been evolved. But during all that time Mr. Freshfield has continued to find pleasure on one side of the snow line or another, and to delight those who take the same pleasure by telling them, on occasions all too rare, what he found there and why he liked it. How many summits must his foot have trodden? How many mountain valleys must he have known?

> "Conturbabimus illa, ne sciamus,
> Aut ne quis malus invidere possit,
> Cum tantum sciat esse. . . ."

Mr. Freshfield brings to his task of communicating his pleasure to others qualities more valuable than mere experience. He has an ironic wit, wide reading, and a retentive memory, and he has always written as a scholar and a man of taste. The hardships and discomforts of mountaineering are easier to bear when encountered with a certain rough jocularity. But that which cheers on the hillside is often intensely depressing in the study, and the stock Alpine joke, preserved like a fly in amber in the pages of the Alpine periodicals, has a shrunken and almost repulsive appearance. Mr. Freshfield does not disdain to jest. But he is too witty to be facetious.

Mr. Freshfield will always be associated, in particular, with those Italian Alps which he made his own in the years before 1875 and to which he allured his countrymen by the volume published in that year. That charming book must have sent so many people to the district of which it treats that it is difficult to think of Mr. Freshfield without Val Maggia, or of Val Maggia without Mr. Freshfield. This book cannot hope to make so wide an appeal. It does not happen to every lover of the mountains to have the time to visit Japan or the Mountains of the Moon or the Kabyle Highlands. Not all of us, even if we had time, have the capacity for enduring heat which enables

Mr. Freshfield to take a midsummer holiday in Corsica. Still, here is a fine feast for all who like to commune in spirit with a fellow-lover of the hills. The papers entitled "Behind the Bernina" (Val Malinco, Val Masino, and Val Codera) and "The Bergamasque Alps" are a sequel to "The Italian Alps," and in revisiting these enchanted glens the author recaptures and reproduces the charm of "that large utterance of the earlier gods." The Maritimes and the Gran Sasso are exactly the setting for him, and wherever Mr. Freshfield goes he takes with him the classic writers who have fed his imagination and formed his style. It gives a certain pleasure to catch him out in a misquotation, and that from Milton, a common misquotation from whom dogs Mr. Freshfield's name. It will be found on page 46.

Expositions of Atomic Physics.

(1) *Recent Developments in Atomic Theory*. By Prof. Leo Graetz. Translated by Dr. Guy Barr. Pp. xi+174. (London: Methuen and Co., Ltd., 1923.) 9*s*. net.

(2) *The New Physics: Lectures for Laymen and Others*. By Prof. Arthur Haas. Authorised Translation by Dr. Robert W. Lawson. Pp. xi+165. (London: Methuen and Co., Ltd., 1923.) 6*s*. net.

(3) *The A B C of Atoms*. By Bertrand Russell. Pp. 175. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1923.) 4*s*. 6*d*. net.

(4) *Modern Electrical Theory*. By Dr. Norman Robert Campbell. Supplementary Chapters. Chapter 17: The Structure of the Atom. (Cambridge Physical Series.) Pp. x+161. (Cambridge: At the University Press, 1923.) 10*s*. net.

THE theory of atomic structure has, during the past few years, reached a stage of sufficient success and stability for it to be possible to describe many of its features in a simple manner. There is a general agreement as to the validity of certain fundamental conceptions, such as the nuclear structure, the interpretation of isotopes, and the general functions of the outer electrons, while, to turn to more delicate points, the quantum theory and the wave theory of radiation, like an ill-assorted couple of individually worthy people, have learnt to live together in peace by a tacit agreement not to insist too much on each other's faults, so that it is possible for their friends to ignore their essential incompatibility. In short, the times seem propitious for popular summaries of recent advances in molecular physics, and a large number of such books, appealing to various circles of readers, have recently appeared, some of which are now before us.

(1) England is traditionally successful in the writing of simple scientific expositions for general reading, so that it is the more astonishing that two of these books should be translations from the German, and that these two should be but representatives of a large number of such translations not of works, like Sommerfeld's celebrated treatise, distinguished by great learning and great industry, but of ordinary lectures and essays peculiar for neither novelty of matter nor elegance of exposition. It is difficult, for example, to find any compelling reason for the appearance of Prof. Graetz's book in English dress. This summary of recent atomic theory was written while the War was still in progress (in fact, part of it is based on lectures delivered in territory occupied by the Germans), and, while it has been revised by the insertion of new matter, imperfectly incorporated with the old, the last revision was nearly two years ago. In consequence, the book is seriously behind the times. To take one example only: it is stated, in what purports to be an exposition of Bohr's views, that the electrons are arranged in concentric rings, each ring containing a number of electrons, the model for neutral helium, in particular, being figured with two electrons at opposite ends of the diameter.

Apart from being out-of-date, the book is vitiated by a deplorable looseness of expression which is very liable to mislead the general reader for whom it is intended. We are told that radium emanation loses its activity, "unlike radium, thorium, etc., which keep their activity for ever"; that for reflection to take place, X-rays must fall on the crystal at practically grazing incidence; that the nuclear charge determines the ordinal number in the periodic system, "and therefore determines also its atomic weight." The account of positive rays is bad. In short, the author does not seem to be sufficiently familiar with his material. Altogether, the book is superfluous, and it is a pity that such praiseworthy production in the matter of paper and print as it enjoys should not be devoted to a better object.

(2) The book of Prof. Haas's is a better performance, but is scarcely what it is implied to be, a book for laymen. In a hundred and fifty small pages, the author runs quickly through the electromagnetic theory, the kinetic theory of gases, the electron theory, the quantum theory, recent work on the structure of the atom, and the theory of relativity. It is scarcely necessary, in the face of this programme, to labour the fact that the treatment is far too laconic to be of use to any one with but little foreknowledge of the subjects handled. The language is simple enough, but such features of modern physics as the conception of a black body, the gyromagnetic effect, the quantum of action, and so on, cannot be clearly explained in single paragraphs by the mere device of omitting mathematical symbols.

The book gives a good summary of those branches of knowledge which it handles, a summary which can be read with profit by young students who want to get a general view of what they are learning: it is more like an index than an exposition. Many will differ from the translator, who has otherwise performed his task well, over his decision to express the extreme numbers, usually written in index notation, in words, such as a "quadrillionth part of $1\frac{1}{2}$ grams," or "800 billion per second." It is true that he gives a table of this notation in his introduction, but the scheme is of doubtful advantage.

(3) Now Mr. Bertrand Russell has succeeded in writing a book on the atom which is really accessible to the general reader. He uses a simple and lively style, which does not disdain to find in the flea "which crawls for a while and then hops" an image of the motion of the electron in the Bohr atom. His book is very readable, and gives what is in the main a very good account of the fundamental features of modern atomic theory. Unfortunately, Mr. Russell's unfamiliarity with the practical side of physics has led him into some extraordinary statements, such as that a spectrum which is "a continuous band of colours, like a rainbow," is called a band spectrum, or that fluorescence is "the subsequent emission of light of exactly the same frequency as that which has been absorbed," or that, "broadly speaking, there are three lines, the K, L, and M lines, which make up the X-ray spectra." The author makes an attempt, which seems a little too ambitious, to expound Hamiltonian mechanics without symbols. He has, obviously, written mainly under the influence of Sommerfeld's book: to have rendered some of the main lines of thought in that book comprehensible to a wide circle of readers is no mean feat.

(4) Dr. Norman Campbell appeals to a different circle, that of students who are specialists in physics. He continues the task of bringing parts of his "Modern Electrical Theory" up-to-date by means of monographs which he calls chapters. The book before us shows some of the valuable qualities which physicists have learnt to associate with its prolific author, whose impulsive claim and vivacious enthusiasm in the cause of progress find frequent expression in such a passage as:

"If we are hidebound by tradition, let us by all means stick to Amperean and Maxwellian theory, reject as a pernicious heresy, unsanctioned by the Fathers of the Church, all modern theory of spectra; let us retire as hermits to the desert of ignorance and refuse to have any dealings with the wicked, bustling world of modern science. If, on the other hand, we believe that progress in science is not impossible, and that the age of discovery did not end abruptly in 1870, let us be confident in our beliefs, and attribute to genius in our own time an authority no less and no greater than that of our intellectual forbears."

It is regrettable that this spontaneity of utterance seems to be allied to a breathless haste which has led to the omission of all mention of important pieces of work, and a certain carelessness which impairs much that has been written. It is, no doubt, outside the design of the book to devote attention to the methods of experiment by which the knowledge has been won, but, even so, it seems questionable to say of the positive rays that they "are never homogeneous in velocity," and so to ignore all Dempster's work. It is scarcely fair to Aston to say that he merely "re-designed Thomson's apparatus." It is strange to refer in detail to the discrepancy between the Bohr and the Weiss magneton, and to say nothing of Pauli's theory or of the work of Gerlach and Stern. Nobody is more impressed with the advisability of correctness in dimensions than Dr. Campbell, and yet he gives h, a unit of action, in ergs on page ix, while according to his equations on page 82 and elsewhere it is erg cm.! The notation is at variance with that of chapter xv., and is not consistent in the book itself. The index is futile.

Unfortunately these faults are but typical: it would be a distasteful task, but an easy one, to extend the list. Maturer reflection would, it seems certain, have led Dr. Campbell not only to introduce certain modifications in his exposition, but also to cancel his abuse of Sir William Ramsay, which serves no good purpose. The conclusion is irresistible that the author could have written a very much better book if he had only been willing to take more trouble and more time over it.

E. N. DA C. ANDRADE.

Our Bookshelf.

Electrical Engineering Practice: a Practical Treatise for Electrical, Civil, and Mechanical Engineers, with many Tables and Illustrations. By J. W. Meares and R. E. Neale. Fourth edition, rewritten and enlarged. In 2 vols. Vol. 1. Pp. x+584. (London: Chapman and Hall, Ltd., 1923.) 25*s.* net.

In the new edition of Meare's and Neale's "Electrical Engineering Practice," the scope of the work has been widened and the matter has been suitably rearranged. The book is thoroughly up-to-date and reflects clearly the present state of the industrial knowledge of electrical engineering in Great Britain. The authors are a little hampered at times by having to keep closely to the specifications and nomenclature definitions of the British Engineering Standards Association (the B.E.S.A.), the Wiring Rules of the Institution of Electrical Engineers, and the recommendations of the International Electrical Commission. The B.E.S.A. has always many committees sitting revising specifications for materials, machines and apparatus and dealing also with nomenclature and symbols. As these specifications are issued periodically it is not easy for authors to keep pace with them. The committees are not necessarily bound by their previous decisions. For example, the older generation of electricians recom-

mended that "continuous current" and "virtual value" should be used instead of "direct current" and "effective value." The younger generation has simply reversed these decisions. Our sympathies are with the authors who strive to model their nomenclature on the very latest recommendations, and find later that changes have been made. The constant strivings of electrical engineers after standardisation in specifications have done much to stabilise the industry.

The authors in many places where there is doubt give the variants, as, for example, effective virtual and root mean square (R.M.S.), ground and earth, and several other synonyms. They measure both magnetic induction B and magnetic force H in the same unit, namely, the gauss, which is defined to be one line of magnetic flux per square centimetre.

From the teacher's point of view, however, this leads to hopeless difficulties. We can recommend this book to those engineers who have a sound knowledge of theory and want to know the latest practical problems which the engineer has to solve.

Geologic Structures. By Bailey Willis. Pp. xi+295. (New York and London: McGraw-Hill Book Co. Inc., 1923.) 17*s.* 6*d.*

THIS book is essentially different from James Geikie's "Structural and Field Geology," which makes its appeal through its fine presentation of rocks as they actually appear on bare surfaces of the crust. The two works may well stand side by side. Prof. Bailey Willis concerns himself here with the mechanics of rock-displacement and rock-folding, and illustrates these by photographs of his series of models made to illustrate the structure of the Appalachians. He uses mixtures of wax, plaster, and turpentine, producing strata that yield very variously to mechanical stress. The deformation of an incompetent series under load provides material that returns, as it were, into the core of a rising arch formed by competent strata that can lift a load when laterally compressed, or into the core of a syncline when the competent series lies below them and is bent downwards, displacing matter in the depths (p. 148). Hence we have highly crumpled series between strata of more simple curvature. The shearing of materials in sediments as well as in schists, so that new parting-planes are set up, accompanied by thinning and elongation of the mass, is frequently brought before us in this stimulating volume. Moreover, we never lose sight of the tridimensional character of the structures described. There is a valuable chapter on field-methods, in which the author remarks (p. 28) that "the explorer should have the pluck of an American and the self-respect of a Chinese." The book provides geologists with very pleasant reading.

G. A. J. C.

Differential Equations. By Prof. H. B. Phillips. Pp. vi+78. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 6*s.* 6*d.* net.

DR. PHILLIPS'S little book is not a treatise on differential equations in the ordinary sense. He does not deal with any but the most elementary equations, and his aim is purely utilitarian, namely, to provide "thorough drill in the solution of problems in which the student sets up and integrates his own differential equation." There are a very large number of problems, with some worked out in the text. The problems are from all branches of applied mathematics, physics, physical chemistry, etc. We can certainly advise students of these subjects to become acquainted with the easier types of differential equations through the agency of Dr. Phillips's attractive and readable book.

A few criticisms of detail may perhaps be allowed. In the example on p. 6 the minus sign should be used *at once* in the form $dR/dt = -kR$, instead of leaving the negative in the form of an incidental result of the calculation. On p. 25 something should be said about the geometrical properties of homogeneous equations of the first order. The definition of phase angle on p. 66 is incorrect. There are also a number of mistakes and misprints.

S. B.

An Introduction to the Study of the Compounds of Carbon, or Organic Chemistry. By Ira Remsen. Revised and enlarged with the collaboration of the author by Prof. W. R. Orndorff. (Macmillan's Manuals for Students.) Pp. xii+567. (London: Macmillan and Co., Ltd., 1923.) 10*s.* net.

REMSEN'S text-book has for many years been regarded as perhaps the best introduction to organic chemistry. It is extremely well written and not obscured by tedious details, and is well within the student's capacity. Theory is kept within bounds, and one feels that to the author, at any rate, organic substances are not chalk marks on blackboards. In the new edition the essential character of the book is preserved, but by omitting illustrations and directions for experiments, it has been found possible to bring the text thoroughly up-to-date and to include some rather more advanced material. Very little calling for criticism can be found, but it is suggested that the theory of esterification on p. 67 is unsound, and that ethylene is not most conveniently prepared from the dibromide (p. 276): Newth's method is not even mentioned. Again, on p. 282, some account should have been taken of Chattaway's work. Apart from such trifles, the book is clear, up-to-date, and accurate, as well as readable.

Tracks of British Birds. Edited by H. Mortimer Batten. Life size. Printed on cloth chart, 20 in. by 30 in. (Edinburgh and London: W. and A. K. Johnston, Ltd., 1923.) 4*s.* net.

THIS forms a companion chart to "Tracks of British Animals," already noticed in these columns, and follows the same general lines. Four categories of birds are represented, namely, swamp birds, ground birds, perching birds, and birds of the seashore, each with about ten examples. The tracks are reproduced life-size, and a few brief explanatory notes on the general subject are given at the foot of the chart. Organisations such as Boy Scouts and Girl Guides, in which instruction in the craft of the country side occupies a good deal of attention, will find this chart invaluable, and it will be welcomed by teachers of Nature Study in schools as a most useful aid to the teaching and cultivation of powers of observation. The use of the word mavis as the common name of the song-thrush is, we believe, only general north of the Tweed, and we suggest the addition of the latter name for the benefit of those who are not familiar with the Scotch term.

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.*]

Hydrone and Water: Thunderstorms and Globe Lightning.

PROF. ARMSTRONG (NATURE, Dec. 8, p. 827) humorously appeals to me and other physicists to rush in and immerse ourselves in his aqueous difficulties, where apparently he hesitates to tread. Had FitzGerald been alive he might have been a willing victim, for he was always ready to apprehend the difficulties of others and often illuminated them by a flash of genius.

Prof. Armstrong sometimes seems more at home in an atmosphere likely to generate heat, than in the placid evolution of electricity or light; but in this instance he really does seem to want a question answered, though he does not put it very clearly. If he wishes us to enter a complex molecular assemblage, like hydrone, we may soon get out of our depth; for we know that he despises H_2O, and even H_2O is not as clearly apprehensible as we should like, in terms of atomic structure. A molecule as big as a fist would in some respects be advantageous. But what has that to do with electrical manifestations?

If we reply to Prof. Armstrong's apparent question in terms of elementary electricity, we shall be told—no doubt with perfect truth—that chemists knew all that before. Still, I will run the risk of a few platitudes. Dr. G. C. Simpson and I have both answered, publicly or privately, about the effect of aggregating small charged spheres into large ones, or vice versa; so to this I will only add that I am more disposed than is Dr. Simpson to attribute a great deal of atmospheric electricity to the influence of an outside source, namely, the sun. But Prof. Armstrong says that his point is more fundamental than that. He harps upon the need for electrodes, and constantly uses the term "circuit." I suggest that he rather over-emphasises these things. Electrodes are only necessary if the separated charges are to be conveyed to a distance by conduction: but they can travel by convection, and electrical separation can occur by displacement. Electrodes are needed for a galvanometer, not for a gold-leaf electroscope.

Examples.—A crystal of tourmaline warmed or cooled will exhibit opposite electrifications at its two ends, and if the crystal could be broken they would be separated. Pressure applied to other crystals shows a similar effect. Any conductor properly broken in an electric field will separate the electricities, just as silk rubbed on glass will exhibit electric separation when pulled apart. The same sort of thing Dr. Simpson expects in broken water drops. And certainly Armstrongs (both of the name) well know that drops of pure water propelled through a suitable nozzle will emerge electrified. In none of these cases are there electrodes, or any obvious circuit, and yet electric energy is displayed.

In a sense, it is true, there must always be a circuit of some kind. Electricity behaves rather like an incompressible fluid of which space is completely full. We cannot generate electricity; we can only separate or decompose and move apart the opposite kinds. But the circuit may be completed by insulated displacement, as well as by conduction.

The position is a little complicated by the singular and surprising fact that positive electricity is more closely identifiable with matter than the negative variety,—a prevision of which fact was intuitively grasped by Benjamin Franklin long ago. This great difference in massiveness between the two kinds of electricity enables electrical separation to go on *in vacuo*, and seems to me likely to be responsible for much of the energy of electrical separation subsequently displayed in the earth's atmosphere,—displayed most obviously when the magnetically separated entities come together again.

But what has all this to do with hydrone and water? Prof. Armstrong will not fail to notice, and probably contemn, my caution in keeping high and dry.

But now to be incautious. If Prof. Armstrong has qualms about supposing that rearrangements or combinations of H_2O in a hydrone molecule can effect electrical separation, I think those qualms are judicious; it would be too much like seeking a generation of one kind of electricity only. At the same time, if any cause can be assigned which would separate the opposite electricities of matter into different regions of a globe, an enormous amount of energy would be displayed, sufficient for ball-lightning. The quantities dealt with are prodigious. But where is such cause to be found? Could the opposite charges be centrifugalised apart? Could they, in rushing together, form a cyclone which would keep them from collapsing together for a time? The speed required, to maintain a shell of protons round a nuclear group of electrons, like a sort of inverted large-scale atom, is not unreasonable. A spherical vortex has been worked out by Prof. W. M. Hicks; what does he think of the suggestion?

I have no wish to enter the lists against the high meteorological authority of Dr. Simpson, but I do not feel that the last word has been said about the electrical energy of thunderstorms. Nor do I suppose that the last word has been said about what constitutes a chemical molecule, nor yet about hydrone.

OLIVER LODGE.

Salisbury, December 9.

Industrial Research Associations.

I HAVE read with much interest the article entitled "Industrial Science" appearing in NATURE of December 1, and I would beg to thank you for pointing out that the scheme of the Department of Scientific and Industrial Research for the establishment of Research Associations has not had a fair chance. Few could have foreseen the difficulties which it has encountered, and still fewer could realise what these actually are unless engaged in industrial operations.

As a firm believer in the ultimate success of the co-operation of science with industry, and as one who has followed closely the initial stages of one of the largest of the Research Associations, I should like to add that I am convinced that the scheme inaugurated by the Department is fundamentally a good one, and in my opinion is likely to have a very far-reaching effect, in helping our industries to face with confidence the unusual difficulties of the present situation, due no doubt in large measure to the lack of appreciation in the past of the value of science to industry.

I am aware that there are many who do not believe in the value of Research Associations, and that recently it was suggested in another journal that the "least direct way of helping industry by science is the quickest: stimulate research at existing institutions," etc. I appreciate most thoroughly the research work that is being done in the universities and similar institutions, and I am in reality most

anxious to secure the help and co-operation of these institutions, but the above suggestion, in my opinion, omits several important considerations. For example, commercial men are not very often in a position to appreciate when the difficulties of an industrial process are suitable problems for scientific research, and as a consequence many problems which should be referred to the universities for scientific help might fail to be so treated. Again, considerable knowledge both of textile processes and of the appropriate sciences is often necessary even to diagnose the cause of a defect, the solution generally requiring the co-operative efforts of the textile expert, the chemist, the physicist, and the botanist. Such qualities could scarcely be found combined in either the university professor or the industrialist.

Even assuming that these difficulties have been surmounted and the university professor is trying to solve an industrial problem, it seems that the writer of the above quotation has scarcely realised the amount of time which the university professor would have to spend in learning the conditions in which his new discoveries would have to be applied, without which information his researches, though they might be very fruitful in the accomplishment of scientific fact, would in all probability be of no real value to the industry. If, on the other hand, the university professor devoted the necessary time and thought to the solution of the industrial problems submitted to him, he might find himself with little or no time to devote to his professorial duties.

For such reasons, and from nearly four years' experience, I am satisfied that efficient co-operation between science and industry can be obtained by means of Research Associations, where highly trained scientific men will have daily intercourse with the industry, either as a whole or with the particular section of it connected with the special research problems they have in hand. In these circumstances such men may not only overcome difficulties as they arise, but, what is far more important, they will also certainly point out new lines of advance. I believe indeed that Research Associations will establish a necessary link between the universities and industry, and will be the means of stimulating the industries to take advantage of the opportunities provided.

KENNETH LEE,
Chairman.

The British Cotton Industry
Research Association,
Manchester, December 4.

Experiments on Alytes and Ciona.

THOSE who have followed this discussion may be interested in its subsequent course. I lately received the following letter, undated, from Dr. H. Przibram, director of the Versuchsanstalt, to which I have made the reply subjoined. W. BATESON.

December 2.

Vienna, XIII./7,
Hietzinger Hauptstr. 122.

My dear Professor Bateson,

Having read your offer about Kammerer's Alytes in NATURE, No. 2811, my proposal is this: that you may carry out your previous intention of coming to Vienna yourself. I would gladly renew my invitation to you to spend some time at my house. Thus you would be given ample opportunity to examine the specimen without risk of its loss. It was mainly my wish to satisfy you that made me consent to Kammerer taking the specimen to England. I am sorry you have not availed yourself of this opportunity, but I could scarcely take the responsibility of entrusting the unique sample to anybody else (I had in fact declined to do so on a previous occasion, as Mr. Boulenger will affirm).

It is not probable that I shall be away from Vienna at any time before the middle of April next. At any rate, please write beforehand, when you intend coming. It would indeed be a great pleasure to see you with us.

In case you have noticed Mr. Munro Fox's letter in NATURE, No. 2818, on Ciona, I would like to direct your attention to the fact that the discovery of its siphons lengthening with repeated removal was not made first by Kammerer. It was known so long ago as 1897 by Mingazzini's experiments, which were, in their turn, based on a previous observation of our friend in common, Jacques Loeb, as he mentioned to me in 1907 during my stay in California. So I do not see how Mr. Fox's inability to reproduce the experiment allows him to deny Kammerer's success with the first generation.

Believe me, dear Professor Bateson, most sincerely, your old friend, HANS PRZIBRAM.

If you think it desirable that my answer may be known in public, I would be glad if you would send this letter as it is to the editor of NATURE for publication.

December 2, 1923.

Dear Dr. Przibram,

I was not without misgiving that difficulties might be raised. For that reason I offered a sum, 25*l.*, calculated to cover the railway fare, 10*l.*, of a special messenger, with a sufficient margin. I understand the obstacle is not financial, or I would gladly now double my offer.

Thank you for a most kind invitation. It would be delightful to see you all in Vienna once more, which I was prevented from doing last year. Some day I certainly hope to come, if only to look at the new marvels of the Versuchsanstalt. But as regards Dr. Kammerer's Alytes, which as it still seems to me ought to be the most convincing exhibit of all, I doubt the value of such a journey. If I were to come, and—as it might happen—return with scepticism unabated, could I do more than add one to the number of those who already have seen and yet have not believed?

In my last letter I explained how I missed making a proper examination here. Reports had varied, and I drew the inference that the nature of the black marks must be mainly a question of interpretation. Not until I saw the toad at the Linnean meeting, with the unexpected and misplaced development on the *palm of the hand*, did I discover that there was anything so positive to examine. As I thought over the incident it struck me as extraordinary that this, the real peculiarity of the specimen—which, indeed, it was set up to display—had never been mentioned by Dr. Kammerer. He left England immediately after the meeting. I might, no doubt, have been a little quicker, but in amends, and in the hope of bringing the matter to a definite issue, I made the offer, not an unfair one, which you have declined.—Yours truly,

W. BATESON.

Colour Vision and Colour Vision Theories.

IN a recent letter to NATURE (September 29, p. 473) Dr. Edridge-Green has condemned the colour theory of Young and Helmholtz by the sweeping statement: "There is no fact that directly supports the trichromatic theory." It is scarcely credible that such men of science as Young, Helmholtz, Maxwell, and Abney could have deliberately adopted a theory of colour vision with nothing at all to commend it.

Dr. Edridge-Green further states that I have written several papers supporting the trichromatic theory, but implies that they are included among many which though "written to support the trichromatic theory are found on examination to give facts strongly adverse to it." It is true that my papers support the theory, but the inference that they were written for that purpose is incorrect. The papers are discussions of experimental researches on the effects of fatigue of the eye, and the results, usually given in the form of persistency curves, are set forth independent of any theory. The experimental fact, disclosed by the curves, that the disturbances induced by fatigue in the eye invariably affected the red, green, and violet colours, could not in my judgment be interpreted in any other way than in support of the trichromatic theory.

Dr. Edridge-Green also quoted one sentence from one of my papers in which I refer to a difficulty arising from the visual complexity of the part of the spectrum between the wave lengths 0·470 μ and 0·570 μ, which includes the region where the sensation curves of Abney and of König have two intersections, and those of Exner three. He states that this part of the spectrum is complex only on the trichromatic theory, while on his it is quite simple, and that my results therefore "should be as stated," or, in other words, accord with his theory. My former experiments, and more especially those very recently published, which show how colour vision in one eye is affected by reflex action arising from fatigue in the same eye and in the other, prove that the spectrum in its physiological action is exactly as complex as the sensation curves indicate it to be. I find a transition point, or, as it now seems better to term it, an equilibrium point or colour, corresponding to each of the intersections of the sensation curves. These facts are experimental, and certainly support the trichromatic theory in the most detailed and explicit manner. Indeed it was the occurrence of these complex intersections of the trichromatic sensation curves that enabled me to predict and later to discover these equilibrium colours.

The difficulty that Dr. Edridge-Green quotes from my paper regarding vision in the green has now been removed by further investigations which are described in a paper, "On Reflex Visual Sensations," recently published in the Journal of the Optical Society of America, August 1923. The solution is remarkably concordant with Prof. Peddie's conclusion contained in his recent book, which had not been published when that paper was written, and also in his letter in NATURE of October 27, p. 621, that in the visual process we have a double set of three variables, one of which arises from the internal action of the visual apparatus. This conclusion to which Prof. Peddie has come, from the interpretation of many phenomena of colour vision, accords with my own experiments on reflex sensations, though I would express it as a set of three variables acted upon by two separate and opposite stimulations, direct and reflex, the former acting to fatigue or depress the sensations, and the latter to enhance them. The double stimulation of the three sensations seems to be the necessary fundamental connecting principle in colour vision. By its employment many facts which were admittedly difficult to reconcile with the trichromatic theory are now seen to be completely in harmony with it.

By the discovery of reflex visual action upon the colour sensations it now seems possible legitimately and confidently to establish the trichromatic theory of colour vision upon the broad physiological foundations so securely laid by the researches of Sir Charles Sherrington.

FRANK ALLEN.

Department of Physics,
University of Manitoba,
Winnipeg, Canada.

PROF. PEDDIE seems to suggest that no one understands the trichromatic theory but himself. I resent his remarks in this connexion, and for this reason, unless some one else joins in the discussion, this is my final letter.

The trichromatic theory, which is very simple, has been thoroughly understood by physiologists since it was propounded. In former times most physicists, like Prof. Peddie, overlooked the physiological aspects of the question, but this is not the case with the physicists of the present day, as may be seen by the writings of Sir Oliver Lodge, Prof. A. W. Porter, Dr. Houstoun, Prof. Andrade, Dr. Troland, Dr. C. L. Martin, and others. The question is primarily one of physiology and not a mathematical problem on the functions of three variables. By physiology we are limited to one set of fundamentals for normal vision for one person. A man cannot have five and six toes on one foot at the same time. Now each set of facts requires a different set of fundamentals which makes the theory quite untenable. Let us compare, for example, the fundamentals of Abney and Burch. Abney gives the red sensation as affected by light of all wave-lengths. Burch gives the red sensation as affected by light from $\lambda 760\,\mu\mu$ to $\lambda 555\,\mu\mu$, with other points of difference. Abney gives $\lambda 548\,\mu\mu$ as stimulating the fundamentals, in sensation luminosities in the following proportions: red sensation, 49·7, green sensation 35·6, and blue sensation 0·035. Dr. Troland writing on the same subject, using the word minuthesis instead of fatigue, gives his results as follows:

"The general conclusion to be drawn from the work is therefore that minuthesis due to one colour does not alter the luminosity of another colour to a degree differing appreciably from that in which it is altered itself. In other words, the change in sensitivity to brightness occasioned by stimulation of the retina is independent of the wave-length constitutions of the minuthetic and of the reacting lights. This seems to imply that the luminosity function is not essentially linked with the color or chromatic function and stands in contradiction to the views of Abney, Ives, and others who treat luminosity as the sum of the primary colour values of any stimulus. The present results appear also to conflict with experimental data along similar lines published by Abney and by Burch, so that further study of the problem would seem to be required on a larger number of subjects."

These results are in a complete agreement with those of Prof. A. W. Porter and myself. (See Proceedings Royal Society, 1912, and the "Physiology of Vision," page 248.) Prof. Peddie's explanations are not explanations on the trichromatic theory: in the first he introduces a fact which can only be explained on my theory; in the second and third he gives no explanation. The positive after-image of red disappears before that for green, therefore on the trichromatic theory, if yellow be compounded of red and green, red having disappeared, the positive after-image of yellow should change to green, which it does not.

F. W. EDRIDGE-GREEN.

London, December 8.

The Optical Spectrum of Hafnium.

IN a letter to NATURE of October 27, p. 618, in which we gave a complete list of the lines belonging to the hafnium spectrum between 2500 and 3500 Å.U., we announced a detailed examination of the remaining part of the spectrum which can be obtained photographically. The result of this examination will be found in a paper, now in the press, which will appear shortly in the Math. Phys. Proceedings of the Royal Danish Academy. This paper contains

a list of all the hafnium lines (about 800) found between 7300 and 2300 Å.U., together with a detailed discussion of our methods and results. In the meantime we give here a list of the strongest lines in the region between 7300 and 3500 Å.U. Some of these lines (denoted in the table with an asterisk) have already been published at the Gothenburg meeting of Scandinavian Naturalists, where, on July 13, we presented a list of some 20 characteristic hafnium lines between 4500 and 3500 Å.U.

The spectra were produced as described in earlier letters to NATURE. In the table the lines are given to 0·01 Å.U. in international Å.U. in air, but the errors may amount to about 0·05 Å.U. In the region of the longest wave-lengths, where the accuracy is less, we give the values to 0·1 Å.U. The intensity is given both for arc and spark spectra in the usual scale (1 to 6). For the longest wave-lengths our spark spectra were not strong enough to permit us to give spark intensities, and above 5100 Å.U. the spark intensities are only of relative value and can be compared directly neither with the corresponding arc intensities nor with the spark intensities of the shorter waves.

λ	I.		λ	I.		λ	I.	
	Arc.	Spark.		Arc.	Spark.		Arc.	Spark.
3505·20	6	6	* 4174·32	4	5	5040·79	6	6
* 3522·98	5	5	4206·54	4	5	5047·43	5	4
* 3535·50	5	5	4232·36	4	6	5181·92	6	3
* 3552·66	5	6	4272·82	4	5	5243·97	5	2
3561·64	6	6	4320·65	4	5	5298·04	6	3
3569·03	5	6	4336·69	5	6	5311·54	6	4
3597·42	4	5	4350·52	4	6	5354·74	6	2
* 3616·86	5	6	* 4356·32	5	6	5373·88	6	3
* 3644·29	6	6	4367·91	4	5	5452·88	5	3
3665·28	4	5	4417·34	4	6	5463·31	6	3
* 3675·73	5	5	4422·70	4	5	5550·58	6	4
* 3682·22	6	6	4533·15	5	5	5552·10	6	4
3699·69	5	5	4565·93	5	5	5613·28	5	3
3701·12	5	6	4598·86	6	6	5719·20	6	4
* 3717·80	5	5	4620·85	6	5	5902·91	6	3
3719 28	6	6	4622·70	4	5	6185·15	5	
* 3777·73	5	5	4655·18	6	5	6386·36	5	
3793·34	5	5	4664·13	5	5	6644·7	6	
* 3899·92	4	5	4782·77	4	5	6754·6	5	
* 3918·06	6	6	4800·51	6	6	6789·4	6	
3923·90	5	5	4837·24	5	5	6819·0	6	
* 3951·80	5	5	4859·24	4	5	7063·7	5	
4062·85	4	5	4863·29	4	5	7131·8	6	
4080·44	5	5	4877·59	4	5	7237·1	5	
4093·16	6	6	4975·20	6	5	7240·8	5	
4127·75	4	5	5018·14	6	4			

As mentioned in our first letter (NATURE, March 10, 1923), we must expect to find some of the most prominent hafnium lines among the zirconium lines measured before hafnium was discovered, as all commercial zirconium contains from one-half to five per cent. of hafnium. In fact, we find in the region of the spectrum, for which Exner and Haschek's zirconium measurements are sufficiently exhaustive, nearly all the strong hafnium lines here given among Exner and Haschek's zirconium spark lines as weak lines of intensity 1 or 2. Since Bachem (Diss. Bonn, 1910) gives only the three lines 6386, 4093, and 3505, these lines may, until further investigations are made, be taken as the most persistent or ultimate hafnium lines in this part of the spectrum.

H. M. HANSEN.
S. WERNER.
Universitetets Institut for teoretisk Fysik,
Copenhagen, November 19.

Scientific Names of Greek Derivation.

MAY I follow Prof. Grenville Cole (NATURE, November 17, p. 724) in supporting Sir Clifford Allbutt? The prefix "dino-," as thus spelled, is ambiguous. We who know that "dinosaur" means "terrible lizard" may smile at the undergraduate and his "dinnosaur." But how would you pronounce "Dinocystis"? Wrongly, no doubt, as I did myself until I learned that the first begetter of the name derived it from δίνειν, to swirl, because the rays are spirally coiled. The same for Dinocharis and Dinophysa. Well, then, what about the giant corkscrew shell from the Hastings Sand—the Dinocochlea of B. B. Woodward? That perhaps means "spiral coil"; or does it mean "monster coil"? Should it, in short, be Deinocochlea or Dinocochlea?

We may, in systematic nomenclature, feel bound by the rules for transliteration recommended by one or other international committee; but in writing English let us be free. Alas! here comes the Society for Pure English with its Tract XIII., and invites us to print "coeval," "medieval," "primeval," and "peony." Why? If you eliminate the bouquet of the grape, the wine may be the purer, but it tastes no better. Already you may hear others than undergraduates speak of ĕconomics and ĕcological. These changes of spelling do not follow the debased pronunciation, they induce it; and so the meaning and force of words vanishes with their savour. Pure English indeed! Fortunately some impure English, called slang, still has "a tongue with a tang."

Next Prof. Cole deals with the writing and printing of diphthongs. The British Museum, he reminds us, writes "Moeritherium." That is because the officers of its Geological Department and others long since discovered that the use of digraphs (œ, æ, etc.) to represent diphthongs was the most fruitful source of misprints. Let us help the printers and our pockets! Otherwise I foresee the day when the undergraduate will call "this fascinating creature" the Merrytherium.

F. A. BATHER.

LIKE Prof. Cole (NATURE, November 17, p. 724) I prefer to transliterate the Greek letters, especially the vowels and diphthongs, directly into English—to represent, for example, αι by *ai* instead of *æ*, and ει by *ei* instead of *i*. Perhaps the worst examples I know of the emasculation of Greek diphthongs are the old-established Miocene and Pliocene, which show not only a weakening of ει to *i*, but also a further degradation of αι to a simple *e*. I am afraid it is too late to restore these words; but I am sorry to say that there are those who, on the specious plea of consistency, wish to write Cenozoic for Kainozoic and to extend this system of transliteration indefinitely. What this means is illustrated by the fate of the two words καινός and κενός, both represented by "ceno-," which in Cenozoic and Cenocrinus means "recent," and in Cenoceras and Cenosphæra means "empty," a most unnecessary and unreasonable confusion of distinct words.

JOHN W. EVANS.

An Uncommon Type of Cloud.

THE type of cloud photographed by Dr. Lockyer (NATURE, November 17, p. 725) is very frequently seen at Kodaikanal in south India during the thunderstorm season in April and May. It is always associated with thunder and always appears after the thunder clouds have expended their electrical energy. This often happens quite suddenly when the storm is of local origin.

On one occasion when developing a photographic plate at the Observatory I received a slight shock from a lightning discharge nearby, or more probably from an induced charge in the lead lining of the developing table. Since then I have hesitated to go up to the Observatory during thunderstorms, and have been accustomed to look out for the "all clear" signal which these mammato-cumulus clouds give us.

Another remarkable fact connected with local thunderstorms at Kodaikanal, and probably elsewhere, is the curious roaring sound emanating from the cloud before a storm begins. At first I considered this was due to heavy rain approaching, but concluded that this could not be so. The situation at Kodaikanal is such that one may find oneself very near to a cloud mass rising over the steep sides of the mountains, and the sound always appears to come from the cloud itself, and not from the ground or from trees. Possibly Dr. Simpson can explain this; he would probably have heard it at Simla.

J. EVERSHED.

Ewhurst, Surrey,
November 25.

Consumption of Fish by Porpoises.

IN the course of our cruises, we have often harpooned porpoises of various species, and occasionally investigated the contents of the stomach. Sometimes the stomach was found to be empty, but in most cases it contained remains of fish, though these were, as a rule, so decomposed by the digestive fluids that identification was impossible. Now and again, however, it could be done. In the vicinity of the Continental Slope, for example, west of the English Channel, where porpoises are nearly always found in abundance, we found great bundles of the pelagic pipe-fish, *Entelurus æquoreus* L., in the stomachs of porpoises taken. But as a rule, the porpoise evidently prefers fish of somewhat more fleshy build than the pipe-fish.

The present note is occasioned by the recent preliminary investigation of a sample from one of the cruises of the *Thor*. On June 24, 1910, being then off the south coast of Spain, in the Mediterranean (between 36° 10′ N., 4° 42′ W., and 36° 19′ N., 4° 0·6′ W.), we harpooned a female specimen of the common long-nosed porpoise (*Delphinus delphis* L.). The stomach contents consisted of fish-residue: more or less dissolved soft parts, crumbling backbones, otoliths, and eye-lenses. I noted that most of the fish-bones were green, but no identification was attempted. The most interesting feature was the great number of otoliths, or ear-bones, of fish. When these were sorted out and counted, there were no fewer than 15,191 of different sizes, though mostly small. Several species were represented, about five; but, owing to lack of material for comparison, I cannot give any further determination at present. Some are presumably those of Scomberesox, clupeoids and scomberoids, possibly also scopelids.

The sample is interesting, inasmuch as it gives some slight idea of the porpoise's enormous consumption of fish: in the stomach of this one specimen we found remains of no fewer than 7596 fish. How long the porpoise took to collect the whole 7596 it is impossible to say, since we do not know how long the otoliths remain in the stomach before being dissolved or passed out. The fact that otoliths are not always found in the stomachs of porpoises seems rather to suggest that they do not remain there very long.

JOHS. SCHMIDT.

Crystallisation of Cementite in Steel.

WITH reference to the particularly interesting article by H. C. H. C. in NATURE of November 17, p. 728, might I mention the following amongst many other examples which have come under my notice illustrating the tendency of cementite to form cell walls or a network under conditions where the occurrence of pearlite is more commonly anticipated? In dead mild steels the occurrence of cementite in either network or comparatively massive formation has been recognised by a number of investigators. Fig. 1 illustrates an exceptional case in which isolated cell walls were found only near the edge of a dead mild-steel plate, in a region otherwise microscopically carbonless. The only apparent explanation of this occurrence was that the plate must have become carburised locally during the processes of manufacture.

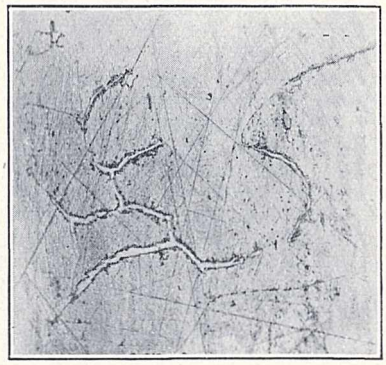

FIG. 1.—Cementite network in mild steel. ×300.

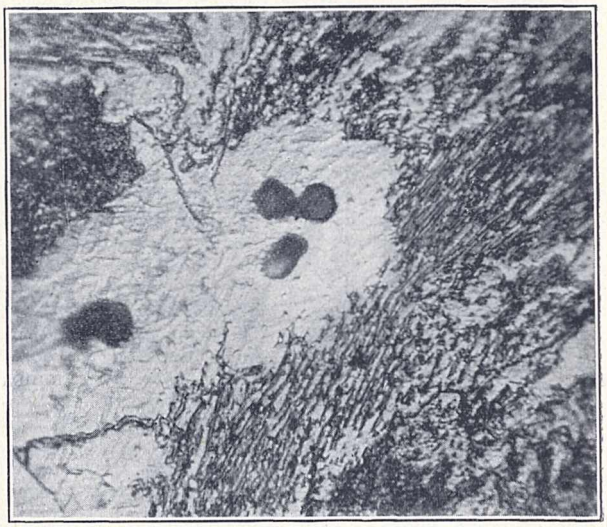

FIG. 2.—Cementite in ferrite grain junctions, in nickel steel. ×1500.

In the alloy steels, the simultaneous occurrence of structurally free ferrite and juxtaposed carbide network would be regarded as uncommon, but Fig. 2 shows an instance of this occurrence in a large oil-hardened nickel-steel forging. At the magnification of 2500 with which the original photograph was taken by means of the super-microscope, the carbon-containing constituent can readily be seen to be lamellar pearlite, which makes easy the identification of the carbide plates in the ferrite boundaries.

F. ROGERS.

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Minute "Organisms" isolated from the Virus of Mosaic Disease of Tomato.

THE nature of the infective principle in plants suffering from mosaic disease is obscure, although most recent workers favour the view that it is a living organism. Allard and Duggar have emphasised the minuteness of the causal agent, whilst Matz, Kunkel, Nelson, and others have described protozoan-like bodies in the cells of affected plants.

A considerable amount of work has been done on this problem at Cheshunt, and the present note records the isolation and growth in pure culture of a minute "organism" from the filtered virus of tomato mosaic.

Isolations were made from affected plants by a modification of Noguchi's method. Tubes of sterile extract of tomato stem and leaf (100 gm. fresh material to 1000 cc. distilled water) were prepared, and into each was dropped a small piece of living tomato tissue cut, under aseptic conditions, from the interior of healthy green fruits. Ten tubes were inoculated by touching the tomato tissue under the liquid with a loopful of tomato virus filtered aseptically through a sterile Doulton candle. Ten uninoculated tubes were left as controls. All tubes were incubated in a Bulloch's anaerobic jar for two months, and on removal were found to be clear. The tubes were then left under ordinary atmospheric conditions, and two months later one tube was contaminated by a fungal growth, but the liquid in the remaining nineteen was quite clear in both the inoculated and the control tubes. This liquid was examined for micro-organisms by plating and streaking upon different culture media, but no growth was observed. On the glass, however, of each of the original inoculated tubes about one centimetre above the liquid were small brown bodies, the largest of which was 200μ in diameter. No such bodies were present in the controls.

These bodies were tightly fixed to the glass, and not easily detached. They are brittle and break into fragments of a crystalline appearance. The bodies are discoid convex, and when stained with borax carmine the surface shows concentric and radiating markings. They clear in acid with evolution of gas, the cleared bodies having a fine granular appearance. When stained by Giemsa's method they resemble bacterial colonies, containing deeply stained purple granules standing out distinctly on a stained background. These granules are 0·3 to 0·4μ in diameter (occasionally smaller granules are seen) and appear as cocci, diplococci, polar bodies, or unstained rods. These are not merely crystals or detritus but definitely organised bodies growing in colony formation. Distinctive preparations have been made by staining with Giemsa for 24 hours and then differentiating with absolute alcohol. The granules are best seen in smears made from the cleared colonies prior to fixation by drying.

Tubes of virus kept in the laboratory for six to eighteen months under aerobic conditions revealed similar colonies on the glass in those tubes where no toluene had been added for preservative purposes or from which the toluene had disappeared. After acid clearing and staining, the minute granules were readily demonstrated. Films made from the clear liquid in the tubes bearing the colonies were also stained with Giemsa, and purple-stained granules similar to those so abundant in the colonies were regularly found in these preparations. They were not numerous, five or six only being seen in a single field, and appearing as cocci or as diplococci.

Continued cultivation of the "organism" has been maintained in tubes of tomato extract containing cubes of sterile raw tissue. (The addition of 0·3 gm. calcium carbonate to 10 c.c. of extract hastens the production of colonies. Increased concentration of carbon dioxide in the atmosphere also seems to assist in the formation of colonies and alters their appearance; the brown colonies becoming white and chalky.) Numerous media have been inoculated with negative results, but one inoculation is especially interesting. A flask of lemco gelatine containing a high proportion of gelatine was inoculated with a drop from one of the original culture tubes. No growth was apparent for four months, but after six months the surface was covered with minute hard white bodies, which on examination proved to be similar to those described. Colonies transferred to Noguchi tubes dissolved in the liquid, and films prepared from this ten days later showed the presence of minute granules either singly as diplococci or as aggregates in alveolar plasmodium-like structures in which cocci stood out deeply stained in comparison with the faintly stained matrix.

The bodies forming on the glass of Noguchi tubes and in the liquid, and the lemco colonies, have been inoculated into healthy plants under various conditions; and while there are indications that they may be causally related to mosaic disease, no definite claim can yet be made. The presence of these "organisms" in the virus of tomato plants suffering from mosaic, and their very interesting nature, appear, however, of sufficient importance to warrant the immediate direction of the attention of workers on this difficult problem to their existence. A detailed investigation of the character and genetic relationships of the "organisms" recorded in this note and their relation to mosaic disease is being carried out at Cheshunt.

W. F. BEWLEY.

Experimental and Research Station,
Cheshunt, Herts, December 3.

Globular Lightning.

YOUR correspondent, Mr. E. Kilburn Scott, suggests in NATURE of November 24, p. 760, that "the ball may be a mass of concentrated nitrogen oxides," and considers that this would "fit in well with the formation and action of such gases," and he compares the chemical activity of lightning with the well-known reactions occurring in high-tension arc flames.

Although I do not wish to be understood as expressing any opinion regarding "globular" lightning, I should like to point out that in the letter which appeared in NATURE of September 15, p. 396, I produced evidence in connexion with the extremely vivid and prolonged thunderstorm of July 10, 1923, which left no doubt that the chemical changes that occurred then resembled those of the silent electric discharge, rather than high-tension arc flames, because, although there was no increase in the proportion of the oxides of nitrogen in the air within the area of the storm, there was a very great increase in the proportion of ozone.

I may add that since the proportion of nitrogen peroxide is always much higher in London than in country air, and is considerably greater in winter than in summer, we may look, as in the case of sulphur dioxide, to combustion of coal as the probable source of most of it at least. The seasonal changes of the curves for these two variable ingredients of the atmosphere are very similar, and are not in any way related to that for ozone.

WILLIAM C. REYNOLDS.

"Wharfedale," Upminster, Essex,
November 26.

Rejuvenescence and the Testicular Graft.

By Dr. F. H. A. MARSHALL, F.R.S.

IT has been known from very early times that castration in both man and animals, besides causing the suppression of the sexual instinct, produces marked changes in the bodily conformation and the secondary characters of sex, and that these effects are far more definite if the operation be performed before puberty. There are numerous references to the subject in the works of Aristotle, who remarks on the immense modifications in the general configuration brought about by the mutilation of a comparatively minute organ. The abnormal height of the eunuch, his undeveloped larynx and soprano voice, and the absence of hair on the face and other parts of the body where it is usually present in men are among the well-known effects of testicular deprivation. The domestic animals also furnish striking examples of the consequences of castration, and the same may be said about birds. Thus the testes, besides being responsible for the development of the sexual instinct, are an essential factor in the formation of the bodily characters associated with maleness. The manner in which this influence is exerted, however, has only comparatively recently been ascertained, and there are still many gaps in our knowledge.

According to Berman, the author of "The Glands regulating Human Personality," the first to conceive the idea that the gonads exert their effect through an internal secretion poured into the blood was Bordeu, who was Court Physician to Louis XV. in the eighteenth century. Berthold, however, in 1849 was the earliest to base the idea on experimental proof. This investigator removed the testes from cocks and transplanted them into new positions in the body, and he noted that the birds developed or retained their male characteristics (voice, sexual and combative instincts, growth of comb, wattle, etc.) just as though they were normal males. These results were attributed by Berthold to substances formed by the testes irrespective of their position, and thus he was the first to put on a definite experimental basis the idea of an organ elaborating a hormone which, after being carried in the circulation, acted upon other and distant parts of the body. Little account was taken of Berthold's work at the time, and it was not until much later that the conception of organs having an endocrine function was revived by Claude Bernard, who applied it to the liver. In recent times Berthold's work on the testicular graft has been confirmed for a large number of animals, and the fact that the testis, in addition to producing the semen, gives rise also to one or more chemical substances of the nature of hormones has been established.

The notion that the testis produces an internal secretion which, besides being responsible for the male characters, possesses also a rejuvenating influence, is a somewhat different one. It was originally put forward in 1889 by Brown-Séquard, who injected testicular extract, first into animals and then into himself. He was convinced that in both cases beneficial effects accrued, and claimed that he himself underwent a radical change and regained the force and vitality of former years. The extracts were made from dogs' and guinea-pigs' testes, and were injected subcutaneously. At this time, Brown-Séquard was seventy-two years old. The supposed rejuvenating effects, however, did not last, and although this form of treatment was extended to some hundreds of patients suffering from various diseases (rheumatism, sciatica, locomotor ataxia, tuberculosis, etc.) by Brown-Séquard and Brainard, who claimed that good results often followed, the practice of testicular injection was soon discontinued and became generally discredited.

In recent years, however, the idea of testicular rejuvenation has been revived in connexion with grafting experiments. In 1913, Lespinasse, an American doctor, recorded a case of testicular transplantation in a man, but gave no evidence of the persistence of the graft beyond that afforded by sexual potency. About the same time Lydston, of Chicago, is reported to have done similar work with human grafts, and the medical department of the California State Prison is said to have organised transplantation experiments in which testicles obtained from executed criminals were grafted on to senile individuals, but there is no satisfactory evidence as to the results obtained.

More recently (1918) Stanley and Kelker have performed the same operation, and in further experiments the testes of animals were substituted for human ones. It was believed, however, that in all cases the grafts became necrotic and were either absorbed or else the site of operation opened up and the necrotic material was discharged. In a later paper, Stanley has described a large number of experiments (more than 1000 had been carried out by 1922) in which men were injected with partially macerated testis by a syringe. With this method the danger of sloughing was much reduced, and the injected substance could be felt under the skin for months, but it was eventually absorbed. From these experiments Stanley concluded that animal testicular substance injected into the human body caused decided benefit for some time. Among those treated were patients suffering from neurasthenia, epilepsy, asthma, tuberculosis, diabetes, and many other chronic diseases, as well as senile decay. Most of the subjects reported increased sexual activity and resumption of virility where this had been lost. It is said, further, that testicular substance often has a beneficial effect in relieving pain of unknown origin and in promoting bodily well-being, and that the power of vision is sometimes greatly strengthened. The testicles used were those of goats, rams, deer and boars.

Three cases have been described by Lyons in which rams' testicles were transplanted on to men suffering from debility and impotence, and in two of these favourable results were claimed, but the fate of the grafts was unknown.

The above recorded experiments were all carried out in America in the last decade. In the same period, numerous operations of a similar order have been carried out in Europe. In 1915, Lichtenstern, of Vienna, operated on a soldier who had lost his testicles as a result of being wounded in the War. After a few months, the patient showed all the usual signs of

complete castration and suffered from want of vigour and general apathy. Lichtenstern then engrafted an undescended testicle from another individual, and as a consequence the symptoms of castration disappeared and the man became normal. Two and a half years later he was still normal, having been married fifteen months. Further cases of testicular transplantation in men are recorded by Lichtenstern as well as by Kreuter and Mühsam, the operation being performed for eunuchoidism and homosexuality, as well as for debility and impotence, and successful results are claimed. In none of these cases does there appear to be definite evidence as to the fate of the graft, but it would appear almost certain that it must have persisted for some time.

Voronoff, whose work on the so-called "monkey gland" has attracted so much attention, began his experiments on the testicular graft at the Collège de France in 1917. His earlier work was upon sheep and goats, in which he grafted young testes into old animals and into animals castrated before puberty. The best results were obtained by grafting the testes into the scrotal sacs, or in the case of aged animals, upon the testes already present. Retterer and Voronoff, in a paper published last summer, tell us that some of these animals are still under observation at the Laboratory of Experimental Surgery of the College and that they continue to display sexual vigour and ability to copulate. The success attending these experiments led Voronoff to attempt testicular transplantation upon aged men. In connexion with this work, two points are strongly emphasised; first, the advantage of making the graft in a suitable position and preferably the natural position of the organ; and secondly, the importance of biological affinity between the individual from which the testis is taken and the recipient of the graft; consequently, in carrying out testicular transplantation from animals to men, Voronoff selected the chimpanzee as the most suitable animal from which to obtain the graft, since of all the anthropoid apes this species is believed to be the nearest akin to man. The result of the operation in many instances is claimed to be entirely successful. The walls of the arteries are said to have become softened and the capacity for work increased, and, in short, a complete restoration of mental and muscular vigour is stated to have been attained. In the majority of men so operated upon sexual potency also is said to have been revived.

In some of Voronoff's experiments there is definite evidence concerning the persistence of the graft, and Retterer and Voronoff have described microscopic sections of graft tissue after several months of transplantation. Thus the figure of a section of a goat's testis a year after grafting shows cells which might reasonably be supposed to have had an internally secreting function, though the tissue as a whole had undergone considerable degeneration and neither spermatozoa nor interstitial cells can be detected. The authors state that the condition of the transplanted chimpanzee's testis is similar, but they do not appear to have recorded the duration of the graft. On the other hand, Thorek, an American surgeon, who has recently confirmed Voronoff in regard to the persistence and efficacy of the chimpanzee graft when made upon man, has described and supplied photographs of sections of such grafts when removed four months after transplantation, and these show an abundance of secretory cells and every evidence of active life, though the seminiferous tubules had undergone incomplete regression. The good results are attributed to a new technique whereby the vascularisation of the graft was greatly improved.

There is one point of importance on which Retterer and Voronoff differ from most physiologists, and this relates to the elements which are responsible for producing the internal testicular secretion. The bulk of the experimental evidence is strongly in favour of the view that the testicular hormone is elaborated by the interseminiferous or interstitial cells, and Steinach, who has called this tissue the "puberty gland," attributes the supposed rejuvenating effects of vasectomy to the hypertrophy of this gland, pointing out that the spermatogenetic tissue after this operation undergoes degeneration as noted by former observers. According to the French investigators, however, the testicular graft does not contain interstitial cells, the rejuvenating function being due to the epithelial cells which continue to discharge the problematical secretion into the circulation notwithstanding the fact that they become converted by poverty of nutrition into "young connective tissue." On the other hand, in Thorek's preparations, the interstitial cells have proliferated and appear to have been functionally active.

In conclusion, it must be emphasised that the work is as yet in the experimental stage. In many of the cases recorded the effects of "suggestion" are not satisfactorily excluded, and the evidence as to the persistence of a functional graft is still meagre. That the histological results are conflicting and that those of Voronoff are contrary to the usual view as to the source of origin of the hormone, are valid reasons for reserving judgment. Nevertheless, it must be pointed out that the accumulation of evidence in support of the contention that a testicular graft obtained from another individual, and even from another species, may exert a definite physiological influence upon the recipient, is considerably greater than many men of science have so far been disposed to admit.

Some Aspects of the Physical Chemistry of Interfaces.[1]

By Prof. F. G. DONNAN, C.B.E., F.R.S.

LET us now inquire how far the phenomena which are characteristic of a gas-liquid interface occur also at the interface between two immiscible or partially miscible liquids. Many years ago it was shown by Gad and by Quincke that a fatty oil (such as olive oil) is very readily dispersed in the form of an emulsion by a dilute solution of caustic soda. Some experiments which I once made showed that a neutral hydrocarbon oil could be similarly emulsified in a dilute aqueous solution of alkali if one of the higher fatty acids was dissolved in it, whilst the lower fatty acids do not

[1] Continued from p. 870.

produce a similar action. It was shown that the action runs parallel to the lowering of interfacial tension and must be ascribed to the formation of a soap, which lowers the interfacial tension and concentrates at the interface. These phenomena have been further investigated by S. A. Shorter and S. Ellingsworth, by H. Hartridge and R. A. Peters, and by others.

If a substance which is dissolved in one liquid A, and is practically insoluble in another liquid B, is found to have, in very dilute solutions, a strong effect in lowering the tension at the interface A-B, the following interesting questions arise :

(1) What is the amount of the surface concentration or adsorption per sq. cm. of interface ?

(2) Can it be calculated by means of the simplified Gibbs equation ?

(3) How does the surface adsorption vary with the concentration ?

(4) Does the " saturation " value correspond to the formation of a unimolecular layer ?

Some of these questions were experimentally investigated in my laboratory by W. C. McC. Lewis. For the liquid A water was chosen, and for B a neutral hydrocarbon oil. Working with sodium glycocholate as the surface-active substance, it was found that the experimentally measured surface adsorption q was much greater than that calculated by means of the equation

$$q = -\frac{cd\gamma}{RTdc}.$$

Comparing the values with those previously obtained for the air-liquid surface, it is clear we are not dealing with simple unimolecular layers, but with adsorption layers or films many molecules thick. On the other hand, if we calculate from Lewis's results the surface area per molecule as deduced from the surface tension measurements by the simplified Gibbs formula, we arrive at values which are consistent with the gradual building up of a unimolecular layer (of possibly heavily hydrated molecules or micelles). It is possible, therefore, that the Gibbs equation gives the surface concentration of the primary unimolecular " two dimensional " surface phase, and that any building up of further concentrations beyond this layer does not affect the surface tension. In a later investigation Lewis determined the surface adsorption of aniline at the interface mercury-aqueous alcoholic solution, and found in this case a very fair agreement between the observed and calculated results. This case is more favourable, since we can be in little doubt concerning the molecular weight of the solute units. We may conclude, therefore, that Lewis's measurements in this case point to the building up of a primary unimolecular layer, unaccompanied by any further concentration or " condensation " of molecules or colloidal micelles.

Experiments similar to those of Lewis have been very recently made by E. L. Griffin, who has measured directly the adsorption of soaps from aqueous solutions at a mineral oil-water interface. The results obtained are as follows :

Substance.	Average Surface per Molecule adsorbed.
Sodium Oleate . . .	48×10^{-16} sq. cm.
Potassium Stearate . .	27×10^{-16} sq. cm.
Potassium Palmitate . .	30×10^{-16} sq. cm.

These figures are very interesting, for they would appear to indicate the formation of unimolecular surface layers.

We have seen that in the case of the air-water surface there exists an electrical separation or potential difference in the surface layer, and that certain substances can produce pronounced variations, or even reversals in sign, of this electrical double layer. It becomes a matter, therefore, of great interest to inquire whether similar phenomena occur at the interface between two immiscible liquids, and, if so, to ascertain whether such electrical charges or double layers bear any relation to the " stability " of pure emulsions, or fine dispersions of one liquid in another. It is well known that those disperse or finely heterogeneous states of matter known as colloidal solutions depend in part for their stability on the existence of such electrical potential differences. We might expect, therefore, that an investigation of these emulsion systems would throw some light on the general theory of what are called " suspensoid " or " lyophobic " colloidal states.

Investigations with these objects in view were carried out some years ago in my laboratory by R. Ellis and F. Powis. The method employed was to measure directly by means of a microscope the motion of minute globules (suspended in water) under the influence of a known electric field. From the measured velocity and potential gradient, the interfacial P.D. and the electrical charge can be calculated from the theories of Helmholtz, Lamb, and Stokes. The microscopic method has the advantage that the P.D. between the aqueous solution and the glass wall (cover glass or object glass) can be determined simultaneously. It is a remarkable fact that the P.D. between various types of hydrocarbon oils (purified from acid so far as possible) and water was found to be 0·045-0·053 volt, the oil being negative—that is to say, the oil droplet moving towards the anode. If we compare this with the value recently calculated by McTaggart for the P.D. between an air-bubble and water (deduced from a precisely similar type of measurement), namely 0·055 volt, we can draw the conclusion that the potential difference is due to an electric double layer residing in *the surface layer of the water*. The oil droplet moves, therefore, with an attached negative layer or surface sheet, probably determined by hydroxyl ions, this being balanced by a positive layer the charge of which is determined by hydrogen ions.

Perhaps the most remarkable result which has emerged from these electrical investigations of oil suspensions is the relation between the stability of the emulsion and the potential difference of the interfacial double layer. The minute oil globules are in constant Brownian motion and must frequently collide. Why do the forces of cohesion not produce agglomeration or coalescence (coagulation or clearing of the emulsion) ? At distances great in comparison with their own dimensions the electric double layers will act practically as closed systems. But when two oil drops approach sufficiently near each other the conditions will be different, since we must expect a repulsive force when two similarly charged outer layers just begin to interpenetrate each other. Hence the answer to the question asked above is that the third factor is the potential difference or electric density of the interfacial double

layer. Other things being equal, the probability P of an encounter leading to coherence will be a diminishing function of the electric intensity π of the similarly constituted double layers, *i.e.* $dP/d\pi$ will be negative. Hence, of the total number of encounters in a given small period of time, the number which lead to coherence should be a maximum at the point of zero potential difference (iso-electric point of Hardy).

Now the experiments of Powis brought out the very important fact that when the interfacial P.D. (whether positive or negative) is above a certain value, which was about 0·03 volt for his conditions, the rate of coagulation or coherence of the oil drops is relatively small, but rapidly increases when the P.D. falls inside the zone −0·03 +0·03 volt. Under definite conditions there exist, therefore, what we may, speaking broadly, call a *critical potential* and a *critical potential zone*. When the P.D. is outside this zone the emulsion is comparatively very "stable." Very small concentrations of electrolytes, which, as we have seen, increase the P.D., increase this stability. As soon as the concentration of any electrolyte is sufficient to bring the P.D. into the critical zone, the stability of the emulsion undergoes a sudden and very marked decrease, and relatively rapid coagulation occurs. Take, for example, the case of thorium chloride. On increasing the concentration we find that the interfacial P.D. traverses successively the following regions:

(1) Above the critical value (and negative).
(2) Inside the critical zone (negative and positive).
(3) Above the critical value (and positive).
(4) Below the critical value (and positive).

In exact correspondence with this series we find that the emulsion goes through the following states:

(1) Stable (oil particles "negative").
(2) Unstable and flocculating (oil particles negative or positive).
(3) Stable (oil particles positive).
(4) Unstable and flocculating (oil particles positive).

Here we see a very striking analogue and explanation of the phenomena observed by Joly in studying the effect of aluminium salts on the sedimentation of clays, and of the numerous examples of the so-called "irregular series" observed in the flocculation of suspensoid hydrosols by salts with polyvalent cations.

As Linder and Picton showed, when two suspensoid hydrosols, one negative and the other positive, are mixed, then, depending on the ratio, a stable hydrosol (either positive or negative) can be obtained. In continuation of this work, W. Biltz demonstrated the existence in such cases of a "zone of coagulation," *i.e.* a zone of concentration ratios leading to coagulation. A study of the mutual behaviour of a negative oil emulsion and the positively charged ferric oxide hydrosol provides a complete explanation of this curious phenomenon. When increasing amounts of the iron oxide hydrosol are added to the oil emulsion, it is found that the interfacial P.D. falls to zero, and then reverses its sign, becoming increasingly positive —an action which is due to the adsorption of the positively charged micelles at the oil-water interface. When the P.D. is above a certain value (positive or negative) the system is stable. But within the critical zone a rapid and relatively complete mutual coagulation takes place.

These studies of oil emulsions (and of the glass-water interface), by means of the micro-cataphoresis method, have thrown a great deal of light on many previously ill-understood points in the theory of colloids. The following table contains the concentrations (in millimols per litre) of certain electrolytes required to reduce the potential of a certain hydrocarbon oil emulsion from its "natural" value (against pure water) of 0·046 volt to the critical value, 0·03 volt:

——	Concentrations.	Ratios of Concentrations.
KCl . . .	51	2500
$BaCl_2$ . . .	1·9	95
$AlCl_3$ . . .	0·020	1
$ThCl_4$ . . .	0·0070	0·35

These results show the enormous influence of the valency of the cation in a series of salts with the same univalent anion, and explain in a striking manner the analogous effects in the coagulation of lyophobic hydrosols. The exact value of the critical potential and the range of the critical zone will depend, of course, on the experimental definition of "rapid coagulation," and on the concentration, nature, and degree of dispersion of the hydrosol. It is not to be supposed, therefore, that these critical values are constants except under very definite conditions. The fundamental fact is that under given conditions the rate of coagulation of the particles of an oil suspension or of a lyophobic hydrosol undergoes a relatively sudden and very great increase when the interfacial P.D. falls below a certain finite value (positive or negative).

In discussing the "stabilities" of hydrocarbon oil emulsions, it must not be forgotten that I was dealing with very dilute *suspensions* of oil in water, produced by mechanical agitation without the addition of any "emulsifier." I pointed out that in the emulsification of oils in water by means of soap, the soap lowers the interfacial tension and concentrates at the interface. When we wish to produce oil emulsions in the ordinary sense of the term, we must use some such emulsifying agent, and for this purpose many substances are employed, such as soap, gum acacia, gelatin, casein, starch, etc., etc. All these substances concentrate or condense on the surfaces of the oil globules. If we may regard these surface films as very mobile from the molecular-kinetic point of view, it is clear that they will confer an increased degree of stability on the emulsion.

It is probable, however, that the stability of the emulsion is in many cases due to the fact that the surface films possess a very viscous, quasi-rigid, or gel-like character, so that a more mechanical explanation is necessary. As S. U. Pickering showed, oils may be emulsified in water by the gels of certain basic salts; and A. U. M. Schlaepfer has shown that emulsions of water in kerosene oil may be obtained by means of finely divided "carbon." Nevertheless, even in cases where an emulsifier is used, we may hope to succeed in obtaining a more precise physical analysis of the system. It is interesting in this connexion to note that Mr. W. Pohl has recently found in my laboratory that when a neutral hydrocarbon oil is emulsified in

water by means of sodium oleate, the electrical potential difference at the oil-water interface is almost doubled, and that the effects of alkalies and salts on this potential difference are very similar to those found in the case where no emulsifier is employed.

I cannot conclude this account of certain aspects of surface actions and properties without making a passing, though all too brief, reference to the beautiful investigations of Sir George Beilby on the amorphous layer. He has shown that when the surface of crystalline matter is subjected to shearing stress there is produced a surface layer of a vitreous or amorphous character—a "flowed" surface—in which the particular ordered arrangement of the molecules or atoms which is characteristic of the crystalline matter largely disappears. Working at University College, London, Dr. Travers and Mr. R. C. Ray have recently obtained a very interesting confirmation of the Beilby effect. The heats of solution (in kilogram calories per gram mol) of vitreous silica and silver sand (silica as crystalline quartz) in aqueous hydrofluoric acid were found to be 37·24 and 30·29 respectively. After grinding for fifteen hours the corresponding values were 36·95 and 32·46 respectively. If we assume that the internal energy of the amorphous phase produced by grinding is the same as that of the vitreous silica (silica glass), we can calculate from these results that about 31 per cent. of the crystalline silica has been converted by grinding into "amorphous" silica. The densities of silica glass and silver sand were found to be 2·208 and 2·638 respectively. After fifteen hours' grinding the density of the latter was lowered to 2·528. On the same assumption as before, it follows that about 26 per cent. of the quartz has been converted into the vitreous condition. The difference between the figures 31 and 26 is doubtless due to the approximate character of the assumption underlying the calculations and to experimental errors. There seems little doubt, however, about the soundness of the main conclusion—namely, that the mechanical action of shearing stress on crystalline matter is to produce a random molecular or atomic distribution in the surface layers.

Obituary.

Mr. J. M. Wilkie.

MR. JOHN MATTHEW WILKIE died on November 29 after an operation. He was born at Montrose in 1876, and was educated as a pharmaceutical chemist; after passing his minor in Edinburgh he went to Derby and later to London. In 1900 he was appointed as an assistant analyst, and eventually deputy chief analyst, in the laboratory of Boots Pure Drug Co., where he remained until his death.

Perhaps the best known of Mr. Wilkie's researches were the estimation of small quantities of lead, published with Mr. Harvey, the silver methods for the determination of phosphoric acid, and the alkaline iodine oxidation of phenols, the last two researches being published in the journal of the Society of Chemical Industry. He also devised a most ingenious method for the estimation of sulphur and oxidised sulphur compounds, which depended on the formation of acid by the bromine oxidation, but this research has only been published in abstract, as he was never quite satisfied that he brought it to a satisfactory completion. These sulphur oxidation methods have, however, been in use at Messrs. Boots' laboratory for some years with most satisfactory results. The last four years of his life was devoted to an almost monumental research on the determination of minimal quantities of arsenic. Step by step he patiently investigated the points of the method, and at the time of his death his work was concluded, and he was engaged in putting his notes into order for publication. This research was given to the world in abstract at the joint meeting of the Society of Public Analysts with the Nottingham Section of the Society of Chemical Industry at Nottingham on January 17 last.

As secretary to the Nottingham Section of the latter society from 1914 to the present year, he was largely responsible for the success of that Section and the great increase in the membership. He had just become chairman of the Section, and, although he had only presided at one meeting, he signalised that by inaugurating a discussion in which a large number of young members were persuaded to take part. It was always Wilkie's policy to encourage and bring forward young talent, so much so that at Mrs. Wilkie's special request he was borne to his last resting-place by the young men that he used to encourage and talk about so often.

THE issue of *Science* of November 23 contains an appreciative account, by "H. H. W.," of the life and work of Prof. Robert Wiedersheim, the distinguished professor of anatomy in the University of Freiburg, who died on July 12. Wiedersheim was born on April 21, 1848, at Nürtingen-am-Neckar, and went in succession to the Universities of Tübingen and Würzburg. At Würtzburg he obtained his M.D. and became assistant professor under Köllicker (1872–76). In 1876 he went to Freiburg as assistant to Prof. Alexander Ecker, whom he succeeded as professor of anatomy in 1887. This post he held until he retired from active work in 1918. Wiedersheim's work lay in the fields of human and comparative anatomy. In 1882 he published his "Lehrbuch der vergleichenden Anatomie der Wirbeltiere," following up this work with the "Grundriss der vergleichenden Anatomie," covering the same ground in a more concise manner. The last edition of the latter, the seventh, appeared in 1909. A modified translation of the "Grundriss," by Prof. W. N. Parker, was published in 1886 by Messrs. Macmillan and Co., Ltd. He also published a number of monographs, among which "Das Kopfskelet der Urodelen," that on the ear of the Ascalaboten, the anatomy of *Salamandrina perspicillata* and *Geotriton fuscus* are best known. With his death an outstanding figure in the history of the comparative anatomy of vertebrates has passed away.

WE regret to announce the following deaths:

Mr. George Wharton James, of Pasadena, California, known for his work on American Indian ethnology, on November 8, aged sixty-five.

Prof. H. Freeman Stecker, professor of mathematics in the Pennsylvania State College, a worker in non-Euclidean geometry, on October 30, aged fifty-six.

Current Topics and Events.

DR. G. D. LIVEING, who reaches his ninety-sixth birthday on Friday, December 21, may be assured that, in addition to the many personal friends who offer him congratulations on the maintenance of activity and intellectual interest at so great an age, chemists and other men of science, not only in Great Britain but also abroad, think of him with affection and esteem. He has had a remarkable life, and his contributions to scientific knowledge will long remain a permanent testimony to his care in experiment and caution in conclusion. Dr. Liveing went to St. John's College, Cambridge, was eleventh Wrangler in 1850, and in the following year was placed at the top of Class I. in the newly instituted Natural Sciences Tripos. He was elected to a fellowship at St. John's College in 1853, and became professor of chemistry in the University in 1861, a post which he filled until 1908. His name will always be associated with the growth and development of the Chemical Laboratories of the University. In 1879, Dr. Liveing was elected a fellow of the Royal Society, of which he was vice-president for two periods, 1891–2 and 1903–4. He was awarded the Davy medal in 1901 for his contributions to spectroscopy, and in making the presentation, the president of the Royal Society referred to Liveing's work as "one of the most valuable contributions to this department of chemical physics yet made by British workers." The work on spectroscopy was given to the world in numerous papers in the Proceedings of the Royal Society and the Cambridge Philosophical Society, and was brought together in 1915, in collaboration with the late Sir James Dewar, under the title "Collected Papers on Spectroscopy." Dr. Liveing holds the unique distinction of having been in residence at Cambridge for more than seventy-five years in unbroken succession, and his figure is probably well known to most living members of the University.

PROF. KLEINE of Berlin, who has just returned to Europe, has been investigating the therapeutic properties of a drug known as "Bayer 205" in Rhodesia and the Congo in cases of human sleeping sickness and trypanosomiasis of domestic animals—diseases which are such a serious handicap to the development of Africa. It is well known that salts of arsenic and antimony are able in many cases to control these diseases, but these remedies are far from satisfactory, and the remarkable results which were reported in Germany in 1922 in the treatment of experimental trypanosomiasis in animals and in dourine of horses with the new drug "Bayer 205," the composition of which has not yet been made public, aroused much enthusiasm. The completely satisfactory treatment of a human case in Hamburg, after arsenic and antimony had failed at the Liverpool School of Tropical Medicine, excited considerable interest. Other patients were treated at the London School of Tropical Medicine, and it became evident that in many cases the drug had a rapid action on the trypanosomes, and, so far as can be said at present, has effected a permanent cure. The one disadvantage is a certain irritative action on the kidneys, which, however, is not of a permanent nature. Prof. Kleine was granted permission by the British Government to conduct experiments in Rhodesia, and the published accounts of his work show that the hopes which were entertained were fully justified, and that cures can be effected in a large percentage of natives suffering from sleeping sickness even in its advanced stage. As regards the trypanosomiasis of domestic animals, he has noted that it is only efficacious in ridding them of trypanosomes which are most closely related to those which produce disease in man. Experiments on the prophylactic action have shown that if cattle which are to be exposed to the bites of tsetse flies are given an injection of the drug before exposure, the chances of infection are reduced, and even if infection does occur its course is considerably modified. It is understood that Prof. Kleine will, in the near future, give an account in London of his experiences.

IN some cases the American graduate appears to receive a farewell address of the nature of a "pastoral charge" before he leaves the university to make his own way in the world. Such an occasion obviously encourages platitudes, but we may be grateful that the issue of *Science* for October 19 enables Prof. Millikan's address to a graduate class at Stanford University, California, to reach a wider public. He recalls that Senator John Sherman, when addressing a class of graduates in 1891 in which Millikan was included, told them their problem was to make democratic government work in a country three thousand miles one way, by two thousand the other, a government and a country which had been preserved to them by the sacrifices made to them by his generation. Now, as the result of untold sacrifice, 1923 finds the world, by no means yet ready for the task, presented with the problem of making democracy work on a huge scale, not only in the United States of America but also in almost every important nation on earth. Prof. Millikan finds that one of the greatest contributions that science makes to the problem is the discovery that progress is in general made by the evolutionary process. "The whole of Newton is incorporated in Einstein." He decides that if bullets are to be replaced by ballots it will only be "because the nations of the earth learn to take a more rational, a more objective, a more scientific attitude towards life and all its problems." . . . "For in the jungle ignorance and prejudice and impulse and emotion must determine conduct, and so long as that is the case none other save the law of the jungle is possible." Prof. Millikan has no nostrum to propose to eliminate the jungle influence, but looks to "the slow growth of a larger degree of both public intelligence and public conscience than we now have. Intelligence enables one to know better what he ought to do, while conscience keeps him doing as he knows he ought." He concludes that "science, imbued with the spirit of service, which is the essence of religion, and religion guided by the intelligence, the intellectual honesty, the objectiveness and the effectiveness which is char-

acteristic of the spirit of science, can between them, without a shadow of doubt in view of the rate at which discoveries are now being made and at which changes are being brought about, transform this world in a generation."

AT a recent meeting of the Zoological Society, Mr. R. T. Gunther exhibited some vertebræ of a marine Jurassic crocodile, Steneosaurus, which were marked on the sides with discoloured grooves apparently due to contact with blood-vessels. In a letter to the *Times* of December 7, he reported that a dissection of the intercostal arteries of a modern crocodile by Mr. R. H. Burne had confirmed this idea, and he suggested that the unusual markings may have been produced by some calcification of the arteries due to a gouty condition, perhaps in old age. As the appearances are almost unique, Mr. Gunther has presented one of the vertebræ to the Geological Department of the British Museum, where it is now exhibited. The discovery led Prof. Elliot Smith, in a letter to the *Times* of December 12, to recall observations of blood-stains on human bones from Egypt and Nubia, from 4000 to 5000 years old, made by Prof. Wood Jones and himself. In a subsequent letter to the *Times*, Mr. Reid Moir advises caution in interpreting red or brown stains on fossil bones as marks of blood, most of these being evidently due to the deposit of oxides of iron by percolating water.

THE Library of the Chemical Society will be closed for the Christmas holidays from Monday, December 24, until Thursday, December 27, inclusive.

SIR CHARLES SHERRINGTON has received an official communication from the Institut de France informing him that he has been elected a corresponding member of the Section of Medicine and Surgery of the Paris Academy of Sciences, in succession to the late Sir Patrick Manson.

THE Christmas Juvenile Lectures at the Royal Institution, "Concerning the Nature of Things," to be delivered by Sir William Bragg, commence on Thursday, Dec. 27, at 3 o'clock. Succeeding lectures are on Saturday, Dec. 29, Tuesday, Jan. 1, Thursday, Jan. 3, Saturday, Jan. 5, and Tuesday, Jan. 8.

THE Board of Trade announces that by virtue of the Importation of Plumage (No. 2) Order, 1923, the green (or Japanese) pheasant (*Phasianus versicolor*), order Galliformes, and the copper pheasant (*Phasianus Soemmerringi*), order Galliformes, have been removed from the schedule to the Importation of Plumage (Prohibition) Act, 1921. The importation of the plumage of the above-mentioned birds will, therefore, not be permitted without licence on and after January 1, 1924.

THE *Illustrated London News* of December 15 publishes an account by Mr. R. C. Andrews of the discovery of eggs of deinosaurs in the Cretaceous rocks of Mongolia, with excellent photographs of some of the specimens. To emphasise the fact that at least one egg attributed to a deinosaur has been known for many years, it also publishes a photograph of fragments of this egg which have long been in the British Museum. The earlier specimen was found with part of the skeleton of Hypselosaurus in an Upper Cretaceous formation in Provence, France, and the outer surface of the shell is tuberculated like that of the new eggs.

THE following committee has been appointed by the Royal Academy to investigate the quality of artists' materials and the various methods of cleaning old pictures: Sir Aston Webb, Mr. S. J. Solomon, Mr. G. Clausen, Mr. C. Shannon, Prof. A. P. Laurie, Sir Herbert Jackson, Sir Arthur Schuster, Dr. A. Scott, Mr. C. F. Cross, Dr. W. W. Taylor, Dr. R. S. Morrell, Mr. N. Heaton, Mr. P. Tudor-Hart, Mr. J. D. Batten, and Mr. F. E. Jackson.

IN the notice of a "scientific novel" in NATURE of September 1, p. 320, Mr. H. G. Wells was mentioned as the first to exploit in imaginative literature the idea of liberating the energy of the atom. Prof. W. A. Osborne, of the University of Melbourne, thinks this is incorrect, and remarks in a letter to us, "I should not be surprised if the first use in fiction of the possibility of unlocking atomic energy occurred in 'The Crack of Doom,' by the late Mr. Robert Cromie. This story was published in 1895 by Digby Long, and shortly afterwards a cheap reprint appeared from the house of Newnes."

A SERIES of articles on the reconstruction of Tokyo has recently appeared in the *Times* (December 12, 13, and 15). The total value of the houses destroyed in the city is estimated at about 146 million pounds, the number of houses lost being 224,567, of which more than 97 per cent. were burnt. According to Prof. Ichikawa, fire broke out after the earthquake in the building adjoining the University Library. The water supply had already ceased, and, although every effort was made to screen the various rooms, the fire swiftly penetrated into them, the destruction of the library and the greater part of its contents being the work of a few moments.

THE Prince of Wales has consented to become the first member and president of the Fellowship of the British Empire Exhibition, a non-party organisation which has been formed to promote Empire unity. The subscription for membership, two guineas, entitles the member to a certificate of membership, a badge, and a season ticket to the Exhibition at Wembley. The funds thus raised are to be devoted to scholarships for university or technical education, each of the value of 1000*l*. No details are given of the conditions of awards except that candidates must be citizens of the British Empire and either members of the Fellowship or nominated by members. In accepting the presidency of the Fellowship, the Prince expresses the hope that its programme of Imperial education and settlement scholarships will play a valuable part in promoting knowledge of the Empire.

IN addition to the letter from Dr. H. H. Mills, printed in last week's NATURE, page 865, we have received several others in which different views are expressed upon Mrs. Hertha Ayrton's scientific work and influence from those given by Prof. Henry E. Armstrong in the obituary notice which appeared

in our issue of December 1. One of the subjects especially referred to is the anti-gas fan, of which it is pointed out that more than 100,000 were used during the War. As, however, a full discussion of this device as a protection from gas attacks appeared in 1920 in vol. 105 of NATURE, pp. 336, 422, 453, and 612, and Mrs. Ayrton herself took a leading part in it, no useful end would be served by going over the same ground again. With regard to her work on the electric arc, it may be remarked that an appreciation of it appeared in the Journal of the Institution of Electrical Engineers for October last, over the initials of a distinguished authority on electrical engineering.

IN view of the high standard of the essays sent in for the R. 38 Memorial Prize, 1923, the Council of the Royal Aeronautical Society has decided to increase the amount for this year only from 25 guineas to 40 guineas, and to divide the prize between the papers on "The Aerodynamical Characteristics of the Airship as deduced from Experiments on Models, with Application to Motion in a Horizontal Plane," by Mr. R. Jones, and "A Detailed Consideration of the Effect of Meteorological Conditions on Airships," by Lt.-Col. V. C. Richmond and Major G. H. Scott. Both these papers will be published in the Journal of the Royal Aeronautical Society, together with the paper on "The Strength of Rigid Airships," by Mr. C. P. Burgess, Commander J. C. Hunsaker, and Mr. Starr Truscott, which the Council mentions as deserving special commendation. Intending competitors are reminded that the names of entrants for the 1924 prize should be sent in to the Secretary, Royal Aeronautical Society, 7 Albemarle Street, London, W.1, on or before Dec. 31; the last date for the receipt of the papers is March 31, 1924.

THE annual exhibition of the Physical Society of London and the Optical Society, which is to be held on Wednesday and Thursday, January 2-3, at the Imperial College of Science and Technology, South Kensington, will be open in the afternoon (3-6 P.M.) and in the evening (7-10 P.M.). Mr. H. B. Grylls will give a lecture on "The Heape and Grylls Rapid Cinema Machine" at 4 P.M. on January 2 and at 8 P.M. on January 3. Sir Richard Paget will give a lecture on "The Nature and Artificial Production of Human Speech (Vowel Sounds)" at 8 P.M. on January 2 and at 4 P.M. on January 3. More than fifty firms are exhibiting scientific apparatus, and a number of experimental demonstrations have been arranged. Invitations have been extended to the Institutions of Electrical and Mechanical Engineers, the Chemical Society, the Radio Society of London, the Röntgen Society, and the Faraday Society. Admission in all cases will be by ticket only, and members of the above Societies should apply to their secretaries. Others interested should apply direct to Prof. A. O. Rankine, hon. secretary of the Physical Society, Imperial College of Science and Technology, South Kensington, S.W.7.

SCIENTIFIC work in Egypt has just lost a strong supporter owing to the retirement of Mr. E. M. Dowson from the post of Financial Adviser to the Egyptian Government. This post is the highest in the Egyptian Government Service open to a non-Egyptian. Mr. Dowson joined the Service in 1901 as a member of the Survey Department, and on the retirement of Colonel Lyons in 1909, was made Director-General. During the latter part of the War he acted as Under Secretary of State for Finance and later as Financial Adviser, to which post he was definitely appointed in 1919. Having been head of a scientific department he knew the importance of scientific research to the progress of a country and fostered it in every way he could. Of the work carried out under his direction one may mention the geodetic triangulation of Egypt and the precise levelling of the Nile valley. He was also responsible for a number of improvements in the organisation of scientific work under the Egyptian Government, including the formation of the Cotton Research Board and the transfer of the Physical Service to the Ministry of Public Works as a separate department.

A USEFUL piece of work has been done by the British Industrial "Safety First" Association in issuing a revised and extended version of the illustrated pamphlet by Mr. Leon Gaster on "Good Lighting as an aid to Safety." The underlying principles of good lighting are based on a great deal of patient scientific work and somewhat complex investigations, but the main conclusions are here set out in quite simple terms and are illustrated by many telling sketches and photographs. There are, for example, pictures showing how various forms of accidents may be caused by bad lighting, and charts indicating how the frequency of industrial accidents is greatest during the dark winter months. Examples of improved output following the adoption of scientific methods of lighting are quoted, and it is pointed out that the cost of adequate illumination is usually less than 1 per cent. of the cost of production. Reference is also made to lighting conditions in mines and on the railways. The chief recommendations of the Home Office Departmental Committee on Lighting in Factories and Workshops are explained, and the classification of operations into two classes, "fine work" (requiring not less than 2-ft.-candles, and "very fine work" (requiring not less than 5-ft.-candles), is incorporated in the booklet as an appendix.

IN consequence of the existence of the Colorado beetle in France, and in order to prevent the introduction of this dangerous pest into England and Wales, the Ministry of Agriculture and Fisheries deemed it necessary in the early part of 1923 to issue an Order (the Colorado Beetle Order of 1922) which in effect prohibited the entry into Great Britain of living plants and vegetables grown in a wide area in France. Following representations made to the Ministry, and as a result of the visit of investigation to the infected region in France which was made by the Ministry's entomologist during the autumn, it has now been decided to amend the regulations. The Colorado Beetle Order of 1923 has accordingly been issued and came into operation on December 17, revoking the corresponding Order of 1922. The effect

of this new Order will be that in place of the declaration required at present, each consignment of living plants, potatoes, or tomatoes shipped from ports in European France to Great Britain must in future be accompanied by a particular certificate or copy certificate, which must be delivered to an Officer of Customs at the same time and together with the entry relating to the consignment. In future no certificate or declaration of any kind will be required in the case of vegetables for consumption other than potatoes or tomatoes.

A SERIES of articles on "Science and Industry in America," from the pen of Dr. W. Rosenhain, has recently appeared in the *Engineer*, and in the concluding article, on October 26, the author sums up his impressions derived from visits to a large number of scientific and industrial laboratories in North America. It is remarkable that the enormous development of certain laboratories devoted to industrial research, whether under the management of a commercial body, such as the General Electric Co., or of a Government department, such as the U.S. Bureau of Standards, has noticeably had a paralysing effect on the universities, some teachers of science imagining that it is useless for them, with limited equipment, to enter into competition with such great institutions. Such an impression, as the author remarks, would be most unfortunate if it were to become general. The employment of so many competent physicists and chemists in industry has to some extent injured the scientific staffs of the universities, and the standing of the men in charge of teaching and research is not always as high as might be expected from the wealth and population of the country, and from the vast sums expended on buildings and equipment. On drawing up a list of the most eminent men in various branches of scientific investigation, the proportion of Americans is disappointingly small, when the resources of the country are taken into account. This attitude of America towards science and its applications is recognised and deplored by American men of science themselves, and it is a subject of speculation how long it will take so great a nation to awake to the necessity of a change in this respect.

BULLETIN No. 717 of the Department of the Interior, Washington, is on "Sodium Sulphate: its Sources and Uses," by R. C. Wells. This pamphlet deals with the mineral forms of sodium sulphate together with salt cake, nitre cake, and Glauber's salt. The sulphate process of making wood pulp is also described. The booklet is well illustrated with diagrams of crystal forms, equilibrium diagrams, etc.

WE have received from the Canadian Department of Mines a copy of a report on titanium by A. Robinson. The three parts into which the book is divided deal with the metal and its compounds, its occurrences in Canada, and the production and uses of the metal respectively. The book is well illustrated with maps and diagrams. The uses to which titanium and its compounds may be put are fully discussed. These include its use in the metallurgy of steel, arc light electrodes, pigments, mordants, and in the ceramic industry.

Our Astronomical Column.

MERCURY AN EVENING STAR.—Mercury will be visible to the naked eye on a few evenings at the end of December, the planet being above the horizon more than $1\frac{1}{2}$ hours after sunset. At about 5 P.M., Mercury will be visible on very clear evenings a little above the W.S.W. horizon, shining with a rosy light and scintillating after the manner of a fixed star. The brilliant planet Venus will be situated about 8° to the eastwards and afford a clue to the exact position of Mercury, which will shine with far less lustre. A field-glass might be employed to advantage. Early in January, Mercury will disappear from the evening sky, but Venus will remain very conspicuous in the twilight during the ensuing winter and spring months.

THE EINSTEIN SHIFT IN THE SOLAR SPECTRAL LINES.—Allusion was made in this column recently to the announcement of Prof. C. E. St. John that he was satisfied that this shift really exists. He gave further details in a paper read at the meeting of the Royal Astronomical Society on December 14; in his previous researches he had felt it necessary to confine himself to lines that are not subject to pressure shift. But now that the pressure in the photosphere is proved to be low, the choice of suitable lines for measurement is greatly widened. In studying the wave-lengths of iron lines at the centre of the sun's disc and at different levels in the photosphere, he finds a shift in excess of Einstein at the highest levels, in agreement with Einstein at the middle levels, and in defect at the lowest ones; these could be explained by downward and upward currents in the respective regions, superposed on the general Einstein displacement. He also found the latter displacement at the sun's limb; here, too, some other influence was superposed on it; scattering due to the greater thickness of solar atmosphere traversed by the rays was suggested. Mr. Evershed expressed himself in full agreement with the conclusions, but Prof. Newall thought the evidence was still not decisive, as many other disturbing influences were at work on the sun, *e.g.* the Stark effect, polarisation and anomalous dispersion; the observed displacement might be due to these.

FIXED CALCIUM CLOUDS IN INTERSTELLAR SPACE.—Mr. J. S. Plaskett has made an examination of the radial motion indicated by the calcium lines in some Cepheid stars of early type which have been found not to partake of the periodic shift of the other spectral lines. It has for some time been considered that these stars are surrounded by calcium clouds. It is now found that these clouds in various regions of the heavens appear to be stationary relatively to the general system of the stars. The clouds would thus seem to be independent of the particular stars showing the lines, and it was suggested at the meeting of the Royal Astronomical Society on December 14 that there might be a general diffusion of calcium vapour throughout the stellar system, but that in most stellar spectra its presence is masked by the strong H and K lines belonging to the stars themselves. Various difficulties were referred to in the discussion. Some thought that the clouds would be luminous and show bright lines; another difficulty is the practically perfect transparency of the stellar spaces which Dr. Harlow Shapley deduced from his work on the globular clusters. The subject is still somewhat obscure.

Research Items.

EARLY HITTITE RECORDS.—Valuable additions to our knowledge of the early history and political relations of the peoples of Western Asia are made by Prof. Sayce in the concluding part of *Ancient Egypt* for the current year, which has just appeared. Prof. Sayce translates some of the early cuneiform Hittite tablets, recently published by Dr. Forrer, which relate the campaigns of Sargon of Akkad and Naram Sin in Asia Minor. Naram Sin's enumeration of seventeen kings who formed an alliance against him includes rulers of cities in Babylonia, Northern Syria, and Eastern Asia Minor, and proves the intimate connexion which existed between all parts of Western Asia in the third millennium B.C. From one of the Boghaz-Keni tablets, in a record of a later King Telibinus, we now learn that the leader of the Hittite invasion of Babylonia, about 1900 B.C., which overthrew the Amorite dynasty of Khammurabi, was Mursilis I. Telibinus also gives a list of the cities over which he ruled, including Damascus. This is the earliest mention of this city in cuneiform tablets. It indicates that the Hittite sovereignty extended southward as far as the northern boundary of Palestine, and explains how Hittite settlers found their way to Hebron in the time of Abraham.

MATHEMATICAL WORK OF JAMES GREGORY.—In vol. xli. of the Proceedings of the Edinburgh Mathematical Society, Prof. G. A. Gibson gives a critical and historical account of the work of James Gregory. To the ordinary student of mathematics, Gregory is now known almost solely as the man who first used the phrase "converging series" as a technical term, and as the author of the series for $\tan^{-1}x$. The latter series is comparatively unimportant, not a fundamental series like Taylor's, and it is very unlikely that it would have been associated with Gregory's name but for the part it played in the Newton-Leibniz controversy. Yet all contemporary references to Gregory show that he was considered to be among the first mathematicians of his day, quite apart from his fame as the author of the "Optica Promota." Undoubtedly the books he published were of sterling merit, though comparatively few references to them exist in modern mathematical literature.

AL-RAZI [RHAZES] AS A PIONEER CHEMIST.—In No. 3-6 of vol. xliv. of the *Deutsche Literaturzeitung* (Berlin, 1923), Prof. Julius Ruska, of Heidelberg, has an article on the contributions to chemistry of the Persian physician Al-Razi (died A.D. 923 or 932). He points out that a satisfactory history of Islamic medicine and chemistry is still lacking, and remarks that it is necessary to get back to the texts themselves. According to Prof. Ruska, Al-Razi's chemistry, as found in his "Book of the Secret of Secrets," is characterised by the inclusion of a good deal of new material unknown to the Greek alchemists, and also by the classification of chemicals into three classes, according to their origin from animals, plants, or minerals. Prof. Ruska attributes to Al-Razi in addition (*a*) the introduction of sal-ammoniac, and (*b*) the first systematic and well-organised treatment of particular chemical reactions; here, however, he is inaccurate, since Jabir ibn Hayyan (died about A.D. 813) mentions sal-ammoniac very frequently, noting both the natural product and that made from hair, and also devotes several small books to a consideration of such operations as calcination, distillation, sublimation, etc. As Al-Razi was certainly well acquainted with Jabir's books, it is clear that a great deal of the credit for the pioneer work to which Prof. Ruska refers must be given to the latter chemist. It is interesting to note how modern research is restoring to the Muslims the great reputation for chemical skill which they possessed for so long, though it suffered heavily in the latter half of the nineteenth century.

PHYTO-PATHOLOGY IN HORTICULTURE. — The *Gardener's Chronicle* for November 3 contains, under the general title "The Relation between Horticulture and Phyto-Pathology," the first instalment of a paper by Prof. Johanna Westerdijk, read at the International Horticultural Congress at Amsterdam in September last. Dealing with problems of unusual difficulty, this paper seems to be singularly clear and precise, and is none the less valuable for its frank recognition of the numerous lacunæ in our scientific knowledge of the life-history and method of spread of many important horticultural diseases. The present instalment contains a wealth of data upon two important problems—(1) the need for sterilisation of seeds in the case of certain diseases and the methods adopted in various countries in such processes of sterilisation; (2) the successful growth of plants in "sick" soils by the genetic selection of resistant strains.

TREES OF THE GOLD COAST.—The Bulletin of the Imperial Institute, volume 21, No. 2, 1923, contains an interesting account of the trees of the Gold Coast, which is based upon information supplied by Dr. J. M. Dalziel, senior Sanitary Officer of the Gold Coast, and illustrated by four excellent photographs. The trees described occur mainly in the deciduous forests of what is sometimes called the Sudan zone of vegetation. From the forestry point of view the trees are not of great value, but they have many local uses for timber, fibre, gums, and fuel, etc., while the fat of the shea-butter tree (*Butryospermum Parkii*) gives to the open park-savannah forests considerable economic value.

OCEANOGRAPHY OF THE JAVA SEA.—A gap in the oceanographical knowledge of the waters of the Malay archipelago has been filled by the researches of Mr. K. M. van Weel in the Java and South China seas from 1917 to 1920 (Meteorological and hydrographical observations in the western part of the Netherlands East Indian Archipelago: *Treubia*, vol. iv. pt. 1-4, 1923). The lengthy memoir is accompanied by a portfolio of 28 distributional charts. The floor of the Java Sea is shown to slope gently downwards from Sumatra towards the east, barely reaching a depth of 100 metres to the west of Macassar Strait. East of the 100 metre isobath the depths appear to increase suddenly, but this is outside the area of Mr. van Weel's survey. A remarkable feature is a deep channel in Sunda Strait between Sumatra and Java. An erosion channel caused by a strong current moving out of the Java Sea suggests itself, but this explanation does not fit the facts. Mr. van Weel is disinclined to regard it as a tectonic chasm as has been suggested, and leans to the belief that it represents the sunken valley of a large river. He accepts Molengraaff's pleistocene continent on the site of the Java and China seas, and regards the Sunda submarine channel as a submerged feature of that land. All hydrographical as well as a number of meteorological observations are given in full.

RIVER POLLUTION.—The pollution of the River Tyne, and its deleterious effect on the salmon fisheries

is the subject of a well-written paper by Miss E. M. Meek in the report of the Dove Marine Laboratory for 1922–23. Fifty years ago the salmon fisheries of the Tyne were more than ten times as prosperous as they are to-day, and almost conclusive evidence is now given to show that the decline of this industry is due to sewage pollution. The paper is of general interest since it is illustrated by a series of curves correlating the effect of sewage contamination upon the oxygen content of the water. The result of an experiment on *Zoarces viviparus* indicates that the toxicity of the sewage is directly due to foreign substances in the sewage and not to the reduced oxygen content of the water. It would be interesting to know to what extent sewage must be diluted in order that this fish can continue to breed under experimental conditions; also, what is the direct effect, if any, of the reduced oxygen supply.

BOUNDARIES IN THE UNITED STATES.—Bulletin No. 689 of the United States Geological Survey is a complete account of the boundaries, areas, geographic centres and altitudes of all States in the United States, including oversea possessions. It is a revised and enlarged edition of a bulletin that was first published in 1885 and has been republished with additions several times since that date. A brief introduction discusses how boundaries are established and changed, but the greater part of the volume deals with the boundaries of the different States. Full details of the present position of the boundaries and of all past changes are given, with detailed references to treaties and other State documents. In addition to a number of sketch maps, there is a large reproduction of the second edition of the Mitchell map of the British and French dominions in North America as printed in 1774 or 1775. This was the map that was used in forming the peace treaties of 1782 and 1783, for in spite of its imperfections it was the best available at the time. A coloured map shows the routes of the principal explorers from 1501 to 1844 in the territory now covered by United States jurisdiction. The publication contains a great deal of valuable material for the study of the evolution of boundary lines and frontiers.

PHILIPPINE EARTHQUAKES.—The Philippine archipelago is one of the most active seismic regions in the world; yet, near its centre, lies the long narrow island of Cebu, in which, for the last four centuries, almost the only earthquakes felt have come from outside. On this account, the earthquakes that may be considered as belonging to it are of interest, if only in showing that historic time may be too brief to reveal all the areas of seismic change. One earthquake that caused slight damage in Cebu occurred in 1887, and a second on February 28, 1922. The latter is the subject of a brief report by the Rev. M. Saderra Masò, the historian of Philippine earthquakes (Bulletin of the Weather Bureau, Manila, for February 1922). The area of damage included the capital city Cebu and the small island of Mactan to the east. In the channel between the islands, beneath which the origin probably lay, unusual movements of the sea were observed, and on the same day, but at an unknown hour, the cable crossing it was broken.

SUB-SURFACE GEOLOGY IN OILFIELDS.—Until the last few years, sub-surface structural analysis in oilfield work tended to be a very haphazard process. Too often subterranean structures have been described in terms of mapped surface evidence, and methods of correlation of well-log data have been in the main of a somewhat crude character, until the technique of palæontology and petrology was acquired in dealing with the evidence adduced from drilling operations. Some recent reports of petroleum geologists attached to the United States Geological Survey have shown that the necessity for more detailed work of this character is now fully appreciated, and a great deal of minute investigation is being prosecuted in this connexion. It is therefore somewhat of a surprise to see that in the case of the sub-surface study of the Pershing oil and gas field, Osage County, Oklahoma, the author, Mr. W. W. Rubey, has adopted methods depending almost entirely on drillers' reports, graphic well-logs, field-statistics, and the like, rather than the more highly technical and certainly more convincing methods of study. It is open to doubt as to how far graphical methods of interpreting oil-well behaviour lead to really important evidence which may be used as a basis of deduction of subterranean conditions and as a guide to the future course of developments of the oilfield concerned. As criteria of geological circumstances, individual or even collective oil-well performances are of doubtful value if studied without reference to as comprehensive a knowledge of the unexposed rocks as possible. It is not to be expected of the average driller that he is trained in even the elements of lithology; his terminology is necessarily crude and in many instances untrustworthy. It is for the geologist to analyse and name the samples, just as it is his business to use those results for precise correlation below ground. Thereafter, by co-ordination of such evidence and all other statistical data furnished during the life-history of each well, he is in a position to supply the operators with all the information necessary to economical development of the field as a whole.

RAINFALL IN SUMATRA.—The Royal Magnetic and Meteorological Observatory at Batavia has recently published, in Verhandelingen No. 11, a summary of rainfall in the northern part of "Sumatra's Oostkust," by Dr. J. Boerema. The observations are made at the official rainfall stations and the figures are not used unless they cover a period of at least 5 years. There are 288 stations available and in addition 22 stations in Atjeh and 4 in Tapanoeli. Monthly and annual results have been calculated for a normal period of 20 years. Maps for the year and for each month show the areas of equal amounts of rainfall for practically the whole country; also the months of maximum and minimum rainfall. It is estimated by discussion that a monthly mean rainfall calculated from 5 years' observations may differ to the extent of 40 to 50 per cent. from the average obtained from a long series of observations, say 35 years; in the case of 10 years' observations, the deviations are reduced to about half that value. For 30 years the difference from the 35-year normal is only 3 per cent. The rainfall increases from the coast to the mountains, the annual map showing a general rainfall of about 60 to 100 inches near the north-east coast to about 150 to 260 inches in the mountains. An annual average of 263 inches is given at Bandar Baroe. The rainiest season is October and November, with a secondary maximum in April and May. The double tropical periods of rainfall are scarcely disturbed by the monsoons. The minimum rainfall occurs in February and June. Statistics are given of the monthly and annual amount and frequency of rainfall at all stations. More than ordinary interest is associated with the carefully worked results since Sumatra is divided by the equator and falls about equally in the Northern and Southern Hemispheres. Such discussions are of the highest value to the world's meteorology.

HEAT CONDUCTION IN LIQUIDS.—In the issue of the Proceedings of the American National Academy of Sciences for October 15, Prof. P. W. Bridgman, of Harvard, gives a summary of the results of his measurements of the heat conductivities of 15 liquids at 30° and 75° C., and at pressures up to about 12,000 atmospheres. The liquids were placed between two concentric metal cylinders, to the inner of which heat was communicated electrically and the difference of temperature of the two measured. For all the liquids tested, with the exception of water, the conductivity decreases as the temperature rises, and increases with rising pressure. For the more compressible liquids the conductivity at a pressure of 12,000 atmospheres is nearly three times that at atmospheric pressure. If the transfer of energy from molecule to molecule is assumed to take place with the speed v of sound in the liquid, the thermal conductivity should be $4v/d^2$, where d is the distance apart of the centres of consecutive molecules. This relation is shown to be satisfied approximately.

FIRING WITH PULVERISED COAL AND BLAST FURNACE GAS.—The firing of coal in a pulverised condition, that is, 90 per cent. through a 100 mesh screen (100 holes to the linear inch) and 65 per cent. through a 200 mesh, is attracting some attention in Great Britain. In the United States about 30,000,000 tons of coal per annum is being burnt in the pulverised condition, chiefly in the iron and steel, cement, and glass industries. Since 1920 the rapid growth in the application to steam generation has been remarkable, and very soon about 3,000,000 tons per annum will be absorbed in this one operation, although little or no progress has so far been made in Great Britain. One advantage of pulverised coal is that it will work in conjunction with blast furnace gas. In the operations of the blast furnace a large volume of low-grade gas is given off, averaging 90-110 B.Th.U. per cubic foot, with a composition of about 24¾ per cent. carbon monoxide, 5¾ per cent. carbon dioxide, 2½ per cent. hydrogen, ¾ per cent. methane, and 66½ per cent. nitrogen. As a rule the surplus gas is burnt on very crude lines under steam boilers, and because of the great fluctuations in the supply, generally coal has to be used as an auxiliary fuel. This gives bad results, since it is difficult to keep pace with the variations in the gas supply. For these conditions, however, pulverised fuel is good, since it is almost as easy as gas to regulate and adjust, and can be started up or shut down in a few minutes. A good example of this principle is the huge River Rouge power plant of the Ford Motor Co. at Dearborn, Detroit, where 70 per cent. blast furnace gas and 30 per cent. pulverised coal is burnt without difficulty. It has been stated that by neglecting this means of utilising blast furnace gas, Great Britain is at present wasting more than 1,000,000 h.p.

THE EARTH'S ELECTROSTATIC FIELD.—In the September issue of *Terrestrial Magnetism and Atmospheric Electricity*, Dr. S. J. Mauchly reviews the evidence now available as to the daily variation of the potential gradient in the air over both land and sea. The land observations were made at nearly 20 stations between Cape Thordsen in latitude 78° north and Cape Evans in latitude 77° south, and the ocean observations on board the magnetic observing ship *Carnegie* in the Pacific, Atlantic, and Indian oceans. Dr. Mauchly finds that as a first approximation the gradient varies daily from 80 or 90 volts per metre at 4 o'clock to 110 or 120 volts per metre at 18 o'clock Greenwich mean time at all land and sea stations. There appears to be some variation of the magnitude of the daily change and of the time at which the maximum gradient is attained, with the season of the year and with the locality, but these are not sufficient to invalidate the general conclusion. In mid-Pacific and at land stations during June and July, a reduction of the amplitude of the daily change makes it evident that there is also a 12-hour wave, but the observations are not yet numerous enough to justify conclusions being drawn as to its nature and its generality.

SYNTHESIS OF BENZENE.—The classical experiment of Berthelot on the polymerisation of acetylene to benzene, made so far back as 1858, was a fundamental synthesis of benzene, and is still quoted in the text-books. The yield of benzene and allied hydrocarbons, however, was so small that much experimental skill was necessary to prove their presence. The results were not greatly improved by the use of catalysts, the main action in all cases being the decomposition of the acetylene into its elements. In the *Comptes rendus* of November 5 of the Paris Academy of Sciences, N. D. Zelinsky describes experiments on the polymerisation of acetylene in the presence of activated wood charcoal at 640° to 650° C. Under the conditions described, more than 70 per cent. of the weight of the acetylene passed over the charcoal was converted into liquid products. From this liquid absolutely pure synthetic benzene (303 gm.) was obtained, and other substances isolated from the condensate included toluene, *p*-xylene, styrol, indene, naphthaline, fluorene, and anthracene.

SCOTT-STILL MARINE ENGINES.—A great deal of experimental work on the Still engine has now been done by Messrs. Scotts' Shipbuilding and Engineering Company of Greenock, and their experience has enabled the firm to consider the application to actual vessels. The m.s. *Dolius* is now fast approaching completion, and is the first in which a large-scale installation of Scott-Still engines has been fitted. In this system the cylinder on one side of the piston is used as an oil engine (two-stroke Diesel cycle) and on the other side as a steam engine. The water in the jackets is kept at working steam pressure, and any heat passing through the cylinder walls is used to generate steam. Heat is also recovered from the exhaust gases by means of a regenerator, and also by a feed heater. The m.s. *Dolius* is 400 ft. long and has a displacement of 11,650 tons. The total power of 2500 b.h.p. is divided between two main engines of four cylinders, each 22 in. diameter and 36 in. stroke, and running at 115 to 120 revs. per min., giving a ship speed of about 11 knots when fully loaded under service conditions. Steam is generated at about 140 lb. per sq. in., and is first employed at the back of the piston in one cylinder acting as a high-pressure piston, and then is taken to the other three cylinders, which together act as the low-pressure cylinder. Official trials of the engines have been made by the Marine Oil Engine Trials Committee appointed by the Institutions of Mechanical Engineers and Naval Architects. Their report has not yet been issued, but the following summary is available: Average mean effective pressure, oil engine, 77·8 lb. per sq. in.; average m.e.p. steam cycle referred to oil engine volume, 6·6 lb. per sq. in.; total average m.e.p., 84·4 lb. per sq. in.; revs. per min., 122; total indicated horse-power, 1425; brake horse-power, 1251; mechanical efficiency, 87·8 per cent.; oil consumption per b.h.p. per hour, 0·356 lb.; steam evaporated per hour, 2400 lb. An account of the engine, with photographs and drawings, appears in *Engineering* for November 23.

The British Empire Exhibition, 1924.

WIDESPREAD interest throughout the British Empire and elsewhere was aroused by the Imperial Conference, attended by statesmen and representatives from the constituent parts of the Empire, which recently concluded its sittings in London. Among the subjects dealt with at this historic gathering was the natural resources of the Empire and their exploitation, and practical expression to many of the points raised will be given by the British Empire Exhibition to be held next year at Wembley. During the summer months, from April until October, the Exhibition will be a centre of attraction throughout the British Empire and indeed throughout the world. The immediate object will be to furnish a display of the natural resources of the countries of the British Empire and the activities, industrial and social, of their peoples; the ulterior motive is the promotion of Imperial trade. In effect, it should be an impressive spectacle demonstrating the progress of civilisation.

The scheme for a British Empire Exhibition was put forward in 1913 by the late Lord Strathcona, but it was not until 1919 that definite steps were taken to promote such an exhibition. A provisional committee secured the approval of the Board of Trade, the King graciously consented to become patron, and in June 1920 the project was formally launched at a meeting held at the Mansion House. The Prince of Wales became president of the general committee, and in December 1920 an Act of Parliament was passed authorising the Government to contribute to the guarantee fund, and the Dominions Overseas were formally invited to take part in the Exhibition. A site of 150 acres, since increased to 200 acres, was selected at Wembley, and work was commenced.

The magnitude of the part in the Exhibition which will be taken by the Dominions Overseas can be gathered from the following figures: at the Paris Exhibition of 1900, they had 60,000 sq. ft.; at the White City in London in 1908, 110,000 sq. ft.; at Wembley they are having 600,000-700,000 sq. ft. of space. Most of the Dominions are building pavilions to display their exhibits. Australia is spending a quarter of a million pounds on its display; the Indian Empire, about 167,000*l.*; New Zealand, a minimum of 60,000*l.*; and the other Dominions, amounts in accordance with their size. The building for Australia alone covers 150,000 sq. ft., while the Government of India has occupied 100,000 sq. ft.

Other noteworthy buildings within the grounds are the Palaces of Industry and Machinery, and the agriculture section, which will house the Home Country exhibits, and a building for the conferences which are to be an important feature of the Exhibition. To turn to a lighter side, there is a sports stadium about one and a half times the size of the Coliseum at Rome, which will accommodate 125,000 spectators, and an amusement park where the usual exhibition amenities will be provided. All the principal buildings of the Exhibition are of a permanent and substantial nature, and it is hoped that the site will be the home of future large-scale exhibitions.

The British Empire Exhibition is itself of the nature of a company, and the funds necessary for the organising work and construction have been advanced by banks on the security of the guarantee fund. It is hoped that the receipts from gate-money, sale of space in the Exhibition, and other sources of revenue, will render it unnecessary to call on the guarantors. At the close of the Exhibition, the property will be vested in a body of trustees to administer as a site for exhibitions, and any profits obtained, subject to a first charge in favour of the guarantors should it have been necessary to call upon them, is to be devoted to public objects.

In order that the Exhibition may fulfil its purpose—to display the natural resources of the British Empire and the activities of its people—it is obvious that a wide range of exhibits must be included. To all, the general condition is attached that, if manufactured, they must have been manufactured mainly within the Empire, or, if raw materials, they must have been produced within the Empire. To organise such a vast and varied collection is a task of no mean order. For this purpose the exhibits have been divided into 10 sections, 45 groups, and 150 classes. Among the section headings are food, which includes agriculture, fisheries and food-products; raw materials, including minerals and forest products; education, science and art, including the several grades of education and human, animal, and plant diseases of the tropics. Groups in other sections are devoted to aeronautics, telegraphy and telephony, chemical plant, dyes, instruments, hygiene and sanitation, and social economy. More than thirty committees have been appointed, each consisting of experts in a particular subject or branch of industry, to deal with the exhibits. In some cases, the organisation of exhibits has been undertaken by recognised trade associations; *e.g.* the British Engineers' Association is arranging the general engineering section, the British Electrical and Allied Manufacturers' Association the electrical engineering section, the Society of Motor Manufacturers and Traders the motor transport section, and the Association of British Chemical Manufacturers the chemical section. Pure science exhibits are being arranged by the Royal Society and the Association of British Chemical Manufacturers, the latter body having undertaken the whole of the pure chemistry side.

The chemical section itself will be a self-contained hall with about 40,000 sq. ft. of floor space within the Palace of Industry, and the chemical manufacturers' association is spending 100,000*l.* on it. The bulk of the space will be devoted to exhibits from the leading firms of chemical manufacturers in Great Britain, which will be arranged roughly in five groups: (1) heavy chemicals, (2) dyestuffs and intermediates, (3) fine chemicals, (4) soap and perfumery, and (5) scientific. One small section within the Chemical Hall, 2500 sq. ft. in area, will be devoted to pure chemistry, and it is hoped to demonstrate here the body of scientific research on which the chemical industry of Great Britain rests. The organisation of the scientific section is in the hands of a committee of representatives of scientific societies interested which was recorded in our issue of November 3, p. 665. This committee and the Royal Society's committee on scientific exhibits have three members in common, and in this way it is hoped to avoid overlapping.

It will not be possible in the space available for the scientific section to attempt a complete, standing exhibit illustrating the achievements of modern chemistry. The difficulty is to be overcome by providing a succession of exhibits which will follow one another during the period while the Exhibition remains open. For this purpose, the subject has been broken up into a number of sections or branches, and distinguished authorities in the various branches are arranging appropriate displays which will be "staged" in succession. A list of the names of those who have agreed to act in this capacity was given in NATURE of November 10, p. 700. In connexion with the work of the scientific section, a number of descriptive pamphlets indicating the nature

and purpose of the various exhibits will be available, and it is hoped to be able to publish a volume, each chapter of which will be contributed by an authority on the subject discussed, recording in more technical language the state of chemical knowledge at the time of the Exhibition. This volume should be a veritable milestone in the history of chemistry, and should prove a source of information and inspiration for scientific workers for years to come.

The onus of the success or failure of the whole of the chemical exhibits has been accepted by the Association of British Chemical Manufacturers; and now that arrangements are nearing completion, the Association has adopted the courageous policy of giving wide publicity to its doings. Statements have been issued to the Press, and scientific journals with an interest in chemistry have been provided with more detailed information. This has doubtless done much to arouse interest, especially in the scientific world, in the display which is to represent chemistry and chemical industry at Wembley.

The Royal Society's committee on scientific exhibits at the Exhibition is faced with a difficult task. The progress of British science in all its branches, with the exception of chemistry and allied parts of physics, has to be demonstrated impressively and effectively in a space of 2200 sq. ft., by means of a grant from the Government through the Department of Overseas Trade. Here again the field has been divided up into a number of parts, each of which has been put into the hands of an authority. The first classification consists of a primary group (mathematics, astronomy, and physics), and a secondary group (meteorology, geology, metallurgy, engineering, and aeronautics). In each subject there will be (*a*) exhibits and demonstrations illustrating current research, (*b*) instruments, and (*c*) historical material, if space permits. Instruments will be shown mainly from the National Physical Laboratory and the leading instrument makers, while the historical material, consisting of portraits, historical apparatus, and so on, will be drawn mainly from the Science Museum and the Royal Institution.

In organising the pure science exhibit, the aim of the Royal Society's committee has been not to show a mere group of apparatus, but to take some new law or principle, to trace its history, and demonstrate the consequences of its discovery. Thus, to give an example, one series of exhibits will illustrate the discovery and subsequent history of the electron. Starting from the work of Sir William Crookes, illustrated by some vacuum tubes showing the cathode rays and the other consequences of an electric discharge in a vacuum, we shall pass to the researches of Sir J. J. Thomson and the discovery of the electron as a definite entity moving with great velocity, carrying a fixed charge of negative electricity, and having the same mass whatever be its source. This work leads on to the discharge of ions from hot bodies, and the early experiments of Guthrie and the work of O. W. Richardson, on which most of the known laws governing that discharge are based. Then will come the original experiments of Fleming, the phenomena observed in an electric lamp, the discovery of the thermionic valve and its use as an amplifier of wireless waves, and in many other directions.

The National Physical Laboratory is responsible for a section on measuring instruments, illustrating much of its important work in the maintenance of standards of all kinds—thermal, up to temperatures of 2000° C., and electrical, from the currents and voltages used in ordinary practice to those at radio frequency of some 500,000 to the second. On the engineering side there will be exhibits to illustrate recent work on the measurement of stress in solids, the phenomena of fatigue, and the nature of the relative motion of the molecules of a crystal when subject to strain. Wherever possible, the exhibits will take the form of demonstrations, the whole object of the committee being to avoid a "museum" of instruments. The biological exhibits will be selected to indicate some aspects of the progress that has been made in zoology, botany, and physiology, and the varied nature of modern researches in these subjects. There will also be exhibits showing recent results of the study of adaptation, variation and heredity, sex-determination, the physiology of development, etc.

Finally, arrangements are being made for a series of short lectures by scientific workers in connexion with the Exhibition. In short, an attempt is being made to present pure science to the world as a living and progressive subject, and to demonstrate the high value of the work which has been carried out and is still going on in the scientific laboratories of the Empire.

In addition to these purely scientific exhibits, there will be sectional exhibits dealing with the application of science to industry. These will be in the hands of a committee of the Department of Scientific and Industrial Research, acting on behalf of the various Research Associations. Such exhibits will be grouped with their related industries, which will provide the necessary funds as part of their general exhibits. Government research organisations will not have separate exhibits except in so far as they illustrate the working of particular industries such as mining and agriculture; their contributions will go with the pure science exhibit organised by the Royal Society committee.

Reference was made above to what may be termed a Congress Hall, which includes four conference halls with appropriate committee rooms, etc., capable of seating 2142, 550, 180, and 150 persons respectively. A small committee, under the chairmanship of Sir Lawrence Weaver, is making arrangements with various bodies which are organising conferences to be held at the Exhibition. Among the numerous important gatherings which have already been fixed, we may mention the following: an Empire Mining and Metallurgical congress under the presidency of Viscount Long of Wraxall, organised by the Institutions of Mining Engineers and Petroleum Technologists, the Mining Association of Great Britain, the Iron and Steel Institute, the Institute of Metals, and the National Federation of Iron and Steel Manufacturers, to be held during the first week of June; a textiles conference, organised by the Textile Institute, during the second week of June; a World Power conference, organised by the British Electrical and Allied Manufacturers' Association, during the first and second weeks of July; a Museums conference, organised by the Museums Association, during the third week of July; and a conference on Science and Labour, organised by the British Science Guild and the National Joint Council of the Trades Union Congress and the Labour Party, on May 30-31. These conferences will be an important phase in the activities associated with the Exhibition, and the exchange of views promoted will have effects of world-wide significance.

The British Empire Exhibition at Wembley next year will, it is true, be an epitome of the products and the activities of the British Empire. Rightly organised, it can be more. It can show the people of Great Britain, of the British Empire, and, through the numerous foreign visitors it is certain to attract, of the whole world, the progress of industry and the purely scientific work on which all industry is based, in turning to man's need and comfort the natural resources of the world.

Variations in the Level of Lake George, Australia.

ON May 18, 1876, a letter appeared in NATURE from Canon R. Abbay on the subject of the changes in level of Lake George, in the south-east of New South Wales, which in the past hundred years has varied from a small swamp to a depth of 25 feet or more. We have now received from Canon Abbay a letter and a diagram showing the variations of level in the lake from 1817 to 1918. The latter, which is reproduced in Fig. 1, was drawn from information compiled by the late Mr. H. C. Russell, Government Astronomer of New South Wales, up to 1904, and since that date by the Commonwealth Meteorological Bureau. It also shows the "residual rainfall curves" for Goulburn, the nearest station, and for Sydney, 150 miles distant. A residual rainfall curve is obtained by finding the difference of rainfall for each year from the average for the whole period and adding up the differences for successive years, so that the figure plotted for any year represents the total excess or deficit of rainfall from the beginning of observations until that year. The curves show, as Canon Abbay points out, that while rainfall is evidently an important factor in the level of the lake, there must also be other influences at work.

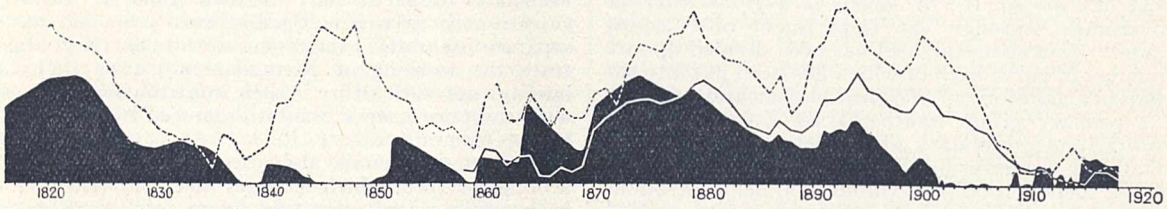

FIG. 1.—Fluctuation of water in Lake George, N.S.W. (Lat. S. 35° 4′; Long. E. 149° 23′). The fluctuations of the water in the lake as shown in black from 1817 to 1904 were compiled from various sources by Mr. Russell, and from 1904 to 1918 by the Commonwealth Meteorological Bureau.
Residual mass curve of Sydney rainfall ..... Mean rainfall at Sydney for 76 years, 48·35 in.
Residual mass curve of Goulburn rainfall ——— Mean rainfall at Goulburn for 60 years, 25·34 in.

The lake is without outlet, and we may accordingly regard its changes of level as determined by the balance between the rainfall and evaporation in its basin, the loss by seepage probably being negligible. As a measure of rainfall the long series of observations at Sydney has been employed from the commencement of the official observations in 1840. The question of evaporation is more difficult, but it has recently been found that in the Central African lakes, Victoria and Albert, the amount of evaporation bears a very close inverse relationship to the number of sunspots, the correlation coefficient between lake level (Lake Victoria) and sunspot number, after elimination of rainfall, being as high as +0·90, and much higher than the correlation with the average rainfall in the basin. In the case of Lake George, a few years of heavy rainfall and slight evaporation result in a considerable rise of level, and if they were succeeded by a series of dry hot years the lake level would fall gradually until it was dry or until another wet period supervened. It was accordingly found best to correlate the changes in level between the beginning and the end of each year (L′) with Sydney rainfall (R), and average sunspot number (S), during the same year, and the following results were obtained:

Correlation between change of level and rainfall; influence of sunspots eliminated: $r = +0{\cdot}35$.

Correlation between change of level and sunspots; influence of rainfall eliminated: $r = +0{\cdot}39$.

The regression equation is:

L′ (in inches) = 0·96 R (in inches) + 0·43 S (Wolf's No.).

The corresponding equation for Lake Victoria, Central Africa, was:

L (Actual level, inches from base) = 0·36 R + 0·36 S.

The years in which the lake was dry have been omitted from the calculations. The results confirm those obtained from Lake Victoria, that variations of evaporation are probably more important than rainfall variations in determining the level of lakes, and that the rate of evaporation is appreciably greater when sunspots are few than when they are numerous.

The diagram shows that the rainfall at Goulburn agrees fairly closely with that at Sydney, but if the rainfall at several stations over the lake basin had been available for a long period, there is no doubt that the correlation with their average would have been appreciably higher than that with Sydney rainfall. It also appears that the evaporation at Lake George is not determined by sunspots to the same extent as that at Lake Victoria. As Canon Abbay points out, the frequency of west and north-west winds would be of great importance in this connexion, and this would be governed by the pressure gradient between, say, Melbourne and Brisbane.

In 1875 Canon Abbay thought that the rise in the lake, which had proceeded fairly steadily from about 1849 until that date, was connected with the destruction of "bush," allowing the rainfall to run into the basin with little loss, but the subsequent fall in level showed that this could not be the cause, since the destruction of the bush continued while the level of the lake was falling. The nineteen-year periodicity which has been advocated in connexion with Australian weather occurs in the lake levels, though not very definitely, and there is also an eleven-year periodicity connected with the sunspot effect. The two chief maxima in the level, about 1821 and 1875, and the two chief periods when the lake was dry, about 1848 and 1905, are separated by intervals of 54 to 57 years, and may represent a quasi-periodicity of about 56 years caused by the interference of these two periodicities; but weather cycles are treacherous things, and it would not be safe to base a forecast on them. C. E. P. B.

Geological Progress in India.

IT is satisfactory to notice that, in spite of financial stress in India, the Government has continued to add to the staff of the Geological Survey, which, with the recruits recently selected, now includes 26 out of the sanctioned 30 officers of the senior grade. The progress of work also during the last few years, since the return to normal duties of those officers who were on active service, has resulted in an approach to completion of many lines of work that had been for some time necessarily left indefinite. Among these the classification of the Tertiary beds of Burma, and their correlation with the Tertiaries of Western India and the standard stratigraphical scale of Europe, are now showing distinct signs of stability.

The untimely death of Mr. E. Vredenburg (NATURE, April 14, p. 505) prevents the completion of the heavy task of summarising the palæontological results, but

the papers which he has published already, together with the work especially of Dr. G. de P. Cotter, are sufficient to permit of a satisfactory classification of the Burma Tertiaries, the correct correlation of which is of great importance to the petroleum industry of the province. Of the distinct steps forward, one of the most important has been recognition of the precise nature of the lateral variation in facies, especially that from north to south, in consequence of the progressive rise and silting of the meridional marine gulf which existed to the east of the Arakan hills in early Tertiary times. Extended mapping of the formations shows how freshwater formations in the north pass southwards into beds of marine origin, while estuarine and littoral beds pass into those of more settled marine origin. The papers of Messrs. Vredenburg and Cotter published in the Records of the Geological Survey (vols. li. and liv.) bring together the main results of this work expressed in tabular form, and additional details have just been issued in a posthumous paper by Mr. Vredenburg (vol. lv., part 1, 1923).

The correlation of the Burma Tertiaries with other areas has been based mainly on marine fossils, but, meanwhile, most valuable studies of the vertebrate remains included in freshwater beds have been carried on by Dr. G. E. Pilgrim. Most of this has been in connexion with the younger Tertiaries of the famous, but, as it proves, not entirely well-known, localities of the west and north-west. Recent work in the Punjab Salt Range shows that some revision of the correlation tables will be necessary, and that it will be possible, when the newly discovered vertebrate remains are studied, to correlate by direct fossil evidence the lower and middle Siwaliks of the Salt Range with those of the Himalayas.

The director's report of the Survey for 1922, just issued by Dr. E. H. Pascoe in the Records, describes, besides a summary of Dr. Pilgrim's most recent work, some interesting results in other parts of India, in addition to those separately noticed in previous pages of NATURE. Among these, an interesting discovery of true Gondwana coal has been made in the Southern Shan States, indicating a Jurassic or Rhætic age, corresponding to a part of the upper division of the Gondwana system in India and some of the coal beds of Tonkin.

Considerable additions have also been made recently to our knowledge of the Deccan trap and of the dykes through which the lava attained the surface. Recent work by Mr. H. Walker in the Tapti valley reveals the interesting fact that the river, for more than 30 miles in an east-west line, follows a fault valley, roughly parallel to the general tendency to rifting which Sir Thomas Holland referred to in his presidential address to Section C (Geology) of the British Association at the meeting in Australia (NATURE, vol. xciv., September 3, 1914, p. 8) as a preparatory condition for the outflow of the Deccan lava sheets.

Another feature of general interest arises from the long-delayed analyses of brines from the Sambhar lake in Rajputana. The economic question which led to a special investigation of this lake 20 years ago arose from the observation of the salt-manufacturing officers that the lake showed signs of depleted resources and consequently possible loss as a source of Government revenue. The investigation undertaken in 1903 by the Geological Survey showed that, while the total amount of sodium chloride stored in the silt rendered nervousness on this account unnecessary, there was a possibility that the continual removal of pure chloride as salt and the consequent increase in the proportion of residual carbonate and sulphate among the soluble salts might increase the difficulty of customary manufacture by fractional crystallisation. A methodical system of sampling was then undertaken annually from various parts of the lake, and Dr. W. A. K. Christie has recently analysed the products. A summary of his results shows that there was a small but definite deterioration in chloride as the result of ten years' work in extracting salt between 1907 and 1916. Taking the two five-year periods to tone out annual variations, the ratio of chloride to other soluble salts in the lake brine has dropped from 86·09 : 13·91 to 85·38 : 14·62. In the brines obtained from the sublacustrine silt the corresponding ratio has fallen from 83·18 : 16·82 to 81·07 : 18·93. Arrangements have been made for resuming the annual sampling of the brines; for unless a system be devised for recovering some of the other salts, the value of the lake as a source of salt will cease long before there is any approach to exhaustion of the total supplies.

Palæontology at the American Museum of Natural History.

THE researches of the palæontological department of the American Museum of Natural History for the years 1918 to 1921 have now been issued as a volume, making the seventh in the series. In all there are twenty-three papers, contributed by Prof. H. F. Osborn, Dr. Matthew, Dr. Gregory, Messrs. Granger, Mook, Von Huene, Miller, Gidley, and Camp. Prof. Osborn describes some new Titanotheres, mostly primitive forms, from the Huerfano, and in two other papers continues his studies on the Proboscidea. One is an account of some American mastodons, and the other is important as giving his views to date on the evolution, phylogeny, and classification of the elephant group as a whole. Dr. Matthew, in addition to faunistic papers, continues, with Mr. Granger, the review of the faunas of the Eocene deposits of the United States. The papers by Messrs. Gidley and Miller are faunistic. There is a series of ten papers by Mr. Mook on crocodiles, recent and extinct; a paper by Mr. Von Huene on reptilian and stegocephalian remains in the Cope collection; and three by Dr. W. K. Gregory, one of them in collaboration with Mr. Camp, which are continuations of his studies on the comparative myology and osteology of vertebrates.

In considering these contributions to our knowledge of palæontology, for the value of which the authors' names are a sufficient guarantee, it will be noticed that the bulk of them are continuations of previous studies, and are designed to attack definite problems. Such, for example, is the series by Dr. Gregory on the muscles and bones, where various parts are compared one by one and worked out in a most systematic manner. These papers will form a mine for other workers. In the same spirit is Mr. Mook's intensive study of the crocodiles and Prof. Osborn's on the elephants.

The volume is a worthy memorial to the energy and devotion of the president and staff of the museum, and the museum without doubt gains from this advertisement of its activity. If the publications by members of the staff of the palæontological department of the British Museum for a similar period were gathered together, it is probable that they would make a worthy companion volume, but, being widely scattered in several publications, the public has never the opportunity to discover this fact.

It may further be noted that, in the period covered by these communications, the American Museum from its palæontological department alone sent six expeditions into the field as far as China, India, and Cuba, as well as in the States themselves.

University and Educational Intelligence.

BIRMINGHAM.—The degree of D.Sc. has been conferred on Mr. C. S. Fox for a thesis on "The Bauxite and Aluminous Laterite Occurrences of India," and supplementary papers; and on Mr. B. M. Griffiths for a thesis on "The Phytoplankton of Bodies of Fresh Water, and the Factors determining its Occurrence and Composition," and supplementary papers.

CAMBRIDGE.—Mr. S. W. P. Steen has been elected to a fellowship at Christ's College.

The secretaryship of the Board of Research Studies has become vacant by the resignation of Sir Geoffrey Butler, now elected representative of the University in Parliament, who has done valuable work in steering the new scheme for the Ph.D. degree successfully past certain initial difficulties.

It is proposed, subject to the approval of the Statutory Commissioners, to bring all University officers appointed in the future under such pension scheme as shall be adopted by the University and approved by the Commissioners; and further, for the University to take powers to come to an agreement with present holders of University offices whereby they may come under the general pension scheme.

It is proposed to admit to the privileges of affiliation graduates of certain other universities who have graduated with first-class honours without the present restriction that they must have passed in English, mathematics, and Latin or Greek at one of the examinations leading to their present degree.

EDINBURGH.—On Monday afternoon, December 10, the Rt. Hon. S. M. Bruce, Prime Minister of the Commonwealth of Australia, visited the University and received the honorary degree of Doctor of Laws. Mr. Bruce was warmly received, especially by a number of Australian students, who formed a compact section of the audience and who gave their distinctive call. In a speech immediately following the ceremony Mr. Bruce emphasised the great need they felt in all the Overseas Dominions that men of university training should take increasing interest in the affairs of their respective countries. At no time in the history of Great Britain or the Empire as a whole had it been more imperative that they should have these men, with all their traditional ideas gathered in the university, to give of their services freely and willingly to the country and to set a standard of good citizenship. He appealed for renewed unity of the people, and said that "a strong and united British Empire is the greatest hope there is to-day for the future peace of the world and for the happiness and security of the whole of humanity."

SHEFFIELD.—The following appointments have been made: Mr. R. A. Morrell, to be lecturer in radiology; Mr. G. Wilkinson, to be lecturer in the history of medicine; and Dr. D. C. Barron, to be assistant-lecturer in medicine.

LONDON.—The following doctorates have been awarded: *Ph.D.* (*Science*): Prabhatchandra Sarbadhikari (Imperial College—Royal College of Science) for a thesis entitled "Cytology of Osmunda and Doodia—On the Somatic and Meiotic Mitosis of Doodia—I"; Mustapha Ahmed Abu Zahra (Imperial College—Royal College of Science) for a thesis entitled "The Mechanical and Graphical Solution of the Two-dimensional Motion of a Cylinder of a General Section in Viscous Fluid subject to Oseen's Approximation"; Hassan Sadek (University College) for a thesis entitled "Miocene Period in the Gulf of Suez Area, Egypt." *Ph.D.* (*Economics*): Emma Annie Winslow (London School of Economics) for a thesis entitled "Budget Studies and the Measurement of Living Costs and Standards."

MR. E. C. DAVIES, a distinguished student of Prof. R. M. Wild at the University of Manchester, has been appointed assistant lecturer in chemistry at the Natal Technical College, Durban, S. Africa.

SINCE our issue of December 15 the following announcements of the election of representatives of the Universities in Parliament have appeared: Oxford—Sir Charles Oman (U.) and Lord Hugh Cecil (U.); Wales—Mr. G. Davies (Lab.).

APPLICATIONS are invited by the committee of the University College Hospital for the Radcliffe Crocker travelling scholarship in dermatology, the approximate value of which is 280*l.*, tenable for a period of twelve months, to be spent at some place of study outside the United Kingdom. Further particulars may be obtained from the Dean, University College Hospital Medical School, University Street, W.C.1.

THE New York correspondent of the *Times* states that Mrs. Montgomery Ward has given 3,000,000 dollars (about 660,000*l.*) to the North-Western University, Chicago, to create a medical centre at the University to be called the Montgomery Ward Memorial. Yale University has announced that 4,000,000 dollars (about 880,000*l.*) of the 15,000,000 dollars (about 3,330,000*l.*) left to it by the bequest of John W. Sterling will be used to erect a library.

RECENT progress in vocational education in America is described in the sixth annual report of the Federal Board for Vocational Education. The enrolment in schools aided by the board has increased steadily from 164,000 in 1918 to 475,000 in 1922, in which year their total expenditures amounted to 12½ million dollars. The outstanding feature of this development has been the growth of the general continuation schools. The main purposes of this type of school are the same as those of the continuation schools provided for by Mr. Fisher's Education Act of 1918. Of the 48 states, 43 now maintain part-time schools for young persons who have left full-time schools to go to work, and 21 have enacted state-wide mandatory or permissive part-time school laws. Although the enrolment in schools of this type has increased from 53,000 in 1918 to 228,000 in 1922, this number is less than one-tenth of the boys and girls 14 to 17 years of age not attending school of any kind. One notable aspect of recent progress in the vocational school movement is its influence on the regular public day schools: "There is a new spirit in elementary education; it is the spirit of attention to practical needs." Conversely the outlook of the vocational education programme is being broadened so as to include much more than simply "specific preparation" for the technical processes of a skilled trade. Some idea of the extent to which employers recognise the value of continuation schooling may be gathered from the fact that at least 25 national associations of employers have set up organised systems of training for employees, some with endowments ranging from 2 to 10 million dollars. The Federal War Department has developed an elaborate system of testing for and teaching trades in the Army, based on a policy of fitting men not only for effective military service but also for success in civil life.

Societies and Academies.

LONDON.

Aristotelian Society, November 26.—Prof. H. Wildon Carr in the chair.—J. W. **Scott**: The incidence of mathematico-physical speculation on philosophy. Mathematical speculation upon philosophical questions is especially forceful at two places—the theory of the infinite and the theory of appearances and their relation to reality. The naïve conception of the infinite has been a common problem for philosophers and mathematicians alike. Kant declares that we can prove with equal cogency that space or time both must be and cannot be infinite; and Galileo points out that an infinite number is a number such that the number of numbers making it up is the same as the number of numbers making up a contained part of it. Philosophers and mathematicians alike do not stop at the difficulty of the naïve conception. For each there is a false as well as a true conception of infinity, and their definitions are curiously alike. The essence of infinity consists for the mathematician in a certain relation between the whole and its parts, and for the idealist philosopher infinity is only to be ascribed to wholes which are self-contained, such as works of art. The other problem, namely, the problem which of the contradictory appearances of a sense-perceived object is the real appearance of the thing, may be solved along the same lines. Perspectives sum into a container. The unity either of a thing or of a sensum is the unity of an infinitude; and an infinitude is something in some sense self-contained.

December 3.—Prof. T. P. Nunn, president, in the chair.—Dorothy **Wrinch**: On certain aspects of scientific thought. Many important scientific hypotheses embody the assumption that certain properties are irrelevant to each other. They may be grouped together as "irrelevance postulates." Thus in the quantum theory there is an important hypothesis to the effect that the energy of a bundle of radiation given off by an atom of matter to the ether, divided by the frequency with which it manifests itself to the spectroscope, is always an integral multiple of a universal constant h. The assumption states that this ratio h has the same value, irrespective of all physical and chemical properties of the matter which emits the radiation. Also other "constants of Nature" such as the charge carried by an electron, the velocity of light, the universal constant of gravitation, correspond each to a "postulate of irrelevance." Einstein has suggested a postulate of irrelevance of a still more radical kind in his assumption that the laws of Nature are invariant with respect to systems of co-ordinates which satisfy certain very general conditions. In the generalised theory of relativity these are the Gaussian systems.

Royal Anthropological Institute, November 27.—Mr. H. J. E. Peake in the chair.—E. H. **Hunt**: Hyderabad cairn burials and their significance. Cairn burials with stone circles are found scattered over the whole of South India. Their numbers indicate that important persons alone could have received this form of burial, and the civilisation represented must have held full sway for a prolonged period. Pots are found inside and outside cists. Body positions are commonly "contracted," though "extended" and "urn" burials are found, and burnt bones. Iron is found constantly, but iron affords no evidence of date in India. Surface denudation of more than fifteen feet of hard soil in places and disintegration of granite slabs in the absence of salt afford evidence of considerable age. History shows that these burials cannot date later than Asoka in any case. Vedic writings are silent. There is a curious series of similarities with early Egypt: (1) Cultivation by irrigation; (2) orientation of graves; (3) burials; (4) polished black and red pots, red pots on ring stands, and pot marks, *e.g.* the "KA" mark; (5) lapis beads, a stone foreign to Egypt, and probably also to India. Parallel with these resemblances an equally striking series of differences can be made out, such as the absence of stone circles in Egypt, though boulders abound.

December 4.—H. **Balfour**: On certain aspects of the technology of the Nagas of Assam. The field-observations recorded were made during a three-months tour through the Naga Hills in company with Messrs. J. H. Hutton and J. P. Mills, resident officials of the I.C.S., in the winter of 1922, during which some 50 or 60 native villages were visited. The prevailing system of "dry" cultivation by *jhuming*, as contrasted with the elaborate intensive system of "wet" terrace-cultivation practised almost exclusively by the Angami, has had devastating effects upon jungle-growth. Among the Ao Nagas, when fire-making is practised for divination or taking omens, it is not necessary to obtain a spark. The ordinary process is followed of sawing a bamboo thong round a stick, but the latter need not be split as it invariably is for ordinary fire-making. When the thong breaks the broken ends are carefully studied, and the omen is taken from the nature of the fracture. This use of an *unsplit* stick for divination has not before been recorded. A type of fish-trap is used, not before described from the Naga Hills, the chief interest of which lies in its almost continuous dispersal from this area through the Malayan and Indonesian regions to Melanesia, affording a valuable culture-link between the extremes of its geographical range. This culture-link is further emphasised by the loom and by other items, which together throw light upon the route followed by culture-dispersal within this wide area. The carved "figure-heads" embellishing the huge monoxyle dug-out gongs of the Ao Nagas are conventionalised representations of the head of the water-buffalo. An account was given of "bull-roarers," recently discovered by Messrs. Hutton and Mills to exist in this region.

Royal Microscopical Society (Industrial Applications Section), November 28.—Sir Kenneth Goadby in the chair.—J. E. **Barnard**: The characteristics of a microscope for general and special purposes. The tests for mechanical efficiency that should be satisfied. —S. H. **Browning**: The application of the microscope to industrial diseases.—C. A. **Newton**: The microscope in the examination of condensed milk. If a film of sweetened condensed milk be examined at a magnification of from 50 to 100 diameters, the sugar it contains can easily be seen. The sugar crystals afford an indication of the good quality of the milk; if they appear clean and well defined, the milk will keep well, while in bad milk, or milk likely soon to become bad, there appears also an acicular crystallisation of the milk sugar. Sweetened condensed milk in its normal state is too dense or too opaque for examination by the higher powers of the microscope necessary to observe any micro-organisms likely to be present. Diluting with nine parts of distilled water, a thinner film is available, and in the case of bad milk it is then easy to see yeast cells (causing milk to become "blown"), and other micro-organisms if any are present.

Linnean Society, November 29.—Dr. A. B. Rendle, president, in the chair.—C. C. **Lacaita**: The Onosmas of Linnæus and Sibthorp, with a note on those of

Tournefort's herbarium.—M. D. **Zalessky**: On new species of Permian Osmundaceæ. An extension of Kidston and Gwynne-Vaughan's work on the anatomy of Permian Osmundaceæ from Russia. Ferns of this affinity in Permian times had a solid wood in the stem, differentiated into an outer zone of normal tracheides and an inner core of short, wide elements. The leaf-trace, on its outward course, changes from mesarch to endarch structure. The anatomy is described in *Bathypteris rhomboidalis* (in which the stele was previously unknown), in two new species of Thamnopteris (*T. Kidstoni* and *T. Gwynne-Vaughani*), and in a new species of Zalesskya (*Z. uralica*) which may be a young state of *Z. gracilis*.—C. L. **Withycombe**: On the function of the bladders in *Utricularia vulgaris* Linn. The bladders are not passive traps, but capture prey by active movement in response to stimuli. The valve is a continuation of the wall; it is two cells in thickness, and closes the mouth completely when its free margin is applied to the collar. It consists of three ill-defined regions; marking the third or marginal flap are four tapering bicellular hairs which are sensory. The quadrifid hairs lining the bladder constantly absorb the fluid within, until equilibrium is reached between the internal negative pressure and the osmotic tension which can be exerted by the cell contents of the hairs. There is now a considerable tension upon the valve, tending to pull it inwards. This is prevented by a cushion of specialised cells within the collar. Only an upward movement can possibly release the valve from its catch, and this is brought about by touching the sensory hairs.

Eugenics Education Society, December 14.—Prof. E. W. MacBride in the chair.—A. S. **Parkes**: Some aspects of reproduction considered in relation to eugenics. Inherent constitution is of prime importance from a eugenical point of view, but the conditions under which reproduction takes place may have the effect of limiting or augmenting the development of the hereditary qualities. If reproduction takes place under bad conditions, the fullest expression of the inherited characteristics will be hindered. Conditions obtaining during the maturation of the germ cells and during the gestation of the fœtus constitute the most potent of environments. The age of the mother is probably one of the most important factors governing the efficiency of the secondary sexual organs of the female for reproduction, and this is especially true of first births. The optimum age for reproduction seems, in the female, to be between twenty and thirty years, and first pregnancies occurring much after this age are attended by great probabilities of mishap.

CAMBRIDGE.

Philosophical Society, November 12.—Mr. C. T. Heycock, president, in the chair.—P. **Lake**: Wegener's theory of continental drift.

November 26.—Mr. C. T. Heycock, president, in the chair.—J. **Barcroft** and H. **Barcroft**: The hæmoglobin of Arenicola. The α band of oxy-hæmoglobin in Arenicola is 18 Ångström units nearer the blue than in human blood, and the α band in carboxy-hæmoglobin 12 Ångström units nearer the blue than in man. The pigment in Arenicola has a greater affinity both for oxygen and carbon monoxide than in the mammalia. The oxygen capacity in Arenicola is approximately 0·01 c.c. of oxygen per hour, an amount which is of the same order as that necessary to maintain the respiration of the worm whilst its hole is closed at low water.—C. **Shearer**: Direct measurements of axial gradients in embryonic tissue.—J. B. S. **Haldane**: A mathematical theory of natural and artificial selection. Pt. I. The effect of selection on the composition of Mendelian populations in certain simple cases is investigated by means of finite difference equations. Selection produces little change in the population when the recessives are few in number, except in the cases of inbreeding, assortative mating, and sex-linked inheritance.—H. Munro **Fox**: (1) The spawning of echinoids. The extrusion of the genital products of echinoids is due to the contraction of muscle fibres in the gonad walls. The contraction of these muscles can be artificially stimulated and spawning thus induced. A spawning male stimulates ripe individuals of both sexes which are in the neighbourhood to spawn. After spawning, *Strongylocentrotus lividus* re-forms ripe eggs in nine days at a temperature of 17°-19°. (2) The migration of a Red Sea crab through the Suez Canal. *Neptunus pelagicus* commenced to migrate through the Suez Canal in 1893, twenty-four years after the canal was opened, and reached Port Said in 1898. The crab has now spread along the Mediterranean coasts to Alexandria and to Haifa.—N. J. G. **Smith**: The parasitism of *Helminthosporium gramineum* Rab [leaf-stripe disease of barley]. This fungus produces leaf-stripe disease without being present in the growing-point, and it causes death if that point is reached. The fungus penetrates each young leaf (and finally the chaffs of the developing ear) from the enveloping sheath, the first sheath being infected from conidia, mycelium, or perithecia borne on the seed or elsewhere.—R. N. **Salaman**: A leaf index as a help to the identification of potato varieties. The first lateral leaflet on the left of the midrib of each leaf is measured, and its index $\frac{\text{breadth}}{\text{length}} \times 100$ calculated. The leaf index of a variety must be ascertained from adult leaves on a healthy plant. The variation of the index within any given variety is a normal one and represented by a normal frequency curve. The probable error of the difference of two means of 20 each is 0·7. A difference of two units in the index may be considered as of significance. Of 65 varieties of which the index was measured, the value of the latter varies between 50 and 72. Neither the place of origin of seed tubers, nor the locality where the plants are raised, has any effect on the leaf index, provided that the plants are healthy. The leaf index is a constant for each variety.

DUBLIN.

Royal Dublin Society, November 27.—Prof. E. A. Werner in the chair.—F. W. R. **Brambell** and J. B. **Gatenby**: On the supposed homology of the Golgi elements of the mammalian nerve cell, and the nebenkern batonettes of the genital cells of invertebrates. The Golgi apparatus in the smallest neurones of Helix is in the perinuclear extra-centric position, surrounding an archoplasmic sphere. In larger neurones it becomes dispersed around the nucleus and the individual elements become much more numerous. Basophil granules, probably representing the tigroid body, and also lecithin (?) granules, are described in the neurones. In silver preparations dark zones are found around the Golgi elements. These probably represent a product of its activity. Long and sometimes branched Holmgren canals were found in the neurones. They were separate and distinct from the Golgi elements. They may be processes of the subcapsular cells. From the position occupied by the apparatus in nerve and germ-cell, from its similarity of micro-chemical reaction in both, and from embryological evidence, it is believed that the nebenkern batonettes of the invertebrate germ-cells are homologous to the Golgi network of the mammalian neurone.

—H. H. **Dixon** and N. G. **Ball**: On the extraction of sap from living leaves by means of compressed air. Branches of *Tilia americana* and *Sambucus nigra* were enclosed in a strong cylinder in such a way that their cut ends protruded. Compressed air at pressures up to 20 atmospheres was admitted into the cylinder, and the liquid which exuded from the cut end of the branch was collected. This liquid was found to be completely, or almost completely, free from sugars. Experiments carried out in early and late summer gave similar results. After the leaf cells had been made permeable by means of toluene vapour the sugar in the expressed sap amounted to about 5 per cent.—H. H. **Poole**: Some experiments on the convection of heat in vertical water columns. Experiments are described on the convection of heat in single and also in double vertical water columns. In most cases, the flow of heat increases much more rapidly than the temperature gradient. The smaller the column the more rapid is the rise of heat flow with rise of gradient. It is concluded that, for the small gradient existing in the earth the effect of convection in water-logged porous rocks would be negligible. Where, however, water-filled fissures occur, we should expect an appreciable increase in the vertical flow of heat.

Royal Irish Academy, December 10.—Prof. Sydney Young, president, in the chair.—J. B. **Gatenby**: Notes on the human ovary, with special reference to the corpus luteum of ovulation. The minute cytology of the lutein cells of the human corpus luteum is described. There is a Golgi apparatus larger than the nucleus; the lutein granules are not true fat, but are probably the mitochondria loaded with lipochrome. A new type of cell is described, called the stellate chromophil cell, probably the homologues of the clasmatocytes of areolar connective tissue. Possible cytological criteria for distinguishing between the corpus luteum spurium and verum are given.

EDINBURGH.

Royal Society, December 3.—James **Chumley**: Deep-sea deposits of the Atlantic Ocean. This detailed research was based on a large series of deposit-samples (1426 in number) collected from the floor of the Atlantic by thirty-five expeditions between 1857 and 1911, varying in latitude from 50° S. to 60° N., and in depth from 110 to more than 4500 fathoms. The examination of these materials was in progress at the *Challenger* Office, Edinburgh, under the superintendence of the late Sir John Murray at the time of his death in 1914. Mr. Chumley, who was associated with Sir John Murray for a number of years as assistant, has finished the descriptions and worked up the results in accordance with the methods established by him. There are detailed descriptions of 1426 samples, which cannot fail to be of signal service in any future oceanographical work in the Atlantic. The descriptions are followed by a discussion of the information furnished as regards (1) the various types of deposits, (2) the distribution of the different constituents entering into the composition of the deposit.

MANCHESTER.

Literary and Philosophical Society, December 4.—W. B. **Wright**: The search for concealed coalfields in the north of Ireland. Valuable areas of unworked coal exist beneath the cover of the newer rocks in the counties of Antrim and Tyrone. The structure of the area covered by the newer rocks is controlled by a series of direct and transverse troughs at the intersection of which the deepest basins occur. As there is a considerable amount of evidence indicating that these basins are more accentuated in the older rocks below than in the overlying cover, they are very likely to contain the coal measures, which form the upper member of the older series. The margin of one of the coalfields so indicated is in fact visible at Coalisland, Co. Tyrone, where the newer rocks have been removed by denudation, and this is now being worked by Sir Samuel Kelly some little distance in from the outcrop. An exceptionally rich series of coals have been penetrated and a large output is confidently predicted.

SHEFFIELD.

Society of Glass Technology, November 21.—H. S. **Houldsworth**: Note on the influence of rapid chilling on the reversible expansion of clay. The phenomena cited are consistent with the explanation that solution of free silica occurs at the higher temperatures of heating, that this separates out as cristobalite or tridymite on slow cooling. It does not so separate on rapid cooling. Some imperfect separation is likely, but not in a sufficiently definite form to be able to exert its proper influence on the expansion phenomena.—P. **Marson**: Glasshouse pots: some notes on their manufacture and use. The mixing, weathering, and preparation of the clays were described. Pots which have been stored for a long period after drying give more trustworthy results than new pots used shortly after drying. Of faults which develop in the drying room the chief are cracks across the bottoms of the pots and drying cracks along the angles inside. Nine days should be occupied in heating up large pots in the pot arch. After setting, the pot should be left to mature in the furnace for not less than 48 hours before filling on.—Kurd **Endell**: The casting process for glasshouse refractories in German glass plants. Tests show that cast pots are denser than hand-made ones. Cast pots are chemically more resistant than hand-made pots, and there is no perceptible difference between them in respect of heat resistance.

CALCUTTA.

Asiatic Society of Bengal, November 7.—N. **Annandale**: Aquatic gastropods. (Zoological results of the Percy Sladen Trust Expedition to Yunnan in 1922.) The most remarkable feature of the water-snails of the province of Yunnan, particularly those of the great lake Erh-hai, is the close resemblance between many of the shells and those of certain tertiary beds in Central Europe. Definite relations exist between these shells and those of the tertiary beds of the Shan plateau, but the resemblance between the Chinese and the European species is due to the convergent evolution.—W. M. **Tattersall**: Crustacea Amphipoda. (Zoological results of the Percy Sladen Trust Expedition to Yunnan in 1922.) Two specimens of Gammarus were collected, *G. annandelei* recently described from eastern China and Japan, and a new species allied to *G. crassus* from the Caspian Sea.—R. B. **Seymour Sewell**: Geographic and oceanographic research in Indian waters. (1) The geography of the Andaman Sea basin. The basin bounded by the Nicobar-Andaman ridge and the ridge itself are of composite character. A barrier-reef of coral exists on the western side of the ridge. (2) A study of the nature of the sea-bed and of the deep-sea deposits of the Andaman Sea and the Bay of Bengal. Charts are given showing the nature of the deposits at different points, the limits of the deposits of mud brought down by the great rivers, and the influence of currents on the bottom. (3) The density and salinity of the waters of Indian seas.

(*a*) The South Burma coast and Mergui Archipelago. The distribution and oscillation of salinities and densities off the coast of Burma at different seasons and times of day and the influence of air temperature, winds and other factors on the density of the surface water are discussed.—Sat Kori **Dutta**: On a peculiar disposition of the liver and the kidney in the genera Clarias and Saccobranchus. R. C. **Majumdar**: The date of the Khaḍga dynasty of Bengal. Hitherto the date has been unanimously read as year 13. The numerical figures should be read as 79 or 73. Referring this year, 79 or 73, to the Harsha era, a date is obtained for the Khaḍga Kings in the 7th century A.D., and this date is corroborated by some Chinese accounts of the political conditions of Samataṭa towards the close of the 7th century A.D.

Cape Town.

Royal Society of South Africa, September 26.—Dr. A. Ogg, president, in the chair.—J. D. F. **Gilchrist**: On a protozoal parasite of the snoek, *Chloromyxum thyrsites*, sp. n. The Cape "snoek" and the Australian "barracouta" (*Thyrsites atun*) show a softening or liquefaction of the muscular tissue, caused by a protozoal parasite resembling Chloromyxum. The spore is quadriradiate, about 12 × 8 microns, has four polar capsules, and only four distinct nuclei were seen. The trophozoite is unicellular increasing by schizogeny or simple fission, and is usually intercellular. Each trophozoite produces a single spore. —B. F. J. **Schönland**: Note on cathode ray absorption. The theory of absorption due to Bohr is in good quantitative agreement with new measurements of the absorption of cathode rays by matter. In applying the theory to measurements of the decrease of velocity of rays in passing through matter, Bohr has deduced the relation $(V_0 - V)\,V_0^3 = ct$, where V_0 = initial velocity, V = final velocity, t = thickness, c = constant. Existing measurements have all been put in the form $V_0^4 - V^4 = Kt$ ..... (2). This last equation reduces to Bohr's form in the case where V and V_0 are nearly equal. The value of c for aluminium deduced from Terrill's observations is $4{\cdot}0 \times 10^{42}$, while that calculated from Bohr's theory is $4{\cdot}1 \times 10^{42}$.—Joseph **Kürschák**: On matrices connected with Sylvester's dialytic eliminant.

Sydney.

Linnean Society of New South Wales, September 26. —Mr. J. J. Fletcher, vice-president, in the chair.—A. J. **Turner**: A revision of the Australian Anerastrianæ (Lepidoptera). Only five Australian genera, which can be easily tabulated, namely, Statina, Calamotropa, Emmalocera, Anerastria, and Saluria, are recognised. Four species are described as new. —C. T. **White**: A new conifer from Southern Queensland. Description of a new species of Callitris, close to *C. calcarata* R.Br. but easily distinguished by the characters of the cones.—R. **Greig-Smith**: The high temperature organism of fermenting tan-bark. Pt. iii. The organism produces carbon dioxide from a number of carbon compounds. These include carbohydrates such as saccharose, dextrose, levulose, maltose, lactose, galactose, xylose, dextrin, starch, gum acacia; alcohols such as mannit, glycerin, amyl, and ethyl alcohols; salts of organic acids such as citric, lactic, succinic, acetic; nitrogenous substances such as peptone, asparagin, meat-extract. Ammonium salts and urea can serve as sources of nitrogen. Raffinose and inulin are scarcely fermented. Oxalates and formates are not attacked.—T. **Steel**: On some abnormal sugar-canes. A series of abnormal sugar-canes grown in Australia is figured and described, comprising examples of forking, multiple and suppressed budding, peculiar joints and regularly malformed joints. It has been observed in Australia that while striped canes grown from "sets" reproduce the characters of the parent cane, seedlings from similar canes are always plain without stripes. This may indicate reversion to an original stripeless cane. Wild native cane in Fiji is always either red or yellow but has no stripes.—A. M. **Lea**: On some Australian Galerucides. These are small but destructive leaf- and flower-eating beetles. Ninety-three species of the genera Monolepta and Candezea are described as new.

Royal Society of New South Wales, October 3.—Mr. R. H. Cambage, president, in the chair.—M. B. **Welch**: (1) The secretory epidermal cells of certain Eucalypts and Angophoras. The elastic covering of rubber found on the young leaves of many of the Eucalypts and the closely allied genus, the Angophoras, is secreted by the outer or epidermal cells, which are of a peculiar shape. This covering acts as a very efficient means of reducing evaporation from the leaf; and the fact that only the more primitive species possess it, seems to indicate that originally the Eucalypts were exposed to much greater extremes of temperature than at present. (2) Note on the effect of temperature on borers attacking seasoned and unseasoned timber. Owing to the difficulty experienced in getting any liquid to penetrate more than a fraction of an inch into sound timber by ordinary methods of application (with the exception of certain of the softer pines and brush timbers), it is not easy to rid infested timber satisfactorily of the borer pest. Where timber is badly attacked there is far greater opportunity for any deterrent liquid to penetrate. A method of eradication which has been tried successfully is the application of heat. A temperature of about 113° F. for one minute in moist air is usually sufficient to kill the borer.—W. L. **Waterhouse**: Note on the occurrence of double embryos in wheat grains. Amongst germinating wheat grains of the varieties Tandilla King and Federation, two grains were found, each having two embryos. Each gave rise to two shoots and six seminal roots. The seedlings are growing, and further studies are projected if grain is produced.

Official Publications Received.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Montserrat, 1921–22. Pp. iv+28. (Barbados.) 6*d*.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1923. Pp. 26. (Bristol.)

Industrial Federation of University Women. Bulletin No. 5: Report for the Year 1922-23. Pp. 75. (London: 92 Victoria Street, S.W.1.)

The University of Manchester: The Manchester Museum Report of the Museum Committee for the Year 1922–23. (Museum Publication 86.) Pp. 19. (Manchester: University Press; London: Longmans, Green and Co.) 6*d*.

The Hundred and First Report of the Commissioners of His Majesty's Woods, Forests, and Land Revenues. Pp. 43. (London: H.M. Stationery Office.) 4*s*. 6*d*. net.

London School of Tropical Medicine: Department of Helminthology. Collected Papers, 1923. (Part 4.) Nos. 36-49. (Reprinted from various scientific periodicals.) (London: 23 Endsleigh Gardens, N.W.1.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 506: Surface Water Supply of the United States, 1919–1920. Part 6: Missouri River Basin. Pp. 411+2 plates. 35 cents. Water-Supply Paper 515: Surface Water Supply of Hawaii, July 1, 1918, to June 30, 1919. Pp. iv+123. 15 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 748: The Twentymile Park District of the Yampa Coal Field, Routt County, Colorado. By Marius R. Campbell. Pp. iv+82+13 plates. (Washington: Government Printing Office.) 20 cents.

Smithsonian Institution: United States National Museum. Bulletin 104: The Foraminifera of the Atlantic Ocean. By Joseph Augustine Cushman. Part 4: Lagenidae. Pp. x+228+42 plates. (Washington: Government Printing Office.)