THURSDAY, FEBRUARY 21, 1918.

HEAT-DROP TABLES.

(1) *Heat-drop Tables. Absolute Pressures.* Calculated by Herbert Moss from the Formulæ and Steam Tables of Prof. H. L. Callendar. Pp. 63. (London: Edward Arnold, 1917.) Price 5*s.* net.

(2) *Heat-drop Tables. H.P. Gauge Pressures. L.P. Absolute Pressures.* Calculated by Herbert Moss from the Formulæ and Steam Tables of Prof. H. L. Callendar. Pp. 63. (London: Edward Arnold, 1917.) Price 5*s.* net.

(3) *Correction Tables for Thermodynamic Efficiency.* Calculated by C. H. Naylor. Pp. 59. (London: Edward Arnold, 1917.) Price 5*s.* net.

THESE three little manuals are compiled at the instance of the Turbine Section of the British Electrical and Allied Manufacturers' Association for a severely practical purpose. Engineers dealing with designs or specifications for steam turbines will use them in framing estimates of performance, and it is to enable this to be done with the least possible expenditure of thought and time that these tables of heat-drop and certain correcting factors have been put into a handy form for office use. They are founded on the calculations of Prof. H. L. Callendar, who has revolutionised our knowledge of the properties of steam. It is satisfactory to see such clear evidence that British engineers are alive to the practical value of Callendar's scientific work, and ready to avail themselves of it in their business as manufacturers of steam-engines.

For a long time it was known that the data regarding steam, which had come down from Regnault and Rankine, and were quoted in all engineering text-books, were erroneous as well as incomplete. Not only did they fail to meet the new needs that arose when superheating became common, but they also contained grave inconsistencies when tested by means of the general thermodynamic relations that hold among the properties of any fluid. In a paper published in 1900 Callendar showed how a rational table of the properties of steam, complete for all conditions that occur in engineering practice, could be deduced, by the aid of well-established data, from a characteristic equation which he assumed to connect the pressure, temperature, and volume of water vapour in any state. He gave various *a priori* reasons for the type of equation which he selected, and also showed that it had this justification, that the results deduced from it were in close accord with the best results of experiment. Later measurements have only served to confirm this conclusion. More recently Callendar, to the very great advantage of steam engineering, has issued a complete set of steam tables based on his method. The publications now under review accept Callendar's values of the properties of steam as authoritative, and give them certain specific applications, in connection especially with steam-turbine design.

Like many other British initiatives, the new departure which we owe to Callendar found its earliest practical development in Germany. To Prof. Mollier, of Dresden, who is himself the author of valuable contributions to technical thermodynamics, belongs the credit of first recognising the importance of Callendar's work. He turned it to good account in the steam tables and diagram which he published in 1906; and in 1910 the present writer introduced (in the third edition of his book on the steam-engine) the Callendar method and Mollier's application of it to the notice of English students of engineering. Mollier's excellent diagram of total heat and entropy, which enables graphic measurement to take the place of calculation, is now well known.

The "heat-drop" with which these books are concerned is the change that occurs during adiabatic expansion in one of the properties of steam, namely, the function $E+PV$ to which Callendar in 1903 gave the now generally accepted name of "total heat." It is the function which does not change when the fluid is forced through a throttle-valve or porous plug. In adiabatic passage through an engine, on the other hand, the total heat changes by an amount which directly measures the work done. Consequently the heat-drop between admission and exhaust is a measure of the utmost amount of work that can be obtained from steam in passing through a turbine or any other form of engine. Hence its great importance in the design of such engines. For reasons that we cannot go into here the same function in other fluids is equally important in connection with practical problems of refrigeration.

It may seem a far cry from the philosophical abstractions of Willard Gibbs to the everyday requirements of the engineer. The genius of Gibbs laid foundations for much subsequent building, which has been sure, if slow. In this matter we have another proof that science, as the handmaid of industry, fulfils herself in unexpected ways. For the total heat, the "drop" of which is here so fully and exactly tabulated, is nothing else than one of the three thermodynamic "potentials" which Gibbs described in his paper of 1875, using the symbols ψ, χ, and ζ. Of these three functions, ψ and ζ have been applied in the thermodynamics of chemistry, and χ—a stone for which the chemists had apparently no use—has indeed become a corner-stone in the temple of the engineer, who, it may be added, has lately adopted ψ also, but with its sign reversed.

The tables have evidently been prepared with much care. One cannot but regret that the compilers have taken the very retrograde step of using the Fahrenheit scale of temperature. English engineers were beginning to free themselves from this vexatious burden. It is a severe and wholly unnecessary handicap to national progress in engineering.

J. A. EWING.

THE ETHNOLOGICAL VALUE OF SHELLS.

Shells as Evidence of the Migrations of Early Culture. By J. Wilfrid Jackson. Pp. xxviii+216. (Manchester: At the University Press; London: Longmans, Green, and Co., 1917.) Price 6*s*. net.

THOSE who are interested in recent developments in ethnological studies are aware that a very active school has arisen within the last two or three years in Manchester under the influence of Prof. G. Elliot Smith, who in 1911 directed attention to the widespread influence of Ancient Egypt in his little book, "The Ancient Egyptians and their Influence upon the Civilisation of Europe." Since that date he has made investigations over a wider sphere, and formulated the theory that a large number of apparently associated customs and objects mark the progress of a complex culture throughout a considerable portion of the earth's surface.

Working on these lines, Mr. J. Wilfrid Jackson, the conchologist and assistant-keeper of the Manchester Museum, has published a series of five papers dealing with the geographical distribution of certain shells employed by man and their cultural significance, four of which he has reprinted with new plates and additional information. These are: "The Geographical Distribution of the Shell-Purple Industry," "Shell-Trumpets and their Distribution," "The Geographical Distribution of the Use of Pearls and Pearl-shell," and "The Use of Cowry-shells for the Purposes of Currency, Amulets, and Charms."

Mr. Jackson has amassed a large number of most interesting and suggestive data in a field that, with the exception of shells used in currency, has been very little studied by ethnologists; from this point of view alone Mr. Jackson has done good service. The employment of the pigment found in certain marine shells for dyeing fabrics was known in the Mediterranean area and West Britain, was practised in prehistoric Japan and still is in China, and also by pre-Columbian Incas, and in Central America, where its use has not yet died out. The distribution is thus discontinuous. Three alternatives suggest themselves: (1) That the industry arose independently in these three areas; (2) that it occurred in the intermediate areas and has since disappeared without leaving any trace; or (3) that it was carried by streams of migration, the carriers of which did not necessarily introduce it wherever they went. This technique implies that the individuals adept in the process actually visited South and Central America: objects (or copies of them) may be carried by a cultural drift alone, but not a special technique, as this implies personal knowledge, which must either be conveyed by individuals directly, or, if transmitted indirectly, it must have been employed during the progress of its migration, and of this there is at present no evidence, so far as the purple dye is concerned.

The same argument applies to the association of the moon-god cult and the shell-trumpet in India and Mexico, and many other associations. The cumulative evidence of ethno-conchology is too great to be ignored, and affords additional demonstration of the spread of a complex culture from the culture centres of the Old World to South and Central America.

A. C. HADDON.

MARINE BIOLOGY AND FISH CULTURE.

(1) *Biologia Marina. Forme e Fenomeni della Vita nel Mare.* By Raffaele Issel. Pp. xx+607. (Milano: Ulrico Hoepli, 1918.) Price 10.50 lire.

(2) *Piscicoltura Pratica. Legislazione sulla Pesca d'Acqua Dolce.* By Prof. Felice Supino. Pp. viii+327. (Milan: Ulrico Hoepli, 1917.) Price 5.50 lire.

(1) THIS manual follows the lines of the course of lectures on marine biology delivered by the author in the University of Genoa to first-year students, and the subject is treated in a manner suitable to their stage of training. The account deals so far as possible with local conditions and with marine organisms as they may be seen by the observant student on the Ligurian Riviera, and especially in the neighbourhood of the small marine laboratory established in 1912 at Quarto dei Mille (some three miles east of Genoa), of which the author is director. After giving an account of the more important features of aquatic animals in general, and of the physical conditions under which marine animals live, the author sketches the general characteristics and biology of the animals of the plankton, and describes briefly a number of selected vertebrate and invertebrate examples. In the following chapters abyssal forms and the littoral fauna are considered, and in the account of the latter the author has included interesting observations on the behaviour of the flagellate protozoa *Carteria subcordiformis* and Cryptomonas sp. and of the copepod *Harpacticus fulvus* in shore-pools under evaporation. By the time the water in the pools has become strongly saline (density about 1·125), these animals have come to rest and show no sign of life. They have entered upon a "latent" condition, and may survive in that state for two or three weeks, recovering on the salinity of the water being reduced again to the normal.

The animals of the various littoral zones and those found among the algæ, especially the fauna of the extensive Posidonia meadows of that region, are treated in a clear and interesting manner, and there is a well-written chapter on the coloration of marine animals. Two chapters deal with fish and fisheries, and a final chapter is devoted to an account of the apparatus and methods used in collecting and studying marine animals. The author has given a stimulating account of marine organisms and their environment, and by means of the well-chosen bibliography at the end of each chapter—an excellent feature of the manual—has directed the serious student to the more important recent literature on the subjects considered. There are 211 illustrations in the text, many of them original.

(2) The volume by Prof. Supino, director of the hydrobiological station of Milan, forms a useful practical guide to the culture of fresh-water fishes, those specially considered being several species of trout, Coregonus, carp, tench, and eel. Details are given of the process of artificial fecundation, of methods and apparatus employed for rearing the young fish and for packing and transporting eggs, young, and adults, and of the raising of trout in ponds. Copies are given, extending to 117 pages, of the laws and regulations relating to fresh-water fish in Italy and in the lakes bounded in part also by Switzerland and by Austria. There are seventy-nine text-figures and fourteen plates.

OUR BOOKSHELF.

British Rainfall, 1916. *On the Distribution of Rain in Space and Time over the British Isles during the Year* 1916. By Dr. H. R. Mill and C. Salter. The Fifty-sixth Annual Volume. Pp. 256. (London: Edward Stanford, Ltd., 1917.) Price 10*s*.

"BRITISH Rainfall for 1916" contains, despite many trying circumstances, the essential features which make this annual so useful. Mr. L. C. W. Bonacina describes the snowstorms of spring, 1916: on the Black Mountains of Brecon snow lay 5 ft. deep. Mr. Carle Salter discusses the differences in rainfall records due to the use of Halliwell and hyetograph gauges; in connection with "The Measurement of Rainfall Duration" he decides in favour of the hyetograph.

The number of rain-days in 1916 was above the average; both absolute and partial droughts were less frequent than the average, but the absolute droughts lasted longer than usual. At Dungeon Ghyll 0·97 in. of rain fell daily on the average during seventeen days in October. At Camden Square the 1916 rainfall was 34 in., an excess of 39 per cent. on the average, while the number of rainy hours was 628, 44 per cent. above the average; at Cray Reservoir, Brecon, 72 in. fell in 1396 hours. At Kendal an inch of rain fell in 32 min. on July 21.

July 7 was perhaps the wettest day ever recorded for the east of Scotland; 29 sq. miles received more than 4 in. of rain; illustrative maps indicate that the rain fell on the left-hand front of a cyclonic depression which advanced from South Wales to Hull on that day.

On August 29, 622 sq. miles in the south of England received on the average 3·23 in. of rain on the left-hand front of a depression coming up-Channel. February was a relatively wet month in England and Wales. In March the normal distribution of rainfall was completely inverted. A widespread drought terminated on August 12. September was relatively the driest month of the year, while October outdid its reputation as the wettest month of the year, most of Ireland receiving double the normal rainfall.

Les Universités et la Vie scientifique aux Etats-Unis. By Prof. Maurice Caullery. Pp. xii+302. (Paris: Librairie Armand Colin, 1917.) Price 3.50 francs.

PROF. CAULLERY, professor of organic evolution in the University of Paris, was exchange-professor at Harvard University in 1916, and during his five months' stay in the United States he made a study of the American university system, especially from the scientific point of view. In his description of the rise, development, and administration of the various universities in the States, and his illuminating account of the extensive facilities offered for scientific research on the other side of the Atlantic, Prof. Caullery seeks, at every opportunity, to point out the lessons which France might usefully learn from American experience. He emphasises the success with which the universities in the United States have produced not only scholars, jurists, and physicians, but also engineers, agriculturists, and financiers—leaders, in fact, in every department of human activity. He urges the desirability of encouraging in France the intimate connection between university activity and contemporary life which he found existing in America.

The volume appeals almost equally to our own people, and responsible authorities should acquaint themselves with Prof. Caullery's message.

The Cause, Prevention, and Treatment of Cancer and other Diseases. By Lt.-Col. W. H. Hildebrand. Pp. viii+163. (London: Cole and Co., 1917.)

THE author offers in this book of fewer than 200 pages a complete explanation of the cause, cure, and prevention of cancer and of "rheumatism, sciatica, lumbago, uric acid, neuritis, varicose veins, arthritis, gout, eczema, pruritus vulvæ, and lunacy." Another short chapter disposes of "adenoids, infantile diarrhœa, tropical dysentery, and hay fever."

"Cancer is a cell-growth actually caused directly by radium or other radio-active mineral substance." "Drinking-water, especially hard water, is the medium through which the radium or other radio-active minerals . . . are generally conveyed into our bodies." The lime and other minerals harden the linings of the various organs, and the radium becomes entangled in this excessive fibrous tissue. Once safely ensconced in the fibrous tissue, it sets up cancerous growth by its continuous bombardment of the surrounding structures. An unsuspected source of radium for this nefarious work is, according to the author, "by *so-called transmutation of lead into radium* in old water-pipes." This is held to account for cancer-houses.

Suggestions for legislation or inquiry by a Royal Commission are plentifully scattered throughout the book, which contains much curious information, of no scientific value.

PATENTS AND SCIENTIFIC RESEARCH.[1]

TO encourage scientific investigation and to utilise the results of that investigation for the benefit of the community are problems of the deepest concern. As such they are to-day receiving the attention of the keenest of intellects, and herein lies the hope that from the turmoil of the Great War, with the suffering it has brought in its train, there may emerge a measure of good. Should the present hostilities bring home to the mass of the population a knowledge that with the future of the country is intimately associated the ability to prosecute scientific investigation with diligence, the mighty struggle in which we are engaged will not have been fought in vain.

To bring the abstract reasoner and the research student into closer touch with the needs of the moment, and to direct their energies into channels which shall be productive of the greatest benefit, is no novel endeavour, for in the past they have been the occasion of much deliberation and the practice of many expedients. Of the numerous schemes having these objects in view, some have proved capable of general application, while others have reflected the special purposes which have called them forth, or the work of the institutions immediately interested. No scheme, however, which has been suggested by a reputable body can be said to have been wholly devoid of merit, or to have been incapable of occasional employment. But whether one scheme or the other is preferable in the circumstances of a special case still remains a matter of opinion, and one upon which divergent opinions may rightly be held.

In scientific investigation, the following up of an idea to its logical conclusion, or until definite results are reached, demands unremitting and often exclusive attention, an attention not to be interrupted by considerations foreign to the business in hand. The aloofness thus necessarily engendered is reflected in the proverbial inability of the devotee to protect himself commercially or to secure adequate pecuniary return for prolonged industry. For the encouragement of research and the freeing of the investigator from the petty tyranny occasioned by the needs of daily living, Prof. T. Brailsford Robertson, professor of biochemistry and pharmacology in the University of California, propounds a scheme which, while leaving the investigator untrammelled, also relieves him of much anxiety as regards his physical welfare. In setting out the scheme Prof. Robertson refers to various projects which have been put in hand for stimulating research and for bringing the student into closer touch with the utilitarian or business side of his operations. Thus there are reviewed the action of the Solvay Institute in Brussels, which has set aside certain proceeds from inventions for the support of scientific enterprise, and the procedure of Behring and Pavlov, who have handed over profits obtained by the sale of articles manufactured in the laboratory. The precedent established by Ehrlich in his disposal of the proceeds of salvarsan forms, in addition, an illustrious example whereby the furtherance of research in a special direction may be assisted. In this instance, however, although it was so highly successful, Prof. Robertson alludes to defects difficult to remove. Notably, the intimate association of an individual investigator with a business enterprise, and the absence of supervisory control of the exploitation of a discovery, were felt to be susceptible of improvement. As regards industrial fellowships, which to so many seem to have justified themselves, they have perhaps served to bridge the gap existing between pure science and industrial progress rather than to initiate new developments.

A plan of wider scope and capable of indefinite multiplication occurred to Prof. Robertson. The scheme is essentially based upon payment by results, the results, however, being in part due to co-ordinate action by the governing body of a university. Prof. Robertson suggests the establishment of a trust for the working of such patents as have been obtained by the investigator. After recouping itself for the expenses of this working, the governing body is to hand over a certain sum of money, and, out of profits, to grant an annuity continuable after death in favour of the investigator's dependents. Unexpended profits are to be pooled in favour of the prosecution of research work in definite directions. A board of directors under the governing body is to be deputed to supervise, if desired, the work of research. The scheme is capable of wide application, similar arrangements for specific purposes being susceptible of multiplication. Moreover, Prof. Robertson and his governing body have shown their faith in the project by entering into an agreement on the subject of the growth-influencing substance "Tethelin," which Prof. Robertson had isolated from the anterior lobe of the pituitary body.

Whether it is desirable for an educational authority to depart from its normal functions and to enter into the bustle and competition inseparable from commercial undertakings is questionable. That it would be satisfactory to the patentee, engrossed in his scientific investigation, admits of little doubt; but hesitancy may well be evinced in assenting to the employment of an academic board in the exploitation of patents. Moreover, although the terms of the incorporation of the University of California would seemingly permit of the University entering into business undertakings, many institutions elsewhere have no such privilege conferred by their charters.

Among the many other proposals for stimulating investigators to further effort is the conferring of rewards in the form of money. This method is of considerable standing and has met with success. But in the opinion of not a few a system is still to be found which is less open to criticism and more uniform in application.

1 "The Utilisation of Patents for the Promotion of Research." By Prof. T. Brailsford Robertson, University of California. Pp. 14. (Privately circulated.)
"A Scheme for the Promotion of Scientific Research." By Walter B. Priest. Third edition. Pp. 88. (London: Stevens and Sons, Ltd., 1910.)
"Observations: an Appendix to the 'Scheme.'" By Walter B. Priest. Pp. 9. (Privately circulated, 1916.)

Mr. Walter B. Priest would regularise procedure and render its operation more certain by assimilating application for State aid to that which obtains when a patent is solicited of the Crown. Mr. Priest has accordingly drafted a Bill, a notice of which appeared in NATURE for January 21, 1909 (vol. lxxix., p. 345). He has since followed up the matter by addressing a series of "Observations" to the Committee of the Privy Council for Scientific and Industrial Research, together with a copy of the Bill and the remarks which accompanied the publication in 1910 of the third edition of the Bill.

The provisions of Mr. Priest's Bill follow closely the Patents Act, 1907, an Act which, while prescribing the method of applying for a patent, modified the substantive law in certain particulars.

According to the plan set out in the Bill and in the "Observations," pecuniary grants

may be restricted to scientific discoveries and improvements in means and appliances not of a patentable nature which, after investigation in accordance with the provisions of the scheme, are found to have effected or contributed to the attainment of purposes of general utility and advantage subsequently to the applications for such grants.

If, however, it should appear that the subject in respect of which an application for a grant was made was of a patentable nature, the applicant was not thereby to be prejudiced, except in so far as he might be called upon to refund what had already been granted, on the assumption that the discovery was not of a patentable nature.

The proposed Bill speaks freely of "discoveries" in respect of which benefits are to be received, as though the full significance of the word was readily perceptible. But what a discovery may be, or a discovery as opposed to an invention, and where the one ends and the other begins, are scarcely even adumbrated.

In patent law a difficulty similar in kind to this is presented when the attempt, usually futile, is made to distinguish between inventions which are said to be based on a "principle" and those which do not embody a "principle." Usually those who talk most of "principles" in this connection confuse the idea of a principle with an object to be achieved, a problem to be solved, or an end to be attained; and a century and more of litigation has failed to elicit a simple and, at the same time, indisputable account of what is understood when this distinction is brought forward. Indeed, the complete meaning of the word "principle," not only in patent law, but also in many another situation, requires much exposition. So with the word "discovery," which looms so largely in the proposed Bill, for difficulties not unlike these would undoubtedly be encountered in the endeavour to distinguish a discovery, in respect of which a grant is to be given, from an invention, for which the reward is a patent.

Seemingly, however, the question as between a discovery and an invention is to be relegated to a body of examiners or advisers, to whom also the settlement of other points is to be entrusted. In some instances the Judicial Committee of the Privy Council is to be called in aid, or, since the establishment of the Advisory Committee of the Privy Council for Scientific and Industrial Research, this committee may be substituted for the Judicial Committee.

A further notable omission in the scheme presented by the Bill is the absence of relief to the individual, who, having found out some profound "law of Nature," at once ingenuously announces it to the society of which he may be a distinguished member. By so doing he often prepares the way for another, who, not having been mentally congested with the work which led up to the discovery, seizes upon its practical application and for his own advantage embodies it in an invention and forthwith applies for a patent. The originator of the idea, in these circumstances, is at the mercy of the subsequent exploiter. Even if this questionable action has not taken place, the originator may by his announcement have precluded himself from embodying his discovery in an invention for which a valid patent could be obtained, since for a valid patent no previous publication is, in general, permissible.

But no useful purpose would be served by discussing the various clauses of the Bill, for although it might be highly desirable to regularise procedure for obtaining grants in aid of scientific research, yet to model a scheme upon that adopted for obtaining a patent seems to be inadvisable. As the Patents Act stands at the present day, it is incomprehensible without interpretation, while its meaning is usually not what it expresses, as judged by meanings ordinarily attaching to words. In what to the uninitiated is clear and permitting of no dispute, a wealth of judicial exposition is unfolded, whereby curious and recondite meanings are found to be hidden in passages apparently clear and simple. Indeed, the Patents Act is the result of historical accident and must be interpreted by reference to history. To apply its provisions to procedure for obtaining a money grant would be at the outset to tie the hands effectually and to obscure the vision of those to whom the examination of applications and the allocation of moneys were entrusted. Far simpler methods—methods more in touch also with modern requirements—could readily be devised. Even at the present moment a system is in operation whereby inchoate inventions, whether based upon new or old discoveries, receive the help of Government and are brought to fruition, to the mutual advantage of inventor and State. But whatever opinions may be held upon schemes hitherto propounded for the stimulation of scientific discovery and for the rewarding of investigation, it is clear that a collation of all known and workable schemes should be undertaken and a serious consideration of them as a whole put in hand. Whether assistance be given by way of pecuniary grant for definite research or through the medium of industrial scholarships, or whether reward be proportioned to results already achieved—results consisting in discoveries or the application of scientific truths to manufactures—or whether the individual be left to the operation of patent law, it is difficult to conceive of an inquiry of more urgency or importance than one which would enter fully into the merits of the various systems which have not only been found successful in practice, but have also failed to pass the preliminary stage of suggestion. A report from a competent authority would be of the greatest benefit and would repay many times the expense and trouble involved in its preparation. The Committee of the Privy Council for Scientific and Industrial Research has the means within its power, and it is earnestly to be hoped that it may see fit to advise men of science, academic bodies, and commercial syndicates as to the best procedure for the encouragement of scientific investigation and the application of results to daily needs.

PRECIOUS STONES AND PLATINUM IN 1916.

TO the twenty-fifth volume of "The Mineral Industry," which deals with the conditions obtaining in the year 1916, Dr. G. F. Kunz, the well-known gem expert, contributes not only, as for many years past, the chapter on precious stones, but also another on that most precious of metals, platinum.[1] In passing we may remark that the scope of this annual publication is not so wide as its title would indicate, the subject being considered entirely from the point of view of the United States.

There is no better or surer indicator of the state of the trade of a country than the business done in jewels. It is not, therefore, surprising to learn that the imports of precious stones into the United States during the year under review reached the remarkable total of ten million pounds sterling, this amount being nearly double that of the preceding year, and exceeding by more than one-tenth the figures for what was at the time considered the exceptionally prosperous year 1913. About two-thirds of the chapter on precious stones is taken up with the precious stone *par excellence*—the diamond. During the year the diamond trade with the United States was very much interfered with by the operations of German submarines, more, however, on account of the considerable rise in the rates of insurance than because of the actual losses suffered. At the beginning of the year the Diamond Syndicate raised the price of rough stones by another 5 per cent. This powerful organisation has secured complete control of the diamond market by acting as agents for the sale of the produce of the Premier mine, and by arranging with the Government of the Union of South Africa to purchase the stones found on the sands of the shore of what was once known as German South-west Africa. We are reminded that diamonds, besides their ornamental use, play an important part in industry, and especially the manufacture of munitions of war, by the fact that in November, 1916—none too soon—the British Government placed diamonds suitable for industrial purposes with emery, corundum, carborundum, and all other abrasive materials, whether natural or artificial, on the list of absolute contraband.

Inasmuch as practically all the diamonds placed on the market pass through London, it may appear strange, except to those acquainted with the formerly rigid restrictions of the powerful diamond-cutters' union, that diamond-cutting should have so long languished in this country. The upheaval caused by the war has brought about a change in this respect. Most of the Belgian cutters fled from Belgium on the fall of Antwerp, and many of them came to England. With their aid a number of factories have been started in London, and particularly in Birmingham. Amsterdam, too, benefited by the ruin of the diamond industry of Antwerp, but owing to the shortage of coal a large number of the small factories there were closed by a committee of the trade, and the business was concentrated in the large establishments.

The improved demand for diamonds brought about a revival of business in the South African fields, and the alluvial deposits were very active; the De Beers Company raised very little blue ground, the stones recovered coming almost entirely from ground already on the floors. A 37-carat stone was found in the recently opened Kameelfontein digging, the stones from which have the peculiar opalescence characteristic of those occurring in the Premier mine. Dr. Kunz points out how little India, once the sole source of diamonds, now contributes to the world's supply. It is thought possible that the deep-seated deposits have never been touched; the problem is attracting some attention, but whether prospecting on a suitable scale would prove commercially profitable is under present conditions more than doubtful.

A few interesting points may be gleaned from the remaining pages of this chapter. A large, though imperfectly formed, trapezohedron of garnet, weighing 4·763 kg. (10½ lb.), was discovered in the course of grading a property in New York in 1915. Rubies, to judge from the experience of the Burma ruby mines, are slowly recovering from the depression under which they have for some years laboured, a depression largely caused by the success that has attended the artificial manufacture of this stone. The demand for sapphires continues steady. The Queensland output was formerly wholly in German hands, and for some two years after the outbreak of war operations were brought to a standstill; but an opening has now been obtained on the London market. It is interesting to note that recent experiments have shown that the transparency of the Queensland stones is much improved if they are subjected to a high temperature.

The extraordinary rise in the value of platinum is a striking instance of what happens when an

[1] (1) "The Production of Precious Stones for the Year 1916." (2) "Platinum for the Year 1916." (New York: McGraw-Hill Book Company, Inc.; London: Hill Publishing Co., Ltd., 1917.)

enhanced demand is coupled with a restricted supply in an uncontrolled market. Owing to the effects of the war the Russian output, which is normally about 95 per cent. of the world's supply, was reduced to about one-quarter, and at the same time platinum was in greatly increased demand for various purposes arising out of the war, such as the contact-process for producing strong sulphuric acid, aeroplane engines, etc. The result has been that the price of refined platinum in New York rose to more than 20*l.* the troy oz.—*i.e.* five times the value of gold weight for weight. Both the high price and the difficulty of obtaining supplies have led to the introduction of various substitutes, such as "palau," a gold-iridium alloy, which has proved very effective for laboratory use; "rhotanium," a gold-palladium alloy, which is satisfactory for all chemical purposes except for use with hot concentrated nitric acid or as electrolytic anodes, and is even better than platinum as a setting for jewels; and "amaloy," an alloy of nickel, chromium, tungsten, etc., which is highly resistant to acid and atmospheric corrosion, and very serviceable in dental work and for surgical instruments. Tungsten appears to have displaced platinum as the material for the targets of X-ray tubes.

PROF. G. A. LEBOUR.

BY the death, on February 7, of Prof. Lebour, the scientific world loses a prominent and interesting figure. Born in 1847 and educated at the Royal School of Mines, he served from 1867 to 1873 on the Geological Survey. He was lecturer in geological surveying at the University of Durham College of Science (later, Armstrong College) in Newcastle from 1873 to 1879, and succeeded Page as professor of geology in that institution. This position he occupied until his death, so that for forty-five years he was connected with the college, and for thirty-nine years occupied the chair of geology. In 1904 he received the Murchison medal of the Geological Society, and in the same year was elected vice-principal of Armstrong College.

The transference of heat through the crust of the earth occupied Lebour's attention early and led to measurements of underground temperature in northern coal-pits, and also, in conjunction with Herschel, to the determination of the thermal conductivities of a great number of rocks. This work, issued in a series of B.A. reports from 1873 to 1881, is well known, and many of the data obtained are accepted as standard.

Lebour's name will always be associated with the geology of Northumberland and Durham. Besides his official maps, he brought out in 1877 an excellent geological map of the county of Northumberland, which is the embodiment of much strenuous, clear-sighted labour. He was joint author with Topley of a widely quoted paper on the Great Whin Sill, which may be said to have definitely established its intrusive character. The stratigraphical relations of the carboniferous rocks form the subject of many papers, in which the divisions of the system and the description and correlation of the important limestones, etc., are set forth with admirable lucidity. The economic aspects of the subject find expression in papers on the Redesdale Ironstones and the coals of the Bernician series, especially those associated with the Little Limestone. The future importance of these coals, which occur in rocks below the coal measures proper, is strongly insisted upon, and the lapse of forty years has but added strength to the views then brought forward. Of many papers relating to the geology of Durham may be noted those dealing with the classification of the salt-measures, the breccia-filled fissures in the magnesian limestone (aptly termed by him breccia-gastes), and the marl slate and yellow sands.

Lebour wrote one book, the "Handbook to the Geology and Natural History of Northumberland and Durham," of which three editions have appeared (1878–1889). It is a very effective monument to his life-work in the two counties, and has the remarkable merit of increasing in value the more it is used.

This brief narration of work accomplished gives, however, no true estimate of Lebour's scientific activity and influence. He was a many-sided man, of wonderful fluency, both in the written and spoken word, and a born teacher. His papers are models of clearness and skilful arrangement of material; they are written in flawless English, and they often display that sense of humour which was one of his notable characteristics. These same qualities were, if possible, accentuated in his lectures. He inspired a great band of workers, who have carried his methods and enthusiasm to the four quarters of the globe, and he was ever ready to help, by his sage advice, those whose steps he had directed towards scientific paths. J. A. S.

DR. JOHN McCRAE.

THE death of Lt.-Col. John McCrae at the early age of forty-four is a sad loss to the Canadian Army Medical Corps and to the profession at large. Dr. McCrae belonged to the type of modern physician in whom the study of disease is based on a thorough training in biology. A pupil of Ramsay Wright and of A. B. Macallum at the University of Toronto, he began his academic career as fellow in biology, and afterwards went to McGill as fellow in pathology. Associated with Prof. Adami at the Royal Victoria Hospital, Montreal, he became known as a popular teacher and a keen investigator of problems in clinical medicine. He was the joint author with Dr. Adami of the well-known "Text-book of Pathology." Always keenly interested in military matters, he joined his old battery at the outbreak of the Boer War, and in 1902 gained his majority and was given command. It is to be hoped that the valuable notes and sketches of his South African campaigns may be published. In the present war he served with the Canadian Artillery, and was in the critical battles north of Ypres. Later he took charge of the medical department of the McGill Hospital, and a few days before his death had been appointed consulting physician to one of the British divisions. He was a keen soldier, with a fine spirit of devotion to duty, and a personality which made him beloved by a wide circle of friends on both sides of the Atlantic.

Among Canadian poets Dr. McCrae had a high place. War poems from his pen have appeared in the *Spectator* and in *Punch*. "Flanders' Fields" has the true ring—and will live:

In Flanders' Fields the poppies blow
Between the crosses, row on row,
That mark our place, and in the sky
The larks still bravely singing fly,
Scarce heard amid the guns below.
We are the dead. Short days ago
We lived, felt dawn, saw sunset glow,
Loved and were loved; and now we lie
In Flanders' Fields.

Take up our quarrel with the foe,
To you from failing hands we throw
The Torch—be yours to hold it high;
If ye break faith with us who die,
We shall not sleep, though poppies grow
In Flanders' Fields.

NOTES.

THE political correspondent of the *Daily Mail* announces that the Government has sanctioned a scheme, which will involve several millions of pounds, to provide capital to develop the dye industries in this country. It has been realised for some time that the provision made in 1915, when British Dyes, Ltd., was established, is altogether inadequate to place the industry in a position comparable with that of the great German syndicate of dye manufacturers. The capital of these firms is more than 50,000,000*l*., whereas that of British Dyes, Ltd., is only about 2,000,000*l*., and the whole of our dye manufacturing firms have much less than one-tenth the capital of the German syndicate. It is obvious, therefore, that even if a co-operative scheme is arranged between these separate enterprises, much more will have to be done to increase the total capital available for the industry, build the necessary plant, and secure a sufficient number of research chemists and chemical engineers to enable our dye manufacturers to face the severe competition to which they will be subjected at the end of the war. The industry is of prime importance to our national development, for it is bound up with many other manufactures, directly or indirectly, and its ramifications enter into most arts of peace as well as those of war. We are glad to learn, therefore, that the Government is taking the necessary steps to make our position strong enough to withstand the severe assaults which it will have to bear when commercial competition is not restricted by conditions of war.

WE learn from a message from the Petrograd correspondent of the *Times*, published in the issue of February 20, that the abolition of the Julian calendar and the substitution of the reformed, or Gregorian, calendar has been formally announced by the Government of the People's Councils. "Attempts from the time of Peter the Great to effect this reform have always failed through ecclesiastical opposition, but now that the Orthodox Church has been divorced from the State its opinions and traditions are entirely ignored."

WE regret to see the announcement of the death, on February 16, at sixty-four years of age, of Dr. F. M. Sandwith, C.M.G., Gresham professor of physic, and lecturer at the London School of Tropical Medicine.

THE King has approved the grant of the Polar medal with clasp inscribed "Antarctic, 1914–16" to Sir E. H. Shackleton, Lieut. Frank Wild, Lieut. J. R. Stenhouse, and other members of the *Endurance* and *Aurora* parties of the Imperial Trans-Antarctic Expedition, 1914–16.

AT the annual meeting of the Optical Society held on February 14, the election of officers and council for the year 1918–19 was announced as follows:—*President*, Prof. Cheshire; *Treasurer*, Mr. H. F. Purser; *Librarian*, Mr. J. H. Sutcliffe; *Secretaries*, Mr. Wm. Shackleton and Mr. T. Smith. *Members of Council*, Naval Instructor T. Y. Baker, Mr. P. F. Everitt, Mr. J. W. French, Mr. E. B. Knobel, and Mr. F. C. Watts.

WE learn from *Science* that the U.S. War Department has established a Chemical Service Section and two lieutenant-colonels have been commissioned—Dr. R. F. Bacon, director of the Mellon Institute, Pittsburg, to have charge of the chemical work in France, and Prof. W. H. Walker, of the Massachusetts Institute of Technology, to have charge of the work in the United States.

THE acting-secretary of the Decimal Association sends us the following extract from the *New York Tribune* of January 22:—"Adoption of the metric system of measurements for artillery and machine-guns and maps for the American overseas forces was announced to-day by the War Department. The change was agreed upon at the suggestion of the French Government to avoid confusion in France."

THE President of the Board of Agriculture and Fisheries has appointed a Committee to advise in regard to all electrical questions connected with the carrying out of experiments in electro-culture, and, particularly, with regard to the construction of apparatus suitable for use on an economic scale and to the making of such electrical measurements as may be necessary in connection with the experiments. The members of the Committee are as follows:—Sir John Snell (chairman), Mr. A. B. Bruce, Prof. V. H. Blackman, Dr. C. Chree, Mr. W. R. Cooper, Dr. W. H. Eccles, Mr. J. S. Highfield, Prof. T. Mather, Dr. E. J. Russell, and Mr. C. T. R. Wilson. Mr. B. W. Phillips, of the Board of Agriculture and Fisheries, will act as secretary to the Committee, and all communications should be addressed to him at 4 Whitehall Place, S.W.1.

WE regret to note that the death of Mr. John Farquharson McIntosh is recorded in *Engineering* for February 15. Mr. McIntosh was born in 1848, and was connected with the Scottish railways for fifty-two years, nineteen of which he served as locomotive superintendent of the Caledonian line. Immediately after his appointment he began to design a series of locomotives, beginning with the "Dunalastair" for the Glasgow and Carlisle passenger service. He was invited by the Belgian Government to prepare designs suitable for the international express service on the State railways from Ostend. Mr. McIntosh was a member of the Association of Railway Locomotive Engineers, and was president in 1911, in which year also he was created a member of the Royal Victorian Order.

AT the outbreak of the war the Swiss Federal Government seized all the instruments installed in Swiss wireless stations, so that such stations could no longer receive the daily time-signals transmitted from the Eiffel Tower. At the urgent request of several establishments, the Swiss Administration of Telegraphs and Telephones decided to arrange for the retransmission of such signals, by telephone, as received from the Paris Observatory. Since August, 1916, therefore, Swiss telephone subscribers have thus been able to receive, by telephone each day, between 10.56 and 11 a.m., the Eiffel Tower signals transmitted to Berne and repeated simultaneously. In a recent communication to the Swiss Geophysical Society (quoted in *La Nature* for February 2), M. Paul Ditisheim, the eminent Swiss horologist, states that this service has worked perfectly, and that the signals transmitted in this manner do not vary more than ±0·087 sec. from the time as transmitted from Paris.

REPLYING to a number of questions raised by the vote for a supplementary sum of 4000*l.* for expenditure in respect of art and science buildings in connection with the Civil Service Supplementary Estimates, Sir A. Mond said, in the House of Commons on Monday, February 18, that the Imperial Institute was partly occupied for the sugar rationing purposes of the Ministry. As to the new Science Museum, it was in course of construction, and incomplete. It had been represented that the work of construction ought to be continued during the war, but he was not in a position to complete the construction of museums in existing circumstances. Considerable expense had been incurred in making the finished part of the building suitable for the work now to be done there. Museums now wholly or partly occupied by Government Departments were the National Gallery, the Tate Gallery, the Wallace Gallery, the Victoria and Albert Museum, and the British Museum, of which a small part had been taken over. The vote was agreed to.

THE Norwich Public Library has received for its extensive local collection a valuable donation from Mr. A. H. Patterson, the well-known Norfolk naturalist. On Tuesday, February 19, the Norwich City Council passed a resolution of thanks to Mr. Patterson for his generous gift of "a large and valuable collection of his writings and sketches, comprising his manuscript notebooks from 1878 to 1916 (including original drawings, printed articles, and letters), a complete set of his published works relating to the natural history of Norfolk, and about a thousand of his political, football, and fishing cartoons of local interest." Mr. Patterson has had the opportunity of making continuous observations for about forty years in a district—the Norfolk estuary (Breydon)—which is particularly attractive to naturalists. It is one of best districts in the country for observation of fishes and birds, including a large number of bird immigrants, some of which are extremely rare visitants to our shores. Great success has attended his unceasing vigilance, and he has been able to make valuable additions to the list of Norfolk fauna, particularly fishes. His notebooks are a mine of valuable information, for in them since 1878 he has recorded day by day his careful observations of the fauna, and has preserved notes of curious and interesting specimens which have been brought to him, pen-and-ink sketches, and coloured drawings of interesting examples, and letters from other naturalists regarding his work.

AT the opening ceremony of the Bose Research Institute at Calcutta, the founder, Sir J. C. Bose, delivered an address, published in the *Pioneer Mail* of December 8 last, in which he pointed out that thirty-two years ago, when he began the teaching of science, it was generally supposed that the Hindu mind, immersed in metaphysical speculation, was unable to undertake scientific inquiries. There were then no well-equipped laboratories, no skilled mechanicians. "Twenty-three years ago some of the most difficult problems connected with electric waves found their solution in my laboratory, and received high appreciation from Lord Kelvin, Lord Rayleigh, and others. The Royal Society honours me by publishing my discoveries and offering an appropriation from a special Parliamentary grant." He added:—"The work already carried out in my laboratory on the response of matter and plant-life has opened out very extended regions of inquiry in physics, physiology, medicine, and psychology; but high success is not to be obtained without corresponding experimental exactitude; hence the instruments and apparatus designed here which stand before you in our entrance hall." The institute is admirably equipped for the special research which its staff intends to undertake. An interesting feature is a small garden of sensitive plants. A large double tracing is being automatically made in two parallel curves, one recording atmospheric changes, while the other summarises the responses of a large tree to these changing conditions for every minute of the twenty-four hours.

SOME exceptionally large stone implements discovered in 1887–88 near the Johnstone River, on the Pacific coast of Queensland, are described in the February issue of *Man* by Mr H. Ling Roth. The materials from which they are made are an altered diabase, argillaceous and micaceous grit, and an arenaceous shale. One implement measures 16·5 cm. by 10·9 cm. by 2·9 cm. Dr. Walter E. Roth, who made some inquiries regarding them, states that at the present day such stone axe-heads are not used—in fact, no stone axes are used. They seem to have been procured from quarries, one about ninety miles from the scene of the discovery. Dr. Roth found, in the neighbourhood of Boulia, an axe-head measuring 9 in. in its greatest diameter—considerably larger than any in the collection now described. These appear to be the largest dressed stones hitherto found in Australia, but the Bankfield Museum possesses a similar implement from Lifu, Loyalty Islands, formed of impure jade. It is not so large as some of the big New Caledonian stones fastened at right angles to a handle by sinnet passed through two holes in the stone.

ACCORDING to an investigation on the "Diet, Nutrition, and Excretion of Asiatic Races in Singapore," undertaken by Prof. J. Argyll Campbell, and published in the Journal of the Straits Branch of the Royal Asiatic Society in 1917, the energy value of the diet of a Chinese, a Tamil, or a Malay medical student was only about 1600 Calories. That of a Brahmin was higher, but, the diet being vegetable, was to a large extent unutilised. To compare with this, we may take the diet of an Anglo-Indian, according to McCay, which was 2800 Calories, and that of a Filipino, which was 2630 Calories. It is suggested that the low-energy value of the Singapore diet may be due to the moist atmosphere, which retards loss of heat by evaporation, so that less food is required. Another contributory cause is the small amount of muscular exercise taken by the Singapore student. Although Europeans in the tropics are not inclined to take much exercise, they cannot keep healthy on a European diet unless they do so. The author found the Singapore students to do as much brain work as his previous European students did.

IN a letter written on Christmas Day, 1917, from Dongonab, *via* Port Sudan, Nubia, Mr. Cyril Crossland reports his having found a species of Ophioglossum growing in a patch of disintegrated coral just below the top of a cliff 136 ft. high on Rawaya peninsula on the Red Sea coast, near lat. 21° N. The species in question is doubtless *O. capense*, Schlecht., which has already been recorded by Prantl as having been collected by Schweinfurth in May, 1864, in an adjacent locality—the western side of Macaur Island, lat. 21° N., on coral detritus. This species, unlike the European *O. vulgatum*, Linn., prefers dry situations. It was collected by Schimper in Abyssinia in sandy desert. The late Prof. Pearson met with it among Acacia scrub in German South-West Africa, and in deep sand at Kiubis, in Great Namaqualand. In Natal it has been found growing only on very dry sandy knolls near Durban. Mr. Crossland remarks that two showers in November constitute all the rain that had fallen at Dongonab during 1917, and that wholly dry years are common. The desert flora of lat. 21° N. is much less abundant, and individual plants are more stunted, than is the case only a hundred miles further south. Generally the plants that occur are confined to water-courses and drainage lines, but the cliff on which he met with the Ophioglossum bears a few bushes near the top.

WE have received the 1916–17 part of the Transactions and Proceedings of the Perthshire Society of Natural Science, the pages of which show a continuance of careful work. Mr. Henry Coates, the curator of the admirable regional museum, deals with some stone cists from the Carse of Gowrie; Mr. Graham Callander has an interesting paper on methods of archæological research; Mr. J. A. Donald discusses to good purpose some of the difficult problems of afforestation; Mr. D. A. Haggart describes, in a racy manner, various faunistic and floristic rambles in Mid-Perth, especially among the hills. One of Mr. Haggart's notes is enthusiastic over the delicious meal which may be made of roast sparrow, and another directs attention to a change of colour exhibited by the beetle, *Carabus catenulatus*, when it is excited. Mr. Barclay, the president of the society, records some interesting botanical rarities, such as *Potamogeton gracilis* (reputed to be a hybrid of *P. alpinus* and *P. heterophyllus*), which differs from all, or almost all, other pond-weed hybrids in being fertile and producing good fruit. It has hitherto been found in Britain in only one station in the Shetland Islands. The Proceedings contain a number of notes of interest, *e.g.* on the activity of a hedgehog in catching bees flying and crawling about in front of a hive, and on the sub-fossil antler of an elk (*Alces machlis*) found near Methven in 1801. It measured 27 in. across from one extreme snag to another, and weighed 8¼ lb. A good photograph is given. The Perthshire Society was founded in 1867, and it deserves to be congratulated on its record of fifty years of activity. It wears well, and is a fine example of what a local Natural History Society should be.

IN an article on "Forestry in the Dominion of New Zealand," just published in the *Quarterly Journal of Forestry* (vol. xii., pp. 1–28), Sir W. Schlich gives an account of the present condition of the forests in that country, and critically discusses their future management. A Royal Commission, which submitted a report to the Government in May, 1913, practically recommended that the valuable native forests should be replaced by artificial plantations of exotic trees. Sir W. Schlich considers it injudicious to neglect the natural forests, and urges that a considerable area of these should be declared permanent State reserves, and managed for the sustained production of timber in such a way that the more valuable species would naturally regenerate themselves. It is a melancholy fact that, apart from a few remnants, the Kauri forests have been destroyed. This wonderful tree yields one of the finest coniferous timbers in the world, and surely something might be done to restore the tree beyond the reservation of a few acres for sentimental reasons. It is asserted by the Royal Commission that "the timber trees of New Zealand are of much slower growth than those grown in forestry operations the world over." This opinion is quite unfounded. Mr. D. E. Hutchins, who has lately been in New Zealand, states that Kauri is fit to cut at 100 years old, and is then 2 ft. in diameter, which is a greater rate of growth than that of most European trees. Sir W. Schlich, using the meagre statistics available, holds that the growth of *Podocarpus Totara*, the second most valuable native conifer, is equal to that of silver fir, which produces the largest yield of timber of any tree on the continent of Europe. The article, which is replete with statistical, economic, and geographical information, is illustrated with four maps of New Zealand, showing the distribution of the forests, rainfall, and physical features.

MESSRS. R. D. SALISBURY and G. N. KNAPP, in "The Quaternary Formations of Southern New Jersey" (Final Report of State Geologist, vol. viii., 1917), illustrate by an admirable series of drawings the stages in the history of the coastal plain, the material of which is largely derived from Glacial outwash, and was accumulated under terrestrial conditions. A former diversion of the Hudson River is suggested.

THE Geological Survey of Scotland has issued a memoir on "The Economic Geology of the Central Coalfield of Scotland, Area II." (1917), covering the country round Falkirk. A number of vertical sections are conveniently included in a pocket at the end. We notice how the miners' words, "fakes," "blaes," and "ribs," which have also invaded Irish geology from the north, are accepted as technical terms, for the benefit of those who will primarily use the memoir.

THE Canadian Department of Mines has issued a recent memoir descriptive of the magnesite deposits of Grenville District, Quebec. Magnesite is a refractory material, extensively used in connection with the manufacture of open-hearth steel, and the British demand has been in the past supplied mainly from Greece, particularly from the island of Eubœa, which furnishes the mineral in a high state of purity, containing about 46 per cent. of magnesia, a little more than 1 per cent. of lime, and less than 1 per cent. of silica. It is of great importance that we should be able to obtain all the materials required for our basal industries from within the British Empire, and hence authoritative information upon these Canadian deposits is very welcome. The Grenville area lies just to the north of the River Ottawa, about midway between the towns of Ottawa and Montreal, and is thus conveniently situated as regards exportation of its mineral production. A considerable number of separate deposits have already been proved to exist; the magnesite is practically everywhere intimately associated with dolomite, so that most of it contains more than 7 per cent. of lime. The quantity of magnesite already proved containing less than 12 per cent. of lime is estimated at close upon 700,000 tons, whilst nearly 500,000 tons of mixed magnesite and dolomite, containing more than 12 per cent. of lime, are also known to exist, and there is evidence that other deposits of magnesite still remain to be discovered. It is important that the attention of ironmasters in this country should be directed to the existence of a new source of supply of this important material.

IN the *Philosophical Magazine* for January Dr. J. G. Leathem discusses the motion of a hydrodynamical liquid past a two-dimensional contained solid having a motion of translation and rotation. The object of the paper is to apply the method of periodic conformal transformation to problems of this class of a more general character than those commonly given in text-books. For this purpose the motion is divided into two portions, viz. a uniform rotation of the solid and liquid and a spinning motion with equal and opposite spin past the solid boundary supposed at rest, the two motions combined making up the required hydro-dynamical solution.

IN the December issue of *The Central* Mr. R. A. S. Thwaites, of Messrs. Allen and Co., Bedford, gives a valuable summary of the results which have been obtained by a study of the effects of the heat treatment of nickel-chrome and other steels on their mechanical properties. This study has been forced on the British steel manufacturers by the authorities insisting that steels for aeroplane engines should satisfy an impact test which the foreign steels available before the war satisfied without difficulty. By hardening the steel at 830° C., and tempering at 640° C. instead of 250° C., the number of foot-pounds required to break a small notched bar by the Izod test can be raised from 25 to 92. The yield point and ultimate strength of the steel are reduced by this treatment, and Mr. Thwaites gives curves showing how all the principal mechanical properties of the steel are affected by tempering at temperatures between 350° and 600° C. From these curves the proper tempering temperature to ensure steel of given mechanical properties may be found.

DURING the last few years a number of experimenters, including Reinganum, Walmsley and Makower, Miehl, Mayer, Sahni, Kinoshita and Ikeuti, have published excellent photographs showing the tracks of individual α particles from radium which strike the photographic plate at glancing incidence. In a recent paper Kinoshita and Ikeuti (Journ. Coll. Sci., Imper. Univ., Tokio, November 20, 1917) sum up our information on this interesting subject, and show a number of such photographs. Special methods were used to obtain very small radiating nuclei, so that the radial tracks of the expelled α particles show up clearly. The track of an α particle (magnification 500 to 1500) is not continuous, but marked by a number of developed grains from ten to twenty in number, depending on the velocity of the particle. An estimate is given of the diameter of these grains, with a discussion of the general theory of their formation and of the action of α rays on a photographic plate.

A RECENT issue of *Industrial Management* (*The Engineering Magazine*) contains several informative articles by officials connected with departments of the United States Government. The Hon. William C. Redfield, Secretary of the Department of Commerce, gives several striking instances of the waste that goes on continually in industry. According to the Department of Agriculture, 65 per cent. of a tree is wasted in converting it into lumber, and ten million dollars further is wasted annually in drying the lumber so made. Again, vast amounts of scrap wood available for making pulp, alcohol, or vegetable products are burned or allowed to rot. It has only recently been realised that whale meat is a delicacy, and that the intestines of the whale make good leather. In the past the carcasses of seals were invariably thrown away after removing the skin, although the blubber can be used to make oil, the flesh for meat, and the bones for fertiliser. Germany, on the other hand, is pre-eminently an economical country, and many of her industries, such as those associated with dyestuffs and explosives, were built up on so-called waste products. The four chief defects in industry to be overcome are:—(1) Separation of science from industry; (2) industrial waste; (3) lack of industrial and commercial education; and (4) ignorance of manufacturing costs. The Hon. L. F. Post gives a summary of the work of the Department of Labour in connection with the war. Among other feats, it has registered 10,000 ship workers in ten days, placed more than 300,000 men in manufacturing employment last year, and adjusted 323 labour controversies in war industries between January 1 and October 25, 1917. Finally, Mr. H. E. Coffin discusses the general organisation of the business department of the United States Government, and analyses the functions of the somewhat complex boards and committees. The complaint has been made that there is too much subdivision. Mr. Coffin, however, thinks that the confusion is more apparent than real—in short, that the three main groups of the war organisation, dealing respectively with purchasing, industrial policy, and labour, are "shaking down."

Engineering for February 15 reproduces some interesting photographs of damage done to the machinery of German steamers interned in Brazil. These photographs illustrate the thoroughness of German destruction; in one case of two damaged cylinders, at least 8000 holes must have been drilled transversely and vertically through the cylinders. The cylinders illustrated had been broken into hundreds of small pieces, and in order to make new cylinders to suit the set of engines it was necessary to collect as many pieces as possible and to patch them together so that the dimensions could be measured accurately. Most of the broken parts were found carefully stored between decks, evidently in order to be used as scrap metal in Germany in the event of the return of the ships to the Fatherland. The number of German vessels interned in Brazil was approximately forty-five, totalling 235,000 gross tons. In the early part of 1917 the Brazilian Government invited Messrs. Vickers, Ltd., to survey the damage and carry out the steps necessary for repair. It was found that the repairs could be carried out in the naval arsenal of Brazil, and great credit is due to the engineering officers of the Brazilian Navy, not only for executing the work, but also for the expedition with which it was carried out.

MESSRS. A. GALLENKAMP AND CO., LTD., of Sun Street, Finsbury Square, E.C.2, have sent us their circulars describing viscometers and centrifugal machines. In the former list are placed Redwood's and Engler's instruments, with details for use. No technical-school laboratory or any works wherein lubricating oils are largely used should be regarded as completely equipped without one of these standard viscometers, for, although it is possible to determine the viscosity of an oil in the usual physico-chemical way, yet the conversion of "absolute viscosity" to "seconds Redwood" is by no means possible with accuracy in every case, and one must remember that the grading of an oil is largely determined by its Redwood number, and not by its true viscosity. In the same list is described a convenient stop-watch for timing the flow of oil. Pensky-Martin's, Gray's, and the Abel flash-point apparatus are also included in this list. For some time past there has been a demand for convenient and compact laboratory centrifuges. In the circular to hand (No. 193) are described hand patterns from so low a price as two guineas to small power-driven instruments, built to run at 5000 revolutions per minute. A modification, designed for the rapid drying of crystals, and based on the design of the works "whizzer," will doubtless be found of value in many laboratories.

OUR ASTRONOMICAL COLUMN.

RELATIVITY AND GRAVITATION.—A pamphlet has just reached us entitled "La spostamento del perielio di mercurio, e la deviazione dei raggi luminosi, secondo la teoria di Einstein," by Attilio Palatini (from *Nuovo Cimento*, July, 1917; Pisa: Stabilimento Tipografico Toscano). The pamphlet, like the article by Prof. Eddington in NATURE of December 28, 1916 (vol. xcviii., p. 328), aims at making the outlines of Einstein's relativity theory clear to those who have not access to his original works. The points in which the new theory differs from our earlier conceptions of Euclidean space and Newtonian dynamics are clearly brought out. As the title indicates, particular stress is laid upon the manner in which it completely accounts for the excess of 43″ per century in the motion of the perihelion of Mercury's orbit, which had been recognised as a difficulty in the Newtonian theory. It is especially noteworthy that the Einstein theory was laid down quite independently of this result, which is therefore in the nature of an undesigned coincidence. It differs in this respect from some other relativity theories, which have assumed arbitrary values for certain coefficients, in order to satisfy the observed facts. Einstein's result involves no arbitrary constant, but simply depends on the ratio of Mercury's velocity to that of light. The pamphlet employs two different methods of development, each leading to the result that the perihelion advances 0·1″ in one revolution of Mercury.

The other test proposed by Einstein for his theory is that a ray of light from a star just grazing the sun's surface and passing on to the earth would be deflected through an angle of 1·75″. It is shown in the pamphlet how this result is deducible from Einstein's principles, and allusion is made to total solar eclipses as affording opportunities for a practical test. The Astronomer Royal has already urged that advantage be taken of the very favourable total eclipse of May, 1919, for experiments of this kind. Prof. Eddington has pointed out that the doctrine that light has inertia would lead us to expect a deflection of 0·88″ at the sun's limb in any case; so the Einstein test depends on the difference between this value and 1·75″.

THE SYSTEM OF κ PEGASI.—The star κ Pegasi is a visual binary having the unusually short period of 11·35 years, and one of the components, as found by Campbell in 1900, is a spectroscopic binary. An investigation of this interesting triple system has been made by Dr. F. Henroteau, utilising spectrograms previously taken at the Lick Observatory, and numerous others recently obtained by himself (Lick Observatory Bulletin, No. 304). Elements of the orbit of the spectroscopic pair, computed for the epochs 1900, 1912, and 1917, clearly show the changes to be expected from the revolution round the centre of mass of the visual system, and they also indicate a revolution of the line of apsides, probably due to perturbations occurring in the spectroscopic binary orbit under the influence of the third body. Combining the data obtained by telescopic and spectroscopic observations, it is shown that the semi-major axis of the orbit of the spectroscopic binary is 511,100,000 km., while that of the visual pair is 1,826,000,000 km. Since the apparent semi-major axis is 0·29″, it follows that the parallax is 0·025″. The total mass of the spectroscopic pair is 10·33 times, and the mass of the other visual component 4·00 times, that of the sun. There are curious variations in the appearance of the spectrum, which seem to be satisfactorily explained by the superposition of an F class spectrum, oscillating in a period of 5·9715 days, upon a spectrum of possibly the same class oscillating by a smaller amount in a period of 11·35 years.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE AND HORTICULTURE.

Baillière, Tindall, and Cox.—A new edition of Cows, Cowhouses, and Milk, G. Mayall.

ANTHROPOLOGY AND ARCHÆOLOGY.

Macmillan and Co., Ltd.—Folk-Lore in the Old Testament, Sir J. G. Frazer, three vols.

BIOLOGY.

Constable and Co., Ltd.—Coniferous Trees, A. D. Webster, illustrated. *C. H. Kelly.*—Spiders and Beetles, and How to Identify Them, S. N. Sedgwick. *John Murray.*—The Life and Letters of Sir Joseph Dalton Hooker, O.M., G.C.S.I., L. Huxley, based on material collected and arranged by Lady Hooker, two vols., illustrated. *L. Reeve and Co., Ltd.*—Flora of Tropical Africa, edited by Sir D. Prain, vol. vi., section 2, part 2, dealing with the orders Ulmaceæ to Cycadaceæ; vol. ix. (Gramineæ), part 2. *The University Tutorial Press, Ltd.*—Text-Book of Botany, J. M. Lowson, Indian edition, revised by Birbal Sahni.

CHEMISTRY.

G. Allen and Unwin, Ltd.—The Treasures of Coal Tar, Prof. A. Findlay. *Baillière, Tindall, and Cox.*—Plant Products and Chemical Fertilisers, S. H. Collins, and a new edition of Aids to Analysis of Foods and Drugs, C. G. Moor and W. Partridge. *Blackie and Son, Ltd.*—A Complete Course of Volumetric Analysis for Middle and Higher Forms of Schools, William T. Boone. *J. and A. Churchill.*—Applied Analytical Chemistry, edited by Prof. V. Villavecchia, translated by T. H. Pope, vol. ii.; Chemical Combination among Metals, Drs. M. Guia and C. Guia-Lollini, translated by G. W. Robinson. *Constable and Co.*—What Industry Owes to Chemical Science, R. B. Pilcher and F. Butler-Jones, with an introduction by Sir G. Beilby ("The Engineer" Series), and a new edition of Laboratory Guide of Industrial Chemistry, A. Rogers, illustrated. *Crosby Lockwood and Son.*—High Explosives: their History, Manufacture, Properties, and Uses, Lieut. E. de W. S. Colver, illustrated. *Longmans and Co.*—Lecithin and Allied Substances: The Lepins, Dr. H. Maclean (Monographs on Biochemistry). *Macmillan and Co., Ltd.*—Sir William Ramsay, K.C.B., F.R.S.: Memorials of His Life and Work, Sir W. A. Tilden, with portraits; The Manufacture of Intermediate Products for Dyes, Dr. J. C. Cain, illustrated. *Scott, Greenwood, and Son.*—New editions of The Chemistry of Essential Oils, E. J. Parry, two vols., and Iron Corrosion, Anti-Fouling and Anti-Corrosive Paints, L. E. Andes. *The University Tutorial Press, Ltd.*—Senior Practical Chemistry, H. W. Bausor.

ENGINEERING.

Benn Bros., Ltd.—Electrical Measuring Instruments: their Design, Construction, and Application, Dr. C. V. Drysdale and A. C. Jolley; The Handling of Materials: A Manual on the Design, Construction, and Application of Cranes, Conveyors, Hoists, and Elevators (being the second and enlarged edition of "Electric Cranes and Hoists"), H. H. Broughton, two vols., illustrated; The Induction Coil, Prof. E. Taylor Jones; Manual of the Telephone, W. Aitken, two vols.; and a new edition of Electric Mains and Distributing Systems, J. R. Dick and F. Fernie. *Blackie and Son, Ltd.*—Tidal Lands: A Study of Shore Problems, A. E. Carey and Prof. F. W. Oliver, illustrated. *Constable and Co., Ltd.*—The Production and Treatment of Vegetable Oils, T. W. Chalmers, illustrated; Locomotive Valves and Valve Gears, J. H. Yoder and G. B. Wharen, illustrated; Physical Laboratory Experiments for Engineering Students, S. Sheldon and E. Hausmann, illustrated; and a new edition of Industrial Electrical Measuring Instruments, K. Edgcumbe, illustrated. *Crosby Lockwood and Son.*—The Aviation Pocket-Book for 1918: A Compendium of Modern Practice and a Collection of Useful Notes, Formulæ, Rules, and Tables relating to Aeronautics, R. B. Matthews, illustrated; The Mechanical Engineer's Pocket-Book for 1918, comprising Tables, Formulæ, Rules, and Data: A Handy Book of Reference for Daily Use in Engineering Practice, by the late D. Kinnear Clark, tenth edition, thoroughly revised and enlarged, by H. H. P. Powles, with a new Electrical Section by Dr. F. T. Chapman; The Engineer's Year-Book for 1918, H. R. Kempe, with collaboration, illustrated; Aviation Engines: their Design, Construction, Operation, and Repair, a book for the Student, Engineer, and all interested in Aviation, by a recognised authority, illustrated; Glossary of Aviation Terms in English-French and French-English, Lieut. V. W. Pagé and Lieut. P. Montariol, illustrated; An Aviation Chart: The Location of Aviation Power Plant Troubles Made Easy. A large wall chart, showing a typical aeroplane power plant in part section, with all important components shown. *Macmillan and Co., Ltd.*—Alternating-current Electrical Engineering, P. Kemp, illustrated. *Sir Isaac Pitman and Sons, Ltd.*—Electric Motors and Control Systems, A. Dover, illustrated; A Small Book on Electric Motors for Continuous and Alternating Currents, W. P. Maycock; Rudiments of Telephony, T. E. Herbert; The Stability and Control of Aeroplanes, A. W. Judge (vol. iii. of the Manuals of Aeronautics); Aeronautical Materials and Methods of Construction, A. W. Judge (vol. iv. of the Manuals of Aeronautics); and new editions of Magneto and Electric Ignition, W. Hibbert, illustrated; Alternating-current Work, W. P. Maycock, illustrated; The Practical Telephone Handbook and Guide, J. Poole, illustrated; The Slide Rule, C. N. Pickworth, illustrated; Gums and Resins, J. Parry, illustrated (Common Commodities and Industries Series); Glass and Glass Manufacture, P. Marson, illustrated. *Scott, Greenwood, and Son.* — The Strength of Ships, J. B. Thomas, illustrated; Elastic Stresses in Structures, translated from the French by E. S. Andrews, illustrated; Machine and Fitting Shop Practice, G. W. Burley, two vols; Modern Steam Boilers, E. Pull; Moving Loads by Influence Lines and Other Methods, E. H. Sprague.

GEOGRAPHY.

Cambridge University Press.—The North Riding of Yorkshire, Capt. W. J. Weston (Cambridge County Geographies).

GEOLOGY.

Cambridge University Press.—Lecture on John Michell, delivered before the Yorkshire Philosophical Society, Sir Archibald Geikie.

MATHEMATICAL AND PHYSICAL SCIENCES.

Cambridge University Press.—The Theory of Electricity, G. H. Livens; Theory of Functions of a Complex Variable, Prof. A. R. Forsyth; Lecture Notes on Light, J. R. Eccles. *C. H. Kelly.*—Stars and How to Identify Them, E. W. Maunder. *Longmans and Co.*—Infinitesimal Calculus, Prof. F. S. Carey, in two sections, Section II.; Differential Equations, Dr. H. Bateman (Longmans' Modern Mathematical Series). *Macmillan and Co., Ltd.*—A Text-Book of Physics for the Use of Students of Science and Engineering, J. Duncan and S. G. Starling, illustrated, in five parts: Dynamics; Heat, Light, and Sound; Magnetism and Electricity; Heat; Light and Sound. *The University Tutorial Press, Ltd.*—Intermediate Text-Book of Magnetism and Electricity, R. W. Hutchinson.

MEDICAL SCIENCE.

Baillière, Tindall, and Cox.—Meat inspection Problems, Dr. W. J. Howarth; Aids to Rational Therapeutics, Dr. R. W. Leftwich; and new editions of Papers on Psycho-Analysis, Dr. E. Jones, and Errors of Accommodation and Refraction of the Eye, Dr. E. Clarke. *A. and C. Black, Ltd.*—A new edition of Radiography and Radio-Therapeutics, Dr. R. Knox. *J. and A. Churchill.*—The History and Present Position of Massage and Medical Gymnastics, Dr. Kleen, translated by Dr. Mina Dobbie; and a new edition of A Manual of Bacteriology, Prof. R. T. Hewlett. *H. K. Lewis and Co., Ltd.*—Regional Surgery, edited by Dr. J. F. Binnie, three vols, vol. i.; The Influence of Sunlight in the Production of Cancer of the Skin, Dr. N. Paul, illustrated; The Action of Muscles and Muscle Rest, Dr. C. Mackenzie, illustrated; Anti-Malarial Work in Macedonia among British Troops, Maj. W. G. Willoughby and Capt. L. Cassidy, illustrated; Gould's Pocket Medical Dictionary; Stitt's Tropical Diseases; Stitt's Practical Bacteriology; and new editions of Dr. H. Lewis Jones's Medical Electricity, revised and edited by Dr. L. W. Bathurst, and Landmarks and Surface Markings of the Human Body, L. B. Rawling. *Longmans and Co.*—X-Ray Atlas of the Skull, Capt. A. A. Russell Green, illustrated; Tube Teeth and Porcelain Rods, Dr. J. Girdwood, illustrated. *Macmillan and Co., Ltd.*—The Life of Sophia Jex-Blake, Dr. Margaret Todd ("Graham Travers"), with portraits; An Enquiry into the Analytical Mechanism of the Internal Ear, Sir T. Wrightson, Bart, with an Appendix on the Anatomy of the Parts Concerned by Prof. A. Keith; Fibroids and Allied Tumours: their Pathology, Clinical Features, and Surgical Treatment, Dr. C. Lockyer, illustrated; Hysterical Disorders of Warfare, Dr. L. R. Yealland; Alcohol and Life: A Manual of Scientific Temperance Teaching for Schools, J. A. Hunter, illustrated. *Masson et Cie (Paris).*—Emotions et Commotions de guerre, Prof. A. Léri; Traitement des Psychonévroses de guerre, G. Roussy, J. Boisseau, and M. d'Œlsnitz; Prothèse fonctionnelle en chirurgie de guerre, Ducroquet; Blessures de la Moelle et de la Queue de cheval; Formes cliniques et anatomiques, Traitement, Prof. G. Roussy and J. Lhermitte; La suspension dans le Traitement des Fractures (Appareils Anglo-Américains), C. Robert et P. Desfosses; and new editions of Traitement opératoire des plaies du Crâne, T. de Martel, and Les Blessures du Cerveau, C. Chatelin.

PHILOSOPHY.

Cambridge University Press.—The Neo-Platonists, T. Whittaker, new edition. *Macmillan and Co., Ltd.*—A Commentary to Kant's Critique of Pure Reason, Prof. N. Kemp Smith; Some Suggestions in Ethics, Dr. B. Bosanquet.

TECHNOLOGY.

Baillière, Tindall, and Cox.—The Alkali Industry, Dr. J. R. Partington. *Benn Bros., Ltd.*—Notes on Design of Electromagnetic Machines, part ii., Design of a Slow-speed Alternating-current Generator ("The Electrician" Monographs). *Constable and Co., Ltd.*—Wool, F. Ormerod, illustrated; Cotton, G. Bigwood, illustrated (Staple Trades and Industries Series).

Crosby Lockwood and Son.—Lockwood's Builder's Price Book for 1918, edited by R. S. Ayling, illustrated. *Scott, Greenwood, and Son.*—A new edition of Grammar of Textile Design, H. Nisbet.

MISCELLANEOUS.

G. Allen and Unwin, Ltd.—Scientific Synthesis, Dr. E. Rignano, translated by W. J. Greenstreet. *Cambridge University Press.*—The Collected Papers of Sir Benjamin Browne, containing, among others, the following contributions:—Education from the Employers' Point of View, Labour Problems, Co-partnership, Insurance, and the Scientific Training of Young Workmen. *Constable and Co., Ltd.*—Man's Redemption of Man, Sir W. Osler, Bart.; Science and Immortality, Sir W. Osler, Bart.; A Way of Life, Sir W. Osler, Bart. *John Murray.*—The Herring: its Effect on the History of Britain, A. M. Samuel, illustrated.

PRIMITIVE CULTS.

MISS M. A. MURRAY contributes to *Folk-Lore* (vol. xxviii., No. 3) a paper on the "Organisations of Witches in Great Britain." The author brings forward certain facts which appear to show a connection between witches and fairies—not the little beings which the fancies of poets have evolved; the fairies of the witch trials are the fairies of Scotch and Irish legend. The ritual of the witches is like the ritual of the fairies: both sacrificed children to their god, whom Christians stigmatised as the devil; both stole unbaptised children for the sacrifice; both sacrificed their god or devil every year, apparently on May Day; both had ritual dances of the same type. "If, as many authorities contend, the fairies are really the aboriginal inhabitants of these islands, there is nothing surprising in their ritual and beliefs being adopted by the invading race. And in that case I am right in my conjecture that the rites of the witches are the remains of the ancient and primitive cult of Great Britain."

Mr. T. J. Westropp, who is doing excellent work in investigating on scientific lines the early remains in Ireland, has republished from the Proceedings of the Royal Irish Academy (vol. xxxiv., Section C, No. 3) a paper entitled "The Ancient Sanctuaries of Knockainey and Clogher, Co. Limerick." Here a cairn commemorates the cult of the goddess Aine, of the god-race of the Tuatha de Danann. She was a water spirit, and has been seen, half-raised out of the water, combing her hair. She was a beautiful and gracious divinity, "the best-natured of women," and is crowned with meadowsweet (Spiræa), to which she gave its perfume. She is a powerful tutelary spirit, protector of the sick, and connected with the moon, her hill being sickle-shaped, and men, before performing the rites at her shrine, used to look for the moon—whether risen or not—lest they should be unable to find their way back. They used to visit her shrine on St. John's Eve, carrying wisps of lighted straw, in order to bring good luck to crops and herds. One day some girls saw her, and she showed them through a ring that her hill was crowded with fairies. Her son, the magic Earl of Desmond, is still seen riding over the ripples of Loch Gur until his horse's golden shoes are worn out. This is a valuable instance of the survival in an attenuated form of the primitive figures of Irish mythology.

The beginnings of religion are discussed in an interesting paper by Dr. E. S. Hartland in the *R.P.A. Annual*, published by the Rationalist Press Association, on religion among the Indian tribes of Guiana, based on the researches of Mr. Walter E. Roth, Protector of Indians in the Pomeroon district, British Guiana. "This attitude towards their external and material environment is reflected in their religion—if we may call it religion, which is merely distrust and dislike of the spirits that are believed to surround them, for the spiritual environment can be less steadily and distinctly contemplated than the material, and therefore is even more the subject of surmise and distrust. The unknown is magnified; the strange, the unusual, the unfamiliar, is regarded with uneasiness, with anxiety, evolving into hostility, with wonder and awe, leading not to inquiry and deliberate scrutiny, but to aversion and terror. Such is the mood, and such are the experiences, to which modern psychology is inclined to trace the beginnings of religion."

SULPHUR IN THE UNITED STATES.

THE Smithsonian Institution issues for publication in the Press interesting descriptive articles upon subjects dealt with in many of the bulletins distributed by it. These articles keep the people of the United States in close touch with the activities of the National Museum and other scientific departments and enable them to appreciate the interest and value of the work being carried on. We print below, in a slightly abridged form, an article upon the subject of Bulletin 102, part 3, of the U.S. National Museum, as it deals with a subject of particular importance at the present time, and refers to the ingenious method by which two sulphur deposits near the Gulf Coast in Louisiana and Texas are worked. The success of the process is such that the Gulf deposits are supplying practically all the crude sulphur in the United States, and its development has shifted the world's largest sulphur industry from Sicily to that country.

Few people realise the extent to which sulphur enters into the manufacture of the materials of everyday life that surround them. Yet it is not primarily because sulphur is necessary to convert the sap of a tropical plant into resilient and versatile rubber or wood-pulp into miles of news-print paper that this substance claims our attention at this time; rather because it is numbered among those substances of prime importance, absolutely essential to the carrying on of war, as entering into the very fabrication of explosives themselves. Hence it is not only a matter of curiosity, but also one of urgent interest, to inquire into the sources of this war mineral.

In this connection the appearance is timely of a publication of the U.S. National Museum under the title "Sulphur: An Example of Industrial Independence." This is by Mr. Joseph E. Pogue, of the Division of Mineral Technology, and presents in a few pages, in a simple and non-technical manner, the striking aspects of one of the most interesting mineral industries in the United States to-day. At the outbreak of the war in 1914 the United States was producing each year about 350,000 tons of sulphur, valued at a little more than 6,000,000 dollars. This quantity not only was sufficient to supply the needs of the country, but also contributed about 100,000 tons to European markets. With the development of war activities, however, the production has increased to meet the growing needs of munition-makers, while the exports have decreased as a result of disturbed trade conditions and the need for building up reserves of this essential material at home.

It is a singular fact that the chief raw materials of explosive manufacture are localised in a remarkable manner, and sulphur is no exception to this rule. In the United States practically the entire supply comes from a number of deposits in Louisiana and Texas, near the Gulf Coast. These deposits are similar in nature, and consist of a series of beds and lenses of pure sulphur at a depth of several hundred feet from the surface.

The discovery of the occurrence of sulphur of this type was made so far back as 1865, in connection with a well drilled for oil. All attempts at mining the sulphur failed, however, until some fifteen years ago, when a highly ingenious method was devised for winning this substance without recourse to the ordinary costly underground operations usually prosecuted in mining. This process makes use of the fact that sulphur melts at a relatively low temperature. By drilling a well through the overlying rock until the sulphur bed is tapped, and then sinking a series of interpenetrating pipes through which superheated steam is forced, the sulphur is melted and forced to the surface as a hot liquid, where it is piped to large bins, into which it pours and cools. This process, which is known as the Frasch process after its inventor, has been described as one of the triumphs of modern technology, and its successful application to the Gulf Coast deposits has in the past fifteen years transferred the centre of the world's sulphur industry from the island of Sicily to the United States, making the States absolutely independent of the rest of the world in this important particular.

With the development of the world-war, the sulphur deposits of the Gulf regions have, of course, assumed special importance as supplying the sulphur needed in the manufacture of gunpowder and other explosives. But in addition to this, these deposits have quite unexpectedly during the past few months been able to meet and solve a critical resource problem arising out of the submarine campaign. This problem concerned the raw materials of the large and very vital sulphuric acid industry, and arose from the fact that most of the several million tons of sulphuric acid used in the United States was made from sulphur-bearing minerals called pyrites, brought as ballast in quantity from large deposits in Spain. The restricted shipping conditions resulting from recent events as a matter of course seriously affected this source of supply, and since sulphuric acid is a product nearly as fundamental to industry as iron or coal, the situation bade fair to assume critical proportions. But it so happens that crude sulphur can also be used in making sulphuric acid, and accordingly the Gulf sulphur deposits have come forward to tide over the dearth of Spanish pyrites until the domestic supplies of pyrites, which are adequate, but as yet only in part developed, can be brought up to a suitable measure of productiveness.

There are numerous lean deposits of sulphur in many of the Western States, but these as yet have practically no effect upon the output of the country. It is certain, therefore, that without the Gulf deposits and the ingenious method of making them available, the United States would have scarcely been able to meet successfully the war needs of sulphur and sulphuric acid, which goes to show, of course, the pressing necessity for widespread appreciation and understanding of the importance of proper development of the mineral industries of the nation.

Scientific research

SCIENCE AS A VEHICLE OF EDUCATION.[1]

THE tendency of the modern school of political thought is to attribute the majority of the great historical events which have attended the various phases of human development to the operation of unseen underlying economic forces. The recognition of this fundamental truth represents a noteworthy advance towards the completer understanding of the factors underlying and determining the evolution of man and of human institutions, but, admitted that economic forces wholly or very largely determine the political evolution of mankind, the question still remains: To what in turn are we to attribute the incessant fluctuations of the ever-urging economic forces? It is not that one consistent economic pressure, incident everywhere and operating in a definite direction, has continually urged mankind towards some undeviating goal; quite the contrary—the economic pressure upon mankind has been fluctuating, variable both in incidence and in direction, and not always advantageous in its immediate outcome.

Not infrequently attempts have been made to correlate these economic forces with geographical conditions, with the happy or unhappy conjunction, here or there, of river, plain, and sea. But the ever-changing aspects of political geography are not to be interpreted so easily. In relation to the brief life of man, the geographic contour of the earth is well-nigh eternal and immutable. Setting aside, without underrating their possible importance, the very few historical instances of decisive variation in geography and climate, such as the desiccation of Central Asia and the extraordinarily rapid shrinkage of at least one great inland sea, Lake Tchad, it is evident that in the long run, were geographical contour and climate the sole factors underlying and determining the incidence of economic forces, the political geography of the world would ere this have become as static as its physical geography, of which it would be the inevitable and deducible outcome. The ceaseless ferment of international politics, never more turbulent than now, would then remain utterly inexplicable.

To find any analogy corresponding with the bewildering intricacy and rapid fluctuations of political history and geography, we must turn to the inward workings of the human mind, of which economic forces are in ultimate analysis merely the outcome and expression, deviated or constrained, but not created by the geographical, climatic, or biological environment in which they find their outlet. Behind the economic forces which have fashioned human destiny we must seek again the more potent forces of human energy, curiosity, and inventiveness.

It is related that when recently the untutored savages of a certain region of East Africa first saw an aeroplane hovering over their heads they worshipped it as a god, or the expression of a god-like power. A group of high-school or university students would have regarded that same aeroplane with mild curiosity or supercilious indifference, so greatly has education, or what passes for education, blinded our eyes to underlying verities, to truths which are patent to the savage! For, if we regard it aright, every automobile, every passing electric street-car, every ray of light we cast into the darkness with the touch of a finger, is a miracle and a monument to the creative intellect of man.

It is these things and such as these that determine the economic forces which fashion the history of man. The discovery of America was not an accident; it was the outcome of measurement and invention, directed by an inspired curiosity regarding the structure of the universe. The discovery of the steam-engine was not an accident; it was the outcome of countless patient investigations inspired by no thought of ulterior gain. Electricity was not harnessed by financiers, but by the monumental intellectual labours of Oersted, Ampère, and Faraday. These things did not happen by chance; they did not, like Athena, spring full-armed from the brain of Zeus; they did not rain down upon earth from heaven, nor have they always been. They were not fashioned in the market-place, nor yet achieved

[1] By Prof. T. Brailsford Robertson. Reprinted from the *University of California Chronicle*, vol. xix., No. 1.

by sporadic flashes of prophetic inspiration. They are the expressions of the creative intellect of man operating under a certain discipline of thought, inspired by the one undeviating desire to understand, and by understanding to control, the environment in which we have our being.

Essentially the same discipline of thought and essentially analogous expansions of economic opportunity have been operative and determinative forces at all stages of man's development, The foreshortening of our remote past, due to its relatively immense distance from our own lives and the accelerated evolution of our own day, tends to render us forgetful of the obscure struggles and achievements of our ancestors. Yet the peoples from whom we sprang did not lack their Faradays or Pasteurs, upon whose accumulated labours they fashioned new civilisations and rose to greater and ever greater mastery over the inanimate, brute forces to which our yet remoter forbears paid the homage inspired by fear. This is the primary impelling force which fashions the fluctuating yet ever-progressing evolution of man, the force of creative human intellect, perchance inspired, yet inspired not without preparatory labour, for, in the words of Pasteur, "Chance favours only the prepared mind."

If the woof of the fabric of history is economic, the warp is supplied by the creative curiosity of man, operating under the discipline of thought which we now call 'scientific," and culminating in discoveries and inventions.

It is strange how little suspicion of these facts enters into the minds of the typical products of modern scientific pedagogy, the vast number of students who in our day patiently submit themselves for years to the exacting discipline of scientific training in order that they may apply it hereafter to the solution of the immediate practical or theoretical problems of their time. The more prolonged and extensive their training, the more intensely specialised their interests become, until the material and spiritual welfare of the vast human family, which alone confers meaning and dignity upon their task, becomes a matter of utter indifference in comparison with the identification of a diatom or the measurement of the angle of a crystal.

There can be little question that as pedagogues and expositors, with a few brilliant exceptions, scientific scholars and investigators have failed, and that in a manner and to a degree most disastrous to the welfare of their chosen field of intellectual endeavour. Notwithstanding several decades of widespread training in scientific method and the scientific discipline of thought, and notwithstanding, also, the multitude of technically skilled and professionally trained men who have issued from our laboratories, there is as yet little or no sympathy or understanding displayed by the public, or even by our own pupils, with the larger problems and broader aspects of science. The reason is not far to seek; deficient sympathy and insight have propagated their like, and we are merely reaping that which we have sown. We have taught our pupils to regard science as an arid, inhuman outgrowth of pure intellectualism, useful perchance, but not endearing, interesting perchance as chess is interesting, but never touching the deeper problems and broader aspirations of mankind save to wither our illusions and proffer the material bait of utility in their stead. Our discipline of thought has taught us to shun hasty generalisation, but we have taught our pupils never to generalise at all, and in teaching them to contemplate and to conquer the difficulties that lie at hand we have deprived them of the exalted vision of the ultimate goals towards which our labours are directed. Thus have we earned, and most richly deserved, the indifference or the veritable hostility of the public, and, crowning absurdity of all, the sciences are everywhere proclaimed antagonistic to the "humanities."

How gross is the caricature of our ideals and our functions which we have implanted in the minds of our contemporaries may be gathered from the words of the great founders of the scientific school of thought. Witness the exalted vision of their labours embodied in the utterances of three great physicists, representatives of three distinct epochs of scientific thought: "I do not know what I may appear to the world," said Newton, "but to myself I seem to have been only like a boy playing on the seashore, and diverting myself now and then in finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me." "The laws of Nature," said Oersted, "are the thoughts of God," or, in the words of a master of our own day, J. J. Thomson: "As we conquer peak after peak, we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, the truth of which is emphasised by every advance in science, that 'Great are the works of the Lord.'" Or, in regard to the function of science towards the welfare of humanity, compare the prophetic utterances of Harvey: "We can never want matter for new experiments. We are as yet got little further than to the surface of things: we must be content, in this our infant state of knowledge, while we know in part only, to imitate children, who, for want of better skill and abilities and of more proper materials, amuse themselves with slight buildings. The further advances we make in the knowledge of Nature the more probable and the nearer to truth will our conjectures approach; so that succeeding generations, who shall have the benefit and advantage both of their own observations and those of preceding generations, may then make considerable advances, 'when many shall run to and fro and knowledge shall be increased,'" with the words of Pasteur, written two hundred and fifty years later: "Science is in our age the soul of the prosperity of nations and the living source of all progress. Without doubt the politician with his tedious and perpetual discussions seems to be our guide. Vain illusion! That which leads us is scientific discovery and its applications." And yet the material welfare of man is not the chief justification of science, for, in the words of the same master: "The cultivation of the sciences in their highest expression is perhaps more necessary to the moral welfare of a nation than to its material prosperity."

In these utterances we read, not the cheap hope of material gain or the paltry personal triumph of the clever solver of an intricate intellectual puzzle, but a sense of "something far more deeply interfused," an expression of the awe and abiding wonder which the contemplation of our universe compels, and a deep conviction of the vast underlying import of natural law in the welfare and aspirations of mankind. Why, then, do we so diligently wrap up these aspirations and convictions in formulæ and conceal them under the cloak of a pedantic affectation of hypercritical exactitude? There is a grandeur in science, wide as the universe itself. There is a human import of science, embracing the material and social welfare of the totality of mankind. Would it not, then, be well to convey some suspicion of these facts to our pupils?

We have succeeded after many years of conflict with educational authorities in introducing scientific studies into the curriculum of schools, but what have we accomplished thereby? Through the agency of the compulsory dissection of flowers, the unalleviated algebra of statics, or the uncertain pursuit of the elusive elements of a chemical "unknown," we have given rise to a rooted aversion to science in the minds of many and have attracted a few to the pursuit of science for the sake of material gain, but in how many minds have we implanted the idea of the intrinsic grandeur or the essential ultimate value of their scientific studies? The spectre of specialism has pursued us. "Science" must be chemistry, physics, geology, botany —anything rather than the study of the dependency of human welfare upon our capacity to control our environment, and the contemplation of the majestic spectacle of the order of Nature gradually unfolding itself to man's consciousness and placing in his hand the implements of ever-augmenting power to control his destinies and attain that ultimate comprehension of the universe which has in all ages constituted the supreme aspiration of man. Had we offered this, had we employed scientific education rather than scientific training as the introductory chapter of the book of scientific knowledge, then all the educated civilised inhabitants of the world to-day would look to science for hope and inspiration, and we should hear no more of the conflict between science and the "humanities," for science would be recognised in its true light, as the first and greatest of the "humanities."

In the universities, even more than in the schools, specialisation has sacrificed education to the exigencies of training. Every opportunity is offered to the student of becoming an expert in the technique and a master of the details of any of the sciences, but on their relationship to the larger needs and aspirations of the world our instructors are silent. This silence arises only too often out of indifference, but where indifference does not prevail then an over-sensitive deference to professional etiquette no less effectually imposes silence upon the professional teacher of science. The desire not to trespass upon the technical field of a colleague and the desire to avoid the criticism of colleagues which may be aroused by the appearance of over-generalisation inhibit in almost every instance any deliberate attempt to open up before the student the deeper foundations and wider implications of the scientific discipline of thought.

As the demands for "vocational training" become more insistent and more complex, this condition becomes more and more aggravated, so that unless measures be deliberately taken to check the prevailing tendencies we may anticipate, alongside the continual improvement of technical training, the progressive deterioration of scientific education, with accompanying decay of scientific philosophy and increasing misunderstanding of the purposes and misapplication of the products of scientific investigation.

Much may be done by the individual teacher; still more might be accomplished by a deliberate campaign of popularisation, by taking the public into our confidence regarding our wider aims and the part played by investigation and discovery in the life and destiny of man. But there is one desirable measure which should be taken by the universities as the official leaders of educational reform, namely, the recognition of the study of the historical development of science in its relationship to human welfare and the evolution of human institutions, as a legitimate department of the many-sided curriculum which the modern universities offer to the student-public. It will be admitted, I think, that scientific investigation, discovery, and invention have played at least as great a part as war, literature, or commerce in the evolution of civilisation, and, that being the case, it is nothing less than astounding that while ample facilities are offered by our universities to the student of the history of war, literature, or commerce, no facilities and no academic recognition whatever are offered to the student of the history of science.

It is perhaps a debatable question whether this end could best be attained by the foundation of a new department and a separate chair or lectureship in the history of science, or whether the situation could preferably be met by the co-ordinated effort of existing departments. However this may be, one thing is certain, that the present atomistic condition of scientific learning in the minds of our students and the restricted utilitarianism of their outlook will not be corrected by offering them a "course in general science," consisting of a *mélange* of ill-assorted fragments of scientific specialities and necessarily failing to furnish either a vehicle of training or a vehicle of education; nor will it be corrected by offering them courses in another specialised course in the history of science in which that history is violently detached from the history of the development of man and of the evolution of his institutions, from the study of the part played by knowledge in determining the reaction of the mind of man to the varying circumstances by which from epoch to epoch he has successively found himself environed; for the new course must above all things be one of the "humanities."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MANCHESTER.—A group of large firms engaged in the principal industries of the Manchester district has offered to the governing body of the School of Technology the sum of 3000*l.*, spread over a period of five years, towards the cost of establishing a new department of industrial management. The Manchester Education Committee has recommended that this gift be accepted and expressed its high appreciation of the donors' public spirit. It is proposed that a lecturer shall be appointed for this period of five years at a salary of 600*l.*, to conduct research in the subject of industrial management, to organise a new department, to lecture to members of the University and to the public, and to assist industrial concerns in the solution of management problems. To make doubly sure that the department shall keep in close touch with practice, a number of managers, directors, scientific experts, and others who have had special experience or are responsible for important innovations, will be invited to deliver public lectures, for which they are being offered substantial fees. These lectures should be of assistance not only to future managers, but also to those already in that position; they will strengthen the idea that management is a science, and that every manager is, or should be, something of a scientific researcher.

SHEFFIELD.—It was something more than a domestic function at which the Marquis of Crewe was installed as Chancellor of the University on Friday, February 15. The ceremony was the first of its kind in Sheffield, as the late Chancellor was born, so to speak, with the University. He was part of the gift of the Crown, whereas Lord Crewe was elected by the Court in the manner prescribed by the charter. The formal act of installation was conceived as taking place at a meeting of the Court in the presence of the University, and the Senior Pro-Chancellor (Mr. H. K. Stephenson), who normally presides over the Court, performed the act of installation. This was a departure from the precedents of Leeds and Manchester, but the Sheffield interpretation of the meaning of the ceremony is probably based on sounder legal grounds. Once in the chair, the new Chancellor took charge of the proceedings with characteristic grace and dignity. Before declaring the Congregation open for the conferment of degrees, he spoke admirably on various burning problems, and his pronouncements should do much to increase the intimacy and friendliness of the relations between the civic and industrial life of the city—close as they already are. It was something to hear the first chairman of the Privy Council Committee on Scientific and Industrial Research say that in his view "the closer the tie between the University and the prime industries of the city the better for both." The honorary graduates were introduced to the Chancellor by the Public Orator (Prof. A. H. Leahy) in terms which did full justice to a great occasion, for an assembly which included the Ambassadors of the great Allied Powers, France, the United States, and Italy, was a memorable assertion of the University's faith in the common cause, and the presence there of representatives of sister universities made that assertion more deeply significant. The University also did honour to itself by conferring the degree of Doctor of Letters on the President of the Board of Education, its former Vice-Chancellor.

DR. R. S. WILLOWS, head of the department of physics and mathematics at the Sir John Cass Technical Institute, Aldgate, London, has been appointed head physicist to Messrs. Tootal Broadhurst, Lee, and Co., of Manchester, in connection with their scheme for cotton research.

MR. D. B. MAIR and Mr. L. C. H. Weekes have been appointed Assistant Civil Service Commissioners. The former will also hold the office of Director of Examinations, and the latter that of Secretary to the Civil Service Commission. Mr. Stanley M. Leathes remains the First Commissioner, but Mr. Herbert W. Paul has retired from the post of Second Civil Service Commissioner which he has held since 1909.

THE course of public lectures on "Some Biological Problems of To-day," arranged in co-operation with the Imperial Studies Committee, are being continued at University College (Gower Street, W.C.) on Mondays at 4 p.m. The remaining lectures of the present term will deal with important questions of food production, as follows:—(1) The possibilities of increased crop production, by Dr. E. J. Russell; (2) Grassland and arable, by Mr. R. G. Stapledon; (3) Farm strategy of the past and for the future, by Mr. K. J. J. MacKenzie; (4) Spraying problems, by Dr. A. S. Horne; (5) Birds and insects in relation to crops, by Prof. S. J. Hickson; (6) Co-operation in food supply, by Mr. A. G. Tansley. The lectures are open to the public without fee or ticket.

THE first four lectures of the public university course on "Animal Life and Human Progress" at King's College, London, have been very well attended. Prof. A. Dendy delivered an introductory discourse on "Man's Account with the Lower Animals," Prof. G. C. Bourne has lectured on "Some Educational and Moral Aspects of Zoology," Mr. C. Tate Regan on "Museums and Research," and Prof. J. Arthur Thomson on "Man and the Web of Life." The remaining lectures of the course will be given by Prof. F. Wood Jones on "The Origin of Man" (February 27); Dr. R. T. Leiper, on "Some Inhabitants of Man and their Migrations" (March 6); Prof. R. T. Punnett, on "The Future of the Science of Breeding" (March 13); Prof. W. A. Herdman, on "Our Food from the Sea" (March 20); and Prof. Robert Newstead on "Tsetse-flies and Colonisation" (March 27). It is intended to publish the lectures in book form with Messrs. Constable and Co., Ltd., after the conclusion of the course.

THE annual general meeting of the Association of Technical Institutions will be held on February 22 and 23, at the Drapers' Hall, Throgmorton Street, E.C. The president, Sir Alfred Keogh, G.C.B., will take the chair, and deliver a short address. Papers will be read on the training of teachers for technical institutions and day continuation classes, by Principal Watson of Keighley, and on the Education (No. 2) Bill, 1918, by Prof. Wertheimer, of Bristol. Among the resolutions to be submitted to the meeting may be mentioned those urging, in the interest of technical education, that scales of salary providing for adequate increases and reasonable prospects should be adopted for all fully qualified full-time teachers, and that the Government be requested to make a grant to technical-school teachers, as it has done in the case of primary- and secondary-school teachers; those expressing general approval of the provisions of Education (No. 2) Bill and recording the opinion that an alternative plan should be allowed in Section 10 of the Bill, such plan being half-time compulsory attendance from fourteen to sixteen years of age, together with encouragement of, and ample facilities for, attendance afterwards at evening classes for two evenings per week on technological or other subjects from sixteen to eighteen years of age, and those expressing disappointment that the Board of Education has not yet withdrawn or modified the objectionable features of the Regulations for Junior Technical Schools.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—Sir J. J. Thomson, president, in the chair.—Prof. O. W. **Richardson**: The photo-electric action of X-rays. In this paper the excitation of electron emission by X-rays is discussed in relation to our knowledge of the photo-electric action of other types of radiation. The ratio E_K/E_A of the energy E_K emitted in the form of K secondary X-radiation to the energy E_A of the primary radiation (wave-length λ) absorbed is found in the case of bromine to be expressed to within the degree of accuracy of the available observations by the formula

$$E_K/E_A = \frac{\lambda}{(1+p)\lambda_K}$$

where

$$p = e^{-0.46 \frac{\lambda_{K\gamma} - \lambda}{\lambda}}.$$

λ_K is the average wave-length of the K radiations and $\lambda_{K\gamma}$ is the wave-length of the shortest K radiation.—F. **Soddy** and J. A. **Cranston**: The parent of actinium. (1) In a full historical introduction the data obtained in 1909 relative to the rays and products of uranium-X are discussed, in so far as they throw light on the various possible modes of origin of actinium. (2) The minute growth of actinium previously put on record in 1913 as having been observed in the old uranium-X preparations has been confirmed by their later history and is now established beyond doubt. (3) Uranium-X_2 can be separated from uranium-X_1 by sublimation in a current of air charged with vapours of carbon tetrachloride at a temperature below visible red-heat. (4) 470 grams of a very pure Indian pitchblende were similarly treated in the expectation of removing eka-tantalum isotopic with uranium-X_2 and giving actinium in an α-ray change of long period. (5) The preparations so obtained were initially free from actinium, but one of them has produced it continuously with the lapse of time. (6) A direct comparison of the amount of actinium in this preparation after the lapse of 2·5 years with that in the original pitchblende showed that it was equal to that in about 0·25 gram. (7) On the assumptions that eka-tantalum and actinium are both long-lived, that no intermediate members intervene between them, and that the preparation contained the whole of the parent of actinium in the original mineral, the period of average life of actinium is calculated to be 5000 years. Nothing can yet be said definitely as to the period of the parent. (8) A second preparation separated from Joachimsthal pitchblende, the treatment of which commenced in 1903, and ended in 1914, with the carbon tetrachloride sublimation, has given a similar growth of actinium. (9) The work was undertaken to test and confirm the view that the parent of actinium occupies the eka-tantalum place in the periodic table, and gives actinium in an α-ray change of long period, itself being formed as the product of uranium-Y, discovered by Antonoff, who suggested that it was the first member of the actinium series. But this mode of origin of actinium, though at present the most probable, is not yet conclusively established to the exclusion of all the other possible modes of origin, discussed in the historical introduction.—Prof. A. **Schuster**: Some problems in the theory of radiation. This paper deals with the oscillatory energy taken up by a simple resonator under the action of white light, and the translatory energy imparted to a molecule by radiation. The first problem has been treated by Planck. It is solved here in a very simple manner, and the method used, when applied to the second problem, leads to the important result that a molecule at rest, within an enclosure of uniform temperature, will, while taking up an oscillatory energy, be set in motion with an acceleration that will increase its speed until the average energy reaches a definite value. If the Rayleigh-Jeans laws of radiation be assumed to hold, the ultimate average energy due to radiation alone is two-thirds of that derived from the kinetic theory of gases.—E. A. **Owen**: The absorption of the radiation emitted by a palladium anti-cathode in rhodium, palladium, and silver. (1) A short account is given of some preliminary experiments carried out with the rays from an ordinary X-ray bulb. (2) A spectrum of the rays from a palladium anti-cathode is obtained over a limited range of wave-lengths by reflection in the (111) face of a carborundum crystal. The spectrum shows that the bulb emits a continuous band of wave-lengths upon which are superposed the characteristic rays of the metal of the anti-cathode, and under the conditions of working in this particular case the relative intensities of the different wave-lengths in the spectrum remained approximately constant. (3) The "end radiation" of the bulb was found to be very homogeneous. (4) There is a minimum of intensity in the spectrum corresponding with the wave-length $0{\cdot}493\times10^{-8}$ cm. On the assumption that the minimum is due to the selective absorption of this wave in the crystal, the value $0{\cdot}493\times10^{-8}$ cm. is assigned to the β line of the J series of silicon. From the experimental results of Barkla and White on the J series of the elements Al, C, and O, the approximate values deduced for the β line of the J series of oxygen and carbon are $0{\cdot}519\times10^{-8}$ cm. and $0{\cdot}559\times10^{-8}$ cm. respectively. (5) Assuming Bragg's mean value of the α line of palladium to be $0{\cdot}586\times10^{-8}$ cm., the following values are obtained for the wave-lengths of the β and γ lines: $\beta=0{\cdot}520\times10^{-8}$ cm.; $\gamma=0{\cdot}509\times10^{-8}$ cm. (6) The absorption coefficients of the rays from the bulb have been measured in rhodium, palladium, and silver. The results show that the relation between wave-length and absorption coefficient is expressed by the relation $\tau/e=K\lambda^3$, where τ/e is the fluorescent coefficient and K is a constant for a given substance over the range of wave-lengths between the absorption bands of that substance. (7) The critical wave-length necessary to excite the characteristic rays of a substance lies in the neighbourhood of the β ray of that substance. The α ray is not excited until the β ray is excited. (8) It is pointed out that the purity of the characteristic lines emitted by a bulb and isolated by reflection at a crystal face will depend, to a great extent, upon the state of working of the bulb.

Zoological Society, February 5.—Dr. A. Smith Woodward, vice-president, in the chair.—Prof. B. L. **Bhatia** and Baini **Prashad**: Skull of *Rana tigrina*, Daud.—G. A. **Boulenger**: Description of a new snake of the genus Oligodon, from Upper Burma.—Dr. R. **Broom**: Two rare South African golden moles. One specimen was described as a new species of Bematiscus, *B. leschae*. Hitherto the giant moles of the eastern Cape Colony have been referred to *B. trevelyani*, but the present type from St. Cuthbert's, Isolo, differs from *B. trevelyani* and agrees with *B. transvaalensis* and *B. villosa* in having the temporal bulla markedly projecting from the side of the skull. The other specimen exhibited was one of the rare mole, *Chrysochloris sclateri*. Hitherto it has been only known from the Nieuwveld and from Basutoland—localities 350 miles apart. The present specimen was from New Bethesda, 130 miles nearer to Basutoland than the original locality.

Mathematical Society, February 14.—Prof. H. Hilton, vice-president, in the chair.—Prof. A. C. **Dixon**: Note on functional equations which are limiting forms of integral equations.—Prof. D. M. Y. **Sommerville**: The singularities of trochoidal curves.—O. **Hoppe**: The primality of $(10^{19}-1)$ (second communication).—L. J. **Mordell**: A statement by Fermat.

EDINBURGH.

Royal Society, January 14.—Dr. John Horne, president, in the chair.—Prof. R. A. **Sampson**: Notes on the Coupar Angus meteorite. This meteorite, which attracted much attention from its brilliancy before it burst, fell on December 3, 1917, and fragments were found in Perthshire and Forfarshire. It is an aerolite or stony meteorite, but the detailed mineralogical characters have not yet been given. It was estimated, from the evidence of a number of witnesses, that it began to blaze at a height of about twenty miles in the atmosphere, probably above Coupar Angus. In regard to the origin of such bodies, it was suggested that they might have been ejected in bygone ages from lunar volcanoes, continuing to circulate since then between the earth and the moon in irregular orbits until finally drawn down upon the earth.—Dr. C. G. **Knott**: The propagation of earthquake waves through the earth and connected problems. When a large earthquake occurs at any part of the earth elastic waves are sent out in all directions through the earth, emerging at the surface as disturbances which can be recorded on delicate seismometers. Up to about 120° from the epicentre, the times at which these variations emerge after the time of occurrence of the earthquake were first tabulated by J. Milne. The increasing number of observations and the improvement of the instruments have led to the tabulation of more accurate data than was possible in the earlier days. Following up certain calculations made in 1908, Dr. Knott, using these more recent data, has made fresh calculations of the velocities of the seismic waves through the earth by a mathematical method based on the theory of integral equations and entirely free from assumptions. As has long been recognised, two types of wave are transmitted through the body of the earth known as the primary (P) and the secondary (S) waves. The broad results of the investigation may be stated thus:—The velocity of the P wave increases steadily with depth from 4·46 miles (7·18 kilometres) per second at the surface to 6·2 miles (10 km.) per second at a depth of 400 miles (650 km.), continuously increasing at a slightly smaller rate of increase until it reaches 7·95 miles (12·8 km.) per second at a depth of 1000 miles (1600 km.), after which, at greater depths, the speed of propagation remains constant. The S wave travels more slowly than the P wave, but changes in very much the same way, the values of the speed being 2·47 miles (3·98 km.) per second at the surface, 3·43 miles (5·53 km.) at a depth of 400 miles, and 4·25 miles (6·84 km.) at depths greater than 1000 miles.—Prof. W. H. **Metzler**: A determinantal equation the roots of which are the products of the roots of given equations.—Prof. R. A. **Sampson**: Studies in clocks and timekeeping. (1) The theory of maintenance. This paper, the first of a series of studies which are in course of execution at the Royal Observatory, Edinburgh, describes in outline the arrangements of the thermostat chamber, etc., and the construction of the three clocks, Riefler 258, Synchronome, and Cottingham, upon which most of the studies are made. Its direct occupation is, however, chiefly theoretical, considering with sufficient detail various dynamical points which arise from the suspension and different maintenances of the clocks and the derivation of a satisfactory differential equation of the motion when the internal resistance is taken into account. The solution of this equation presents some novelty, showing that the frequency in maintained motion is dependent upon the first power of friction, not the second, as has hitherto been held. The discontinuous maintenance is resolved into a Fourier series, and expressions are found for calculating the escapement error and the arc described in each case. In the case of the three clocks above the calculated arcs are numerically verified by comparison with their actual performance.

BOOKS RECEIVED.

Laboratory Glassware Economy. By Prof. H. B. Dunnicliff. Pp. x+92. (London: Macmillan and Co., Ltd.) 4*s*. net.

Hand Grenades. By Major G. M. Ainslie. Pp. v+59. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. net.

Text-Book of Ordnance and Gunnery. By Lt.-Col. W. H. Tschappat. Pp. x+705. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 30*s*. net.

A Text-book in the Principles of Science Teaching. By Prof. G. R. Twiss. Pp. xxvi+486. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

A Short History of Science. By Prof. W. T. Sedgwick and Prof. H. W. Tyler. Pp. xv+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

A Text-Book of Physics for the Use of Students of Science and Engineering. By J. Duncan and S. G. Starling. Pp. xxiii+1081. (London: Macmillan and Co., Ltd.) 15*s*.

Applied Mechanics. Second Year. By H. Aughtie. Pp. 227. (London: G. Routledge and Sons, Ltd.) 2*s*. 6*d*. net.

Airfare of To-day and of the Future. By E. C. Middleton. Pp. xv+192. (London: Constable and Co., Ltd.) 3*s*. 6*d*. net.

The Edinburgh School of Surgery before Lister. By A. Miles. Pp. viii+220. (London: A. and C. Black, Ltd.) 5*s*. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 21.

ROYAL SOCIETY, at 4.30.—The Scattering of Light by Spherical Shells, and by Complete Spheres of Periodic Structure, when the Refractivity is Small: Lord Rayleigh.—The Nature of Heat as Directly Deducible from the Postulate of Carnot: Sir Joseph Larmor.—Curved Beams: J. J. Guest.—(1) Monoclinic Double Selenates of the Iron Group; (2) Selenic Acid and Iron. Reduction of Selenic Acid by Nascent Hydrogen and Hydrogen Sulphide. Preparation of Ferrous Selenate and Double Selenates of Iron Group: Dr. A. E. H. Tutton.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Switchgear Standardisation: Dr. C. C. Garrard.

INSTITUTION OF MINING AND METALLURGY, at 5.30.

CHEMICAL SOCIETY, at 8.—Recent Studies on Active Nitrogen: Hon. R. J. Strutt.

LINNEAN SOCIETY, at 5.—Notes on the Bionomics, Embryology, and Anatomy of Certain Hymenoptera Parasitica, with Special Reference to *Microgaster connexus*, Nees: J. Bronté Gatenby.—Experimental Studies in the Specific Value of Morphological Characters in the Fungi: W. B. Brierley.

FRIDAY, FEBRUARY 22.

PHYSICAL SOCIETY, at 5.—Note on the Use of Approximate Methods in Obtaining Constructional Data for Telescopic Objectives: T. Smith.—A Suggestion as to the Origin of Spectral Series: Dr. H. Stanley Allen.

SATURDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 3.—Problems in Atomic Structure: Sir J. J. Thomson.

MONDAY, FEBRUARY 25.

ROYAL SOCIETY OF ARTS, at 4.30.—The Economic Condition of the United Kingdom Before the War; the Real Cost of the War, and Economic Reconstruction: E. Crammond.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Recent Journey in East Africa: Comte Renauld de Briey.

TUESDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 3.—A National Laboratory of Industrial Research: Sir R. T. Glazebrook.

ILLUMINATING ENGINEERING SOCIETY, at 5.—A Survey of Methods of Directing and Concentrating Light: Lieut.-Commander H. T. Harrison.

WEDNESDAY, FEBRUARY 27.

ROYAL SOCIETY OF ARTS, at 4.30.—Organisation of Commercial Intelligence: Sir W. H. Clarke.

THURSDAY, FEBRUARY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Scattering of Light by Dust-free Air, with Artificial Reproduction of the Blue Sky. Preliminary Note: The Hon. R. J. Strutt.—The Lommel-Weber Ω Function and its Application to the Problem of Electric Waves on a Thin Anchor Ring: Dr. J. R. Airey.—Investigations on Textile Fibres: W. Harrison.—Critical Loading of Struts and Structure: W. L. Cowley and H. Levy.

FRIDAY, MARCH 1.

ROYAL INSTITUTION, at 5.30.—The Modern Dye-stuff Industry: Prof. A. G. Green.

SATURDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—Problems in Atomic Structure: Sir J. J. Thomson.

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