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The British Scientific Glass Industry.

THE review of the development of the British glass industry, given by Prof. W. E. S. Turner recently in his presidential address to the Society of Glass Technology, throws new light on an industry which some have been inclined to think had to be largely created in this country after the outbreak of war. It appears that, even during the early days of its development in the seventeenth century, the industry made three notable contributions to manufacturing technique, namely, the use of coal instead of wood as a fuel, the introduction of covered melting-pots, and the preparation of lead crystal glass, which, in the course of time, ousted the famous Venetian glass from favour. Moreover, right through the nineteenth century, until about 1875, Great Britain held an important place amongst the glass-making countries of Europe, after which date its exports declined, due in a considerable measure to foreign tariff duties.

Prof. Turner shows something of the great revival of enterprise during the war period and afterwards, and of the extensiveness with which glass manufacturers have been installing new plant and machinery. In these phases of activity, no country in Europe can show a comparable record, and we may be permitted to indulge the hope that a brighter period lies before the industry than it experienced between 1875 and 1915.

In these columns we are interested mainly in the subject of scientific glass, and we have been forced to ask at times if the real position in regard to this branch has been understood or appreciated. Most divergent opinions on the merits of British scientific glass have been expressed. On one hand, very severe criticisms have been made of the quality of British scientific glass. On the other, we may say that we have seen letters, written spontaneously, testifying in glowing terms to its merits as compared with Continental glass; and inquiries in large laboratories have shown similar divergence of opinion, the balance of evidence being favourable. Possibly, users of scientific glassware have grown more critical of late years; they have been forced to this position partly by the prominence of the subject and partly by the financial stringency existing in scientific institutions. Moreover, the relations between the manufacturers and the dealers in this country appear not to have been of the most cordial character, and this fact cannot be ignored in estimating the chances of British ware in its claim to recognition.

It is interesting to contrast the beginnings of the chemical and scientific glass industry in the United Kingdom with the early operations at Jena. In our

own country both glass compositions and processes had to be extemporised in a great hurry, and it is indeed creditable to workers like Sir Herbert Jackson outside the factory, and Dr. M. W. Travers, Dr. C. J. Peddle, and Mr. John Kaye inside the factories, that glass vessels at least as durable chemically as any produced in Germany were forthcoming in so short a time. The earlier samples, just like those from Jena, when chemical ware was first made there in 1893, were far from being mechanically perfect. Processes and methods for the graduation of instruments had likewise to be worked out, and it has to be borne in mind that such work was in some instances taken up by persons who were more enthusiastic than competent. Many British people find it difficult to forget these early defects and have been ever ready to sigh for the return of German goods.

The work at Jena, which began about 1881, had ample time to be carried out systematically. The success of the work was due not altogether to the application of new elements to glassmaking but rather to the facilities for a great number of experimental meltings, some of them on a considerable scale, in which the influence of oxides, such as boric, zinc, barium, magnesium, and phosphoric, could be more fully investigated than had been the case by earlier workers. In this way there was gradually built up a series of definite relationships between chemical composition and physical properties, on the basis of which not only were new optical glasses devised but a new type of glass for laboratory use finally developed. Abbe himself was so impressed with the need of financial assistance in these undertakings and with the time consumed in carrying them out as to write: "The difficulties connected with such undertakings are so great, the initial outlay required is so heavy, and success if attained lies so far in the future, that there is little inducement to enterprise. A revolution of the industry can scarcely be brought about in any other way than by the means for its advancement being provided in liberal measure, either by corporations or public authorities."

Both scientific workers and manufacturers in the United Kingdom have well realised the truth of Abbe's remarks, and the user of scientific glass should also understand it. Since the war, despite the severe disappointment of the manufacturer in this country at the support given him, research has gone on continuously. A new type of chemical glassware has appeared on the British market, marking a departure in some ways from previous types and compositions, and as the results of extensive researches now in operation in this country become more and more complete, it is highly probable that still further types will be developed.

It is very likely that the Jena workers in later years acquired much systematic information that was never published. We have done very much here recently to revise the data which they have published and to show in some ways that it was defective and incomplete; while many other lines of research in this country, with the fundamental researches carried out in America, have given us resources of information which the German workers did not possess.

The very fact that, since the war, four new institutions, namely, the Department of Glass Technology at Sheffield, the Society of Glass Technology, the British Scientific Instrument Manufacturers' Research Association, and the Glass Research Association, have not only come into existence, but have also continued in full operation, affords convincing evidence that our manufacturers of scientific glassware are not content with their present attempts but are reaching out for something better. In this endeavour they are worthy of all the help and support, as well as patience, which the body of scientific workers can give them.

Our Nearest Living Relatives.

The Origin and Evolution of the Human Dentition. By Prof. William K. Gregory. Pp. xviii + 548 + 15 plates. (Baltimore, Md.: Williams and Wilkins Co., 1922.) n.p.

IT has so happened that Dr. W. K. Gregory, of the American Museum of Natural History, New York, and the writer of this review have each set out, at an early point in their lives, to seek for a definite answer to the same question: what is Man's lineage? Is he but a branch of the stem which gave the world its great living anthropoid apes—the gorilla, chimpanzee and orang—or must we carry our lineage into a remote geological past to find the point of its separate emergence from the primate phylum? The reviewer approached the problem by making an elaborate analysis of the structural "make-up" of man and of anthropoid apes, noting the kind and extent of their common heritage and the kind and extent of the structural features peculiar to each, which therefore may be regarded as latter-day acquisitions.

Dr. Gregory has sought an answer by following a totally different route. He has approached it by following the geological record; he has an unrivalled knowledge of the fossil remains of early forms of primates found so abundantly in the Eocene deposits of North America; and as teeth and jaws, or fragments of them, are the most persistent parts of the mammalian skeleton, it has come about that the geological history of the various orders of mammals has to be based on an interpretation of dental hieroglyphics. In deciphering

the ancient alphabet of the teeth, particularly as regards the teeth of primate forms, Dr. Gregory is our most highly trained expert. The survey he has now issued embraces not only the American tarsioid and lemuroid fossil forms, lying in or near the basal phylum which has given us our modern apes and lemurs, but also includes an examination of the corresponding fossil forms found in Europe. He deals minutely with the fossil remains of apes found in the Oligocene deposits of Egypt, the anthropoid remains found in the Miocene and Pliocene deposits of Europe and of India—particularly those described in 1915 by Dr. G. E. Pilgrim, of the Indian Geological Survey,—and the various discoveries which have been made of fossil human remains.

Although the routes chosen by Dr. Gregory and by the reviewer have been different they have led to exactly the same goal—namely, that the gorilla, chimpanzee, and man are twigs growing from the same branch of the great primate stem. "Taken as a whole," writes Dr. Gregory, "the testimony of comparative anatomy affords cumulative evidence for Darwin's inference *that some ancient member of the anthropomorphous sub-group gave birth to man*. The detailed studies of the dentition in Part IV. of this work leads me to the conclusion that *the ancient member of the anthropomorphous sub-group* was closely allied to, or even identical with Sivapithecus or Dryopithecus of the Miocene Simiinae."

The reviewer agrees with Dr. Gregory that, on comparing the structural "make-up" of man with that of the great anthropoid apes, "the resemblances are far more numerous, detailed, and fundamental than the differences"; the reviewer would go further and say that in any theory of human lineage the common origin of man, the gorilla, chimpanzee, and orang, must be regarded as a "fixed point" in framing all our speculations. At this early stage in our search for man's pedigree, with only fragmentary documents at our disposal, and with yawning gaps in our book of evidence, complete unanimity between any two investigators cannot be expected.

In Dr. Gregory's opinion mankind is, in a geological sense, a recent product. So late as mid-Miocene times—about a million of years ago if we accept Dr. Gregory's rough estimate—he believes that our ancestry was represented by such fossil forms as Sivapithecus or Dryopithecus—which, so far as we yet know them, must be regarded as true anthropoid apes, not very different from the chimpanzee and gorilla. There is no ground for supposing that in foot or in brain they possessed any trace of the adaptations which have become so pronounced features of the human body. The life-periods and the rate of reproduction of this ancestral stock must have been of the anthropoid order, namely, about seven generations to the century.

In the period postulated by Dr. Gregory for man's differentiation there would have been some 70,000 generations. The representatives of mankind we encounter by mid-Pleistocene times have already a brain which has three times the volume of the chimpanzee brain. Is it possible to conceive a brain like that of the chimpanzee, although constituted upon the same structural and functional plan as is the human organ, attaining a human standard in the course of 70,000 generations? It is true that the discoveries of Dr. Ariens Kappers have shown that the countless myriads of nerve units which make up the human brain are, during the period of development, controlled and grouped by a mechanism the nature of which we can only guess at as yet. Making all allowances on this score, the reviewer cannot conceive the possibility of the extreme structural and functional complexity of the human brain having been evolved from an anthropoid stage in the course of 70,000 generations. While Dr. Gregory is inclined to accept our present knowledge of the geological record at its face value and trace man's origin from an anthropoid of the mid-Miocene period, the reviewer would make allowances for the great blanks in our geological record, which further discoveries will make good, and assume a pre-Miocene date for the divergence of the phyla of man and great anthropoids. It is very difficult to believe that the human brain arose as mushroom-like growth.

Those who have made systematic attempts to determine the evolutionary relationship of one animal form to another know well that it cannot be settled on the evidence of one set of organs; all the structural systems of the body have to be taken into account. Often the evidence of one system—such as that of the teeth, which go with the alimentary system—will seem to clash with or contradict the evidence of other systems. Dr. Gregory is too experienced an evolutionist to make a mistake in this respect; whenever possible he supports or modifies the conclusions reached on dental evidence by appealing to testimony afforded by other systems of the body. Even when this is done it becomes abundantly clear that evolution has not worked on the body of man, ape, or of any animal form whatsoever in a simple and straightforward manner. For example, in that primitive but aberrant primate Tarsius, the embryo establishes itself in the maternal womb in exactly the same manner as do the developing ova of man and anthropoids, and yet the monkeys of the New and of the Old World, which have a simpler type of placentation, are yet infinitely

more akin to man and anthropoids in a structural and evolutionary sense than is Tarsius—in spite of this and other unexpected human likenesses possessed by the latter. To account for the irregular distribution of certain characters possessed by man and Tarsius, Prof. Wood Jones has put forward the claims of owl-eyed Tarsius to pose as one of man's near relatives.

The relationships of Tarsius to man, says Dr. Gregory, "are plainly very indirect and must be traced backwards along gradually converging lines to the primitive tarsioid stocks, which gave rise at different times and at different places to the higher groups of primates." As it has a bearing on such problems as the irregular distribution of the human mode of placentation among the primates, Dr. Gregory quotes with approval a principle enunciated by Dr. Henry Fairfield Osborn in 1908 and "familiar to all close students of mammalian phylogeny, namely, that identical characters are often developed by divergent descendants of a common stock." To the master morphologists of our studenthood days such a statement would have sounded heretical or metaphysical, but to those who are familiar with the complex mechanism of hormones, which regulate the growth of diverse structural elements so that they are moulded to serve a common functional purpose, this statement, made by one who has given a lifetime to the observation of fossil forms, has become of easy acceptance to those who are studying the development and growth of living forms. Our difficulties of accounting for the composite make-up of the human body and of that of his congeners, the anthropoid apes, will disappear once we have mastered the growth mechanisms which lead to the creation of structural modifications and the suppression and perhaps resuscitation of old features.

The reviewer has merely noted here the chief conclusions which years of careful toil have permitted Dr. Gregory to formulate concerning man's origin. The main value of the work he has now published is to provide students of the higher mammalian forms with an indispensable dictionary for the interpretation of dental hieroglyphics. Out of a restricted alphabet, Nature has fashioned teeth into a most elaborate and significant language. How these elements are manipulated so as to provide a profusion and variety of dental forms we do not know but it is clear to the least initiated that upper and lower teeth have to be so fashioned, while still embedded in the gums, that when they come into place in the jaws they will fit each other just as a key does its lock. There must be a correlating mechanism at work to harmonise the bite of opposing cusps. Of this Dr. Gregory is fully cognisant, but we regret that he has not abandoned the confusing system of naming the cusps of molar teeth introduced by Dr. Osborn. In this system the names given to the cusps of upper molar teeth are reversed when applied to the cusps of lower teeth—a method with all the perplexing attributes of a reflected image. Besides, as Dr. Gregory has frankly admitted, the system, which has served a good purpose in its time, is really founded on an erroneous interpretation.

Another small and personal grudge the reviewer may also give vent to—the introduction of the new-fangled nomenclature for the old and well-established generic names we have hitherto been accustomed to give to apes and monkeys. But the reviewer's last words must be those of admiration and of thanks for a standard work.

A. KEITH.

A Reflective Observer.

A Philosopher with Nature. By Benjamin Kidd. Pp. vii+211. (London: Methuen and Co., Ltd., 1921.) 6s. net.

MR. BENJAMIN KIDD was a keen observer of Nature, particularly interested in the problems of animal behaviour and all that throws light on evolution. This volume is a collection of his essays; with the exception of the first two, which deal very attractively with the birds of the Severn estuary, they have been previously published in serials. But in collected form they are very welcome. In all cases there is a characteristic reflective note: What is the deeper significance of this or that occurrence? The primitive language, among birds for example, is undoubtedly a language of the emotions, but it is interesting to notice that it is often a kind of *lingua franca* understood even by widely different species. The young of the mallard, which has probably been the most universally hunted creature on earth, nestle on the observer's bare feet without the slightest instinctive fear. "You take one of them in your hand, and this heir of the ages of the blood-feud shows no fear of you, even tilting its little beak to look inquiringly in your face; evidently thinking no evil, to all appearance hoping all things and believing all things, but certainly quite willing to take you on your merits for good or evil entirely without prejudice." The mother bird is on a tussock near by, "chattering with emotion, every feather quivering with excitement. The hold of the Great Terror of Man is upon her. In a few days, nay, in a few hours, she will have taught it to them, and they will have passed irrevocably into another world." Character is a product of "Nature" and "Nurture."

An interesting experiment was made with a colony of humble-bees which Mr. Kidd kept on his window-

sill. He carefully removed part of the waxen covering of one of the little groups of larvæ, inserted a grub taken fresh from a hive, and covered the whole again roughly, "expecting that the bees would complete the repairs, and so seal up the intruder with the others. But they were not to be cheated in this way, and they would not repair the broken wax until they had smelt out the stranger, whom they dragged out and carried outside the nest, after which they replaced the breach in the usual way." He made the experiment several times, but with no better success. He then placed some hive-bee eggs among a little group just deposited by the humble-bee queen. The bees seemed to be rather puzzled. "One or two of them took them up somewhat aimlessly, and again replaced them as if they hardly liked to openly accuse their sovereign of misconduct, which they seemed to suspect." After some hesitation they proceeded, apparently with considerable relish, to eat the eggs. "So appreciative did they become of the flavour of these new-laid eggs that they would soon accept them readily when I offered them at the end of a needle."

Observations on a captive queen humble-bee supplied with an empty nest were also interesting. She spent several days beating against the window-pane and then gave it up entirely; she showed great interest in brightly coloured objects like brass handles, gilt labels on books, and waistcoat buttons. But she was particularly intrigued by the keyhole of the door, into which she would try to squeeze herself. Apparently it "suggested" the opening into an underground nest.

In the essay on hares there is an interesting paragraph. "It is a moot question whether the hare is a rabbit which has taken to the open or the rabbit a degenerate hare which has obtained comparative safety by taking to a stupid life in the earth. It is an interesting fact in this connexion, and one not often remarked on by observers, that a hare, if it finds an obstacle it wishes to get rid of, will naturally scratch with its front legs with considerable strength and with exactly the same movement as a rabbit. Thus, although the hare lives in the open grass country, never takes to earth, and much dislikes ground infested by rabbits, it has to all appearance latent in its muscles the beginning of an instinct which might be developed into the rabbit's capacity for burrowing."

Of its kind the picture of a midsummer night is difficult to beat; it is as well drawn as Richard Jefferies could have done it. Take the sounds: the churr of the night-jar, calling to his mate; the undertone of the hundred rills and the swollen river; the warning stamp of rabbits that have been disturbed in their feeding; the strident love-note of the corncrake; the shrill cry of the partridge; the nightingale singing to his mate on her nest; and then the larks, the thrushes, the twittering swallows as the fringes of the night overlap the coming day. It is not merely a well-drawn picture; it is a reflective appreciation.

What Mr. Kidd has to say about animal behaviour is always interesting. Obeying the law of parsimony he will press the simplest re-description as far as it will go, and yet he cautions us that "the more the subject is closely studied the less the observer finds himself inclined to accept ready explanations." A young sheldrake, fed on dry ground, went through a kind of dancing or prancing movement, stamping rapidly on the floor with its feet. Darwin connected this with the sheldrake's habit of patting the sand or mud near the worm-burrows on the seashore flats. The stamping is supposed to "make the worm come to the surface," and so the sheldrake keeps on stamping. But Mr. Kidd points out that it is the way of young wild duck in general to stand in the shallow water and stamp gently and rapidly on the muddy bottom. This makes an eddy bringing up food-particles which are then seized and devoured. Three-days-old ducklings, hatched under a domestic hen, exhibit the movements to perfection. Perhaps the sheldrake's stamping is merely a slight modification of a piece of instinctive behaviour general among ducks. But in the opposite direction, Mr. Kidd makes out a good case for refraining from any simplicist interpretation of the behaviour of a collie dog. We fail utterly unless we take into account its ancestry, for it was one of a pack, a social unit. "The dog has probably still some sort of conception of his place as member of a co-operative group, and of his master as the wise and resourceful leader of it." The other essays discuss sea-trout, eels, frogs, birds, squirrels, and the like. All are illuminating and all are delightful.

Metallography in the Workshop.

Steel Thermal Treatment. By J. W. Urquhart. Pp. xv+336. (London: Crosby Lockwood and Son, 1922.) 35*s.* net.

NEARLY all the books which have hitherto been written on the heat treatment of steels are the work of metallurgists. The interesting thing about the present work is that it has been written by a man engaged in the production of machinery and various steel components and tools in his workshops in Leicester. As he states, he has been forced to put into practical use all the recently introduced processes employed in

the heat treatment of steel. Many other tool makers have been in the same position. It has, however, been left to Mr. Urquhart, not merely to make a study of the processes involved, but to write a book on them from a practical engineering view-point. In doing this he has rendered a service to his brother engineers which they will probably not be long in recognising, for he has written his book in language which is as free from technicalities as possible.

The time has gone by when steels as received from the makers were forthwith worked into machines, without any preliminary treatment, and when it was not realised that a thermal process could add enormously to their physical strength and effectiveness. In consequence there has been a revolution in the engine and machine building trades within the last few years, which is only realised by the men engaged in those trades. As the author points out, not only have great improvements been introduced in the treatment of well-established carbon steels, but they have been followed by a remarkable development in the use and heat treatment of alloy steels. These advances have necessitated the application of better systems of applying heat and measuring the temperatures produced, and these in their turn have led to the introduction and development of electrical methods of heating, which are capable of a higher degree of control and accuracy.

The early chapters of the book deal with the recent developments in metallography as applied to steels. The author has mastered the theory of the iron-carbon equilibrium, as applied to both carbon and alloy steels, and this is one of the best parts of the whole book. As he points out, one of the most remarkable effects of alloying nickel with mild steel is the lowering of the temperature of the A_{C1} range, an effect which means diminished cost of working the steel, a greater margin of safety against over-heating, increased ductility, toughness, and resilience in the finished product. The physical characteristics of steels and testing methods are next described, and these are followed by an outline of thermal processes. Chapters on furnaces and their methods of working come next, and a very good account is given of pyrometers and their application to the thermal treatment of steels. Methods of case-hardening, both by solid and gaseous reagents, are next described, and these are followed by details of the various methods of quenching. Later chapters deal with various types of tools and typical heat treatments, and in the last two chapters accounts are given of the thermal treatment of high-speed tool steels and stainless steels.

To some extent the book is an attempt to co-ordinate the work of the laboratory with that of the engineer's hardening department; and with this end in view, the author has included a series of photomicrographs illustrating the structures of steels at various stages of heat treatment under workshop conditions. He has availed himself of the experience of well-known metallurgists, such as M. Guillet and the late Prof. Howe on the academic side, and of Sir Robert Hadfield, Mr. S. Brayshaw, and Prof. Giolitti on the practical side. There is no doubt that the volume will be widely welcomed by practical men, and it should do much to raise the standard of the scientific heat treatment of tools and machine parts. H. C. H. C.

Mosquito Control.

Mosquito Eradication. By W. E. Hardenburg. Pp. ix+248. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 15*s*.

IN this small book the author gives a clear and concise account of the measures which have been found successful in controlling mosquitoes in America. The brilliant results of the anti-mosquito work in Havana and the Isthmus of Panama have been fully appreciated in the United States. Dr. G. A. Le Prince, formerly Chief Sanitary Inspector, Isthmian Canal Commission, wrote, in the Annual Report, U.S. Public Health Service for 1920, "The public view-point has changed; villages, towns, county and state officials, as well as business corporations and railroads, now realise the extent of the large preventable financial loss they incur each year. . . . The people have been watching the campaigns undertaken, and throughout the country they are becoming more and more interested in having their own community and state undertake this work. . . . This calendar year, 101 places are doing work under the supervision of the Public Health Service, and have already appropriated $280,000 therefor."

The modern methods of mosquito control are merely elaborations of those originated by Sir Ronald Ross in the East and by General Gorgas in the Canal zone and Cuba; they have already been described very graphically by Le Prince and Orenstein. But Mr. Hardenburg, who is a sanitary engineer, has treated the subject from a somewhat different point of view from that adopted in "Mosquito Control in Panama." Descriptions are given of the more important American culicine and anopheline mosquitoes. These, though brief, are sufficient to enable a sanitary officer to recognise most of these insects that he is likely to meet with; the information given in the body of the book is supplemented, in an appendix, by a more technical key for the identification of both larvæ and adults.

A good account is given of the preliminary survey work that has to be done before actual operations against the mosquitoes can be commenced. Mr. Hardenburg insists upon the importance of a vigorous propaganda to arouse public interest, and explains, with some humour, how to induce newspaper editors and the "motion picture houses" to "boost" the work.

Drainage of swamps, pools, and salt marshes is dealt with very thoroughly; and detailed directions are given for the construction of drains by handwork or by machinery, for the laying out of a system of tile drainage, and for the construction of tide gates and sluices.

The use of oil and other larvicides, with its advantages and disadvantages, is fully considered; and a whole chapter is devoted to the use of fish to control the mosquitoes. The author writes with enthusiasm on this latter subject, but adopts a more judicial attitude towards the proposal to establish "bat-roosts." The problem of how to deal with the mosquitoes which breed in rice-fields seems to be still unsolved, at least in countries where the people insist upon having rice cultivation near the villages. The habits of the different species of Anopheles, and especially their choice of breeding-places, are so varied that experience gained in one country is not sufficient for dealing with the conditions met with elsewhere. Now, however, thanks to this book, to that of Le Prince and Orenstein, and to Dr. Malcolm Watson's "Prevention of Malaria in the Federated Malay States," public health officers in the tropics are well provided for.

Mr. Hardenburg's book represents the views of a practical man. It can be recommended with confidence to all those who have to deal with sanitation in malarious countries.

The value of the book is much enhanced by the many excellent illustrations with which it is adorned.

H. J. WALTON.

Our Bookshelf.

Das feinbauliche Wesen der Materie nach dem Vorbilde der Kristalle. Von Prof. Dr. Friedrich Rinne. 2 und 3 erweiterte Auflage. Pp. viii+168. (Berlin: Gebrüder Borntraeger, 1922.) 10*s.* 4*d.*

THE new edition of Prof. Rinne's book is considerably larger than the first edition, and presents an altogether wider outlook on the fine structure of matter as exhibited in crystals. The whole work is enriched by an originality of treatment which renders it eminently readable and suggestive. Moreover, the excellent portraits of von Groth, Haüy, Schoenflies, Fedorov, Tschermak, von Laue, Debye, Scherrer, Sir William Bragg, and W. L. Bragg give it an altogether special interest. A reproduction of Albrecht Dürer's picture "Melancholie" is also given, in which the representation of a huge crystal occupies a prominent place, the inference being that Dürer was oppressed by the idea of the hopelessness of man's ever rising to the comprehension and explanation of a natural phenomenon so wonderful and remarkable as that of crystallisation. If Dürer lived to-day, however, how different would be his picture! Its title might well be "Hope," or even "Achievement," rather than "Melancholie."

It is this extraordinary success of recent crystallographic and physical research, and particularly that brought about by the use of X-rays in elucidating the arrangement of the chemical atoms in crystals, that forms the main theme of Prof. Rinne's book, and he regards the whole achievement in its more fundamental aspect, as having revealed the true nature of the fine-structure of solid matter. The book is full of illustrations and diagrams of an original character, including many of the X-radiograms of crystals due to Prof. Rinne's own industry. It is a book of very special merit, and one of the most suggestive and far-seeing that have appeared since the inauguration of these fruitful new methods of research. A. E. H. T.

Elementary Hydraulics for Technical Students. By Prof. F. C. Lea. Pp. vii+224. (London: E. Arnold and Co., 1922.) 7*s.* 6*d.* net.

DR. LEA'S larger work on hydraulics has long been regarded as an authoritative treatise, and the present volume will be welcomed by many who have felt the need for a less comprehensive work. Beginning with clear accounts of fundamental principles, the questions of the flow through orifices and over notches and weirs are discussed. Next follow the flow through pipes and channels and the methods of gauging the flow of water. Vanes, water-wheels, turbines, and pumps are then considered, and the volume closes with a chapter on hydraulic machines. The treatment throughout is simple, which will render the book suitable for use in technical schools; the drawings are well executed, and the text is very readable. A commendable feature is the description of many experiments which may be carried out on a comparatively small scale with inexpensive apparatus. Any student who works systematically through the experiments described will gain a very fair working knowledge of the methods employed and of the manner in which the results are reduced. The book also contains a number of well-selected exercises, with answers; to some of these exercises hints are appended for their solution, while others are left to the student. Hydraulics is not an easy subject to author or student, and Dr. Lea is to be congratulated upon the present volume, which cannot fail to be of service to both teachers and students.

The Czechoslovak Republic. By Jaroslav Císař and F. Pokorný. Pp. vi+218. (London: T. Fisher Unwin, Ltd.; Prague: Orbis Publishing Co., 1922.) 9*s.* net.

THE authors of this volume aimed at compiling a complete handbook to the new state of the Czechoslovak republic and have published an English edition in the hope of spreading a knowledge of their country. There are chapters on the history, topography, population, political organisation, natural resources, industries, trade, transport, etc., with appendices of statistics

and a well-printed, if rather small-scale coloured map. The notes on topography are very brief, covering scarcely two pages, while climate is dismissed in a few lines. More consideration of these fundamental aspects of the economic life of the country would enhance the value of the book.

Of all the new or newly constituted states of Europe probably none has greater possibilities than Czecho-slovakia. Its central situation, varied resources, and rich mineral endowment combine to promise a bright future. Racially also it has fewer thorny problems to solve than most of the new states. Czechs and Slovaks together comprise 68 per cent. of the population, and the only considerable non-Slavonic element is 22 per cent. of Germans, mainly in Bohemia. At the same time the great difference in cultural status between the Czechs and Slovaks, which is emphasised by the comparative lack of communication between their respective countries, is a hindrance to the consolidation of the State. The government is fully aware of this difficulty, and is facing it by the improvement of communications. The section of the Elbe from Aussig to Neratovice has been canalised and operations are in progress as far as Pardubice. From there a canal, 110 miles long, will be built to Prerau on the Beczwa in Moravia. A Danube-Oder canal is also under consideration.

R. N. R. B.

Technical Electricity. By H. T. Davidge and R. W. Hutchinson. Fourth edition. Pp. xii + 514. (London : University Tutorial Press, Ltd., 1922.) 10*s*. 6*d*.

THE object of the authors of this volume is to give a clear exposition of physical principles and to show how they are applied in engineering practice. This is done satisfactorily, and we think that the volume will prove useful to engineering students in the first and second year of their course at a technical college. Engineering practice and phraseology change rapidly, so it is difficult to keep an engineering treatise absolutely up-to-date. For example, the phrase "mean spherical candle-power" is rapidly becoming obsolete. Engineers now use the much more sensible phrase "the average candle-power"; similarly a "half-watt" lamp is now termed a "gas-filled" lamp. It is not strictly correct to say that the international candle-power "is now defined as an illuminating power equal to one-tenth of that of the Harcourt-Pentane lamp." When engineers refer to the international candle they mean the unit of luminous power maintained by the National Physical Laboratories of France, Great Britain, and the United States of America. The Hefner-kerze is used by Germany and Austria, and its numerical value is nine-tenths of that of the international candle. Hence the candle-powers given by lamp manufacturers in Germany are expressed by larger numbers than if they were expressed in international units. This is to their commercial advantage. We were surprised that the international standards for the resistance and temperature-coefficients of pure annealed copper are not given, as they are of fundamental importance in electrical engineering. We hope that the wire gauges, the table for the resistance of copper wires (temperature not stated), and the tables of fusing currents will be omitted from the next edition.

Notes on Qualitative Analysis : Concise and Explanatory. By Dr. H. J. H. Fenton. Supplement. Pp. v + 155-202. (Cambridge : At the University Press, 1922.) 3*s*. 6*d*. net.

THIS pamphlet forms a supplement to Dr. Fenton's well-known "Notes on Qualitative Analysis." The more important and characteristic reactions are given of the rarer elements of more general interest which can be identified by chemical tests. References to "spectra," without any details, are made. No description is given of possible methods of separation. In arranging the elements according to alphabetical order, their chemical relationships are quite obscured, and the information conveys the impression of isolated snippets. The selection of the inorganic and organic compounds is, as the author emphasises, quite arbitrary: one notices more particularly the substances studied by Dr. Fenton himself. Although the book may prove useful to teachers who have not access to the larger treatises, its lack of system and reasonable completeness will somewhat diminish its value as compared with existing manuals of qualitative analysis such as that of Treadwell.

The Fishing Industry. By Dr. W. E. Gibbs. (Pitman's Common Commodities and Industries.) Pp. viii + 135. (London : Sir I. Pitman and Sons, Ltd., 1922.) 3*s*. net.

A VERY concise and comprehensive account of the sea-fishing industry in general is contained in Dr. Gibbs's little volume. There are chapters on the natural history of the edible fishes, molluscs, and crustacea, and on the methods of fishing, but the distinctive parts of the book are those that deal with the mode of fish-curing and conservation, and with the utilisation of by-products. Written with an evident personal knowledge of the processes described, these chapters make a really important contribution to the literature of the sea fisheries.

J. J.

Manuel d'océanographie physique. Par Prof. J. Rouch. Pp. 229. (Paris : Masson et Cie, 1922.) 15 francs.

CAPT. ROUCH'S book is a well-balanced account of oceanography, treated almost entirely from the physical point of view. The first part deals with methods, soundings, the physics and chemistry of sea-water, the study of currents, tides, and tides and the observation of ice-formation. The second part deals in the usual way with the general results of oceanographical investigation. The book is a small one, but it is very concise in its treatment, and it is well illustrated.

Practical Tanning. By Dr. Allen Rogers. Partly based on the Third Edition of "Practical Tanning," by Louis A. Flemming. Pp. xxv + 699. (London : Crosby Lockwood and Son, 1922.) 45*s*. net.

DR. ROGERS is well known for his writings on chemical technology, and as an account of recent American practice his book will prove interesting to English technologists. It deals briefly with all branches of the subject, and is illustrated. The section on analytical methods is brief, but most of the important determinations are covered. A short account of synthetic tanning materials is given.

Letters to the Editor.

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

A Quantum Theory of Optical Dispersion.

WHEN a theory is framed trying to explain a discrepant system of facts, it is a necessary process of thought to take some branch of the theory as more completely true than the rest, and to adjust the remaining parts in such a way that they will fit in with this base, though they may still conflict with one another. This has certainly been true of the quantum theory; the speculations connected with it have as their base the law of the conservation of energy. Now a critical examination of fundamentals does not by any means justify this faith. It is, of course, a fact of observation that, in the gross, energy is conserved, but this only means an averaged energy; and as pure dynamics has failed to explain many atomic phenomena, there seems no reason to maintain the exact conservation of energy, which is only one of the consequences of the dynamical equations. Indeed it is scarcely too much to say that had the photoelectric effect been discovered a century ago it is probable that no one would ever have suggested that the status of the first law of thermodynamics was in any way different from that of the second. On the other hand, Bohr's theory, and especially Sommerfeld's extension of it, have given great encouragement to the belief that in dynamics lay the way to the complete truth, so that in consequence of the triumphs of that theory there has been little thought in other directions. Another impediment is that our whole ideas are saturated with the principle of energy, so that denying it leaves scarcely any foundation from which to start.

Now there is another field of phenomena which forms a consistent whole, but at present only fits into the quantum theory with a good deal of difficulty—that is, the wave theory of light. Interference and diffraction are completely explained by a wave theory, and it would seem almost impossible to devise any really different alternative which would account for them. Here is a base which seems to be free from the objections which attach to energy, and I have therefore been examining the consequences of fitting it in with those parts of the Bohr theory which seem to be most completely established. The result is what I believe to be a satisfactory theory of dispersion—one of the weakest points in the quantum theory[1]—and a great promise of future extensions in other directions.

We shall assume then that the wave theory gives a correct account of events *outside matter*, and it is convenient to take over the terminology of the electromagnetic theory, provided we remember that "electric force" is only to mean "light vector," and that we are not prescribing how the electric force will affect the behaviour of atoms or electrons. The assumption brings with it of course the exact conservation of energy in the æther; it is in interchanges with matter that it need not be conserved. When a wave passes over matter there is a mutual influence, and without any inquiry into what happens to the matter, we can say that it is inconceivable that the effect on the æther should be anything but in the form of an expanding spherical wave. Every such wave can be described in terms of spherical harmonics, and the simplest is the one corresponding to the harmonic of zero order. In this the electric force vanishes at two poles and is elsewhere along the lines of longitude and proportional to the cosine of the latitude, while the magnetic force lies in the circles of latitude. This is the type of wave given in the classical theory by a Hertzian doublet vibrating in a line, and it proves unnecessary for our theory to postulate that any more complicated type is emitted by the atom. If x is the direction of the pole of the wave, then at x, y, z, at a great distance r from the atom, the wave is given by:

$$\left.\begin{aligned} E_x &= -\frac{r^2-x^2}{r^3} f(t-r/c) \\ E_y &= \frac{xy}{r^3} f(t-r/c) \\ E_z &= \frac{xz}{r^3} f(t-r/c) \end{aligned}\right\}, \qquad (1)$$

Next, borrowing from the Bohr theory, we shall assume that when an atom is struck by a wave, there is a certain chance that the atom should emit a secondary wave of the above type. With these assumptions it is possible to argue inductively from the observed fact that if incident waves are superposed the result can be found by an addition of their effects and from the known form of the dispersion formula. There is no need to give the argument, but only its final result. The complete statement of this for unpolarised waves is rather more complicated, but the essential points of the theory are fully represented in what follows.

When a wave, polarised so that the electric force is along x, strikes an atom at the origin there is a chance $A_n(\partial E_x/\partial t)dt$ that in the time dt it will excite the atom to emit a spherical wave of the type (1) with f of the form $a_n e^{-\lambda_n t}\cos k_n t$. *Here* A_n, a_n, λ_n *and* k_n *depend only on the nature of the atom and not at all on the incident force*; λ_n is supposed to be small. Of course $\partial E_x/\partial t$ may be negative; in this case we shall suppose that there is a chance $A_n(-\partial E_x/\partial t)dt$ for the emission of a wave $-f$. We shall be able to treat both cases together and need not make the distinction. The subscript $_n$ indicates that we suppose there are several different ways in which the atom may be excited, each with a separate chance for it.

Consider a simple case, a monochromatic wave polarised along x and advancing along z, which strikes a group of N atoms at the origin. Let the wave be $E_x = H_y = F\cos p(t-z/c)$. The number excited in the interval dt will be $NA_n(-Fp\sin pt)dt$. Consider the secondary wave crossing the point x, y, z, at the time $t+r/c$. This is due to all the atoms which were excited before the time t. The number excited in the interval ds at a time $t-s$ is $-NA_nFp\sin p(t-s)ds$ and each of these will at the time t be giving a wave typified by $f = a_n e^{-\lambda_n s}\cos k_n s$. So the total effect will be a wave which at the time $t+r/c$ at x, y, z has an x-component

$$E_x = -NA_nFp\left(-\frac{r^2-x^2}{r^3}\right)\int_0^\infty \sin p(t-s)ds\,.\,a_n e^{-\lambda_n s}\cos k_n s \qquad (2)$$

$$= NA_n a_n \frac{r^2-x^2}{r^3} F \frac{p^2}{k_n^2 - p^2}\cos pt,$$

provided that λ_n is taken as small. The averaging has entirely blotted out the frequency of the atoms and left only that of the incident wave. Now on the classical theory, if there is a group of N_n electrons

[1] The difficulty is that the standard theory indicates a dispersion formula involving the frequency of the electron's motion in the atom which is quite different from its absorption frequency.

which have a natural frequency of vibration $k_n/2\pi$, the wave they scatter is given by

$$E_x = N_n \frac{e^2}{mc^2} \frac{r^2 - x^2}{r^3} F \frac{p^2}{k_n^2 - p^2} \cos pt.$$

So if we identify $N_n e^2/mc^2$ with $NA_n a_n$ the expressions are the same. But the only difference between the phenomena of scattering and of the refractive index lies in the matter of allowing for the mutual influence of the atoms, an influence exerted by the waves they send out and therefore the same on both theories. So we may at once say that from our result will follow the dispersion formula of Lorentz

$$\frac{3(\mu^2 - 1)}{\mu^2 + 2} = \Sigma_n \frac{4\pi N c^2 A_n a_n}{k_n^2 - p^2}.$$

From the linear way in which the chance of excitation depends on the incident force, it follows that the average effects of superposed waves is additive; in other words, the atoms act as Fourier analysers, sort out the harmonic components of an arbitrary incident wave and refract each component in the proper degree. In all cases the characteristic frequency with which the waves are really emitted will entirely disappear by averaging.

It will be necessary to consider the balance of energy which is nearly but not quite exact, but the present simple equations are not suited for this; they fail to give the balance even in the classical case, and there it must occur. This question is better treated in connexion with absorption. The problem is complicated by the fact that the excited wave may possibly have a phase differing slightly (it may only be slightly) from that of a cosine. I have assumed the form of the damping factor as $e^{-\lambda_n t}$ only for convenience; all that is necessary is that the infinite end should be unimportant. An alternative is to suppose that the wave is undamped but that there is a chance $\lambda_n dt$ in every element of time dt that it should stop. We have only discussed waves polarised along the x-axis and have supposed that the excited waves have this axis as pole; for the general case the formulation must be somewhat changed, but it would take too long to state and prove the modification here. The essential points of the theory are not altered, and it also appears that there should be no particular difficulty in fitting double refraction and rotatory dispersion into our scheme.

A theory of dispersion is not of course complete without including selective absorption. If λ_n is retained in the integration of (2) the result is an expression practically the same as that given in the classical theory when a damping factor is included. Observe that on the present theory, when the forced period approaches the natural, there is no increase either in the number of atoms excited or in the strength of the waves they send out. The whole change is due to the greater efficiency with which they reinforce the primary beam. Our theory gives no explanation of the mechanism of conversion of radiant energy into atomic heat, any more than does the classical theory with its damping factor. The conversion is probably better studied by the consideration of other cases of absorption, such as metallic reflection, and our method of argument, applied to this last, should certainly give interesting results. We shall have to find what emission of spherical waves will diminish the æthereal energy when superposed on the incident wave. Thus a wave like that for dispersion would do for metallic reflection, if the phase is suitably altered, or possibly we may suppose that the wave is again in the form of a cosine, but that the chance of excitation is now proportional to E_x instead of to $\partial E_x/\partial t$. It seems likely that a study of the optical constants of metals would throw light on this question. Afterwards it would be necessary to examine the balance of energy between æther and matter, and this might help in understanding the mechanism of the process.

We may now review how these speculations will modify the accepted theory. As we have made no assumptions as to what goes on inside the atom, we can take over the whole of the dynamics of stationary states. We suppose that an atom is usually in its lowest quantum state. The motions of the electrons will sometimes lead to a favourable configuration, and when this occurs in the presence of a changing electric force, there is a chance that the atom may be jerked into a condition in some way associated with one of its higher quantised states. It at once starts radiating with a frequency corresponding to the return from that state to the lowest. Dispersion throws no light on the amplitude of the wave, for in the formula it always occurs multiplied by the probability factor A_n. It is rather tempting to suppose that it actually goes into the higher quantised state, and then gives a wave of such amplitude and length that, but for the interference with the incident light, it would emit energy $hk_n/2\pi$. If this is so we may perhaps extend our theory to cover pure emission; for, though we have not postulated any precise relationship between electric force and electrons, it seems inevitable that there should be a rapidly changing electric force near a moving electron, and this force would have a chance of jerking the atom into its higher state. On the other hand, difficulties are raised in other directions. For the radiation must be immediate and therefore the state would not really be stationary at all, and the accepted theory of specific heats requires that a molecule should be able to remain in its higher states. In any case there is a clear contradiction to the principle of energy, but the phases of the outgoing waves are so adjusted that for cases of pure scattering or refraction, on the average, as much energy goes out as comes in.

There are many other points that will require attention. In the first place the refractive index is closely related to the dielectric constant. Now though it is quite proper to treat the dielectric constant as a limiting case of refraction, yet it can be regarded electrostatically and it will be necessary to see the physical meaning of this aspect. Again it is possible to count the electrons in the atom by X-ray reflection, and it follows that there must be a relation between the e^2/mc^2 of the classical theory and our $A_n a_n$. In this connexion I owe to Prof. P. S. Epstein the suggestion that the theory will explain the defect observed in the scattering of hard γ-rays below that predicted. Here the wave-length of the incident light is much shorter than the distances between the electrons and the incoherent waves cannot recombine in the way they do under the classical theory. Lastly, it will be necessary to re-examine the deduction of the formula for black radiation, for all present proofs are founded on theorems following out of the conservation of energy.

In view of the great number of problems that are suggested and the probability that it will take a considerable time to deal with them, it appeared to me that it might be of interest to publish this preliminary account of a very incomplete theory.

C. G. DARWIN.

Institute of California,
Pasadena, Cal.

Interspecific Sterility.

DR. BATESON'S letter on interspecific sterility in NATURE of July 15, p. 76, has given rise to an interesting discussion in later issues, which may be summarised thus :—

Sterility between wild species is not nearly so common as was formerly supposed, yet it undoubtedly occurs frequently, both between species with the same number and with different numbers of chromosomes. The cause of this sterility has not yet been made out with any degree of certainty. On the other hand, crosses between domestic races are, almost exclusively at least, perfectly fertile, although Dr. Gates rightly points out that sterility may often be expressed in lethal factors and that lethal factors are of common occurrence in Morgan's "domestic" races of Drosophila for instance.

Dr. Bateson's starting-point is his belief, that domestic races as well as species in Nature have arisen by some process of transmittable variability, let us say by mutation. At least, on no other assumption can I explain his sentence (*l.c.* p. 76) :

"In contemporary variation we witness the origin of many classes of differences, but not this (*e.g.* interspecific sterility) ; yet by hypothesis it must again and again have arisen in the course of evolution from species of a common origin."

Geneticists are aware that this view is not mine. According to my view two genotypically different gametes are required to give rise to new forms : domestic races as well as natural species arise by crossing. If this is the case—and nobody will deny that, at least in the production of "races," crossing plays a most important rôle—there is no cause to assume that sterility has ever "arisen" from fertility in the course of evolution. We have, for the present, to be satisfied with the establishment of the fact that some gametes, differing in constitution, after crossing give rise to wholly or partly sterile progeny, while others give fertile progeny only.

As there is no reason to assume that our domestic products are the result of crosses only of such wild species as from the start gave exclusively fertile progeny—although, as we shall see, such crosses may indeed have been favoured—it follows that the general inter-racial fertility of domestic products must have been "acquired." Consequently the problem under discussion is not how sterility arose from fertility, but how a form-group in which both inter-racial fertility and sterility occurred, became changed into one, the members of which were all interfertile.

It seems to me that the most simple explanation is offered by the assumption that man from the beginning, for example, from the initial cross or crosses among his animals or plants taken from Nature, in an attempt to domesticate them, has selected the most fertile forms and has continued to do so; in other words, that he has persistently exterminated those forms which were intersterile and kept only those which were interfertile.

While at the present moment intersterility of domestic races might offer considerable advantages, allowing, for example, the cultivation side by side of different varieties of flowers without fear of crossing, there was no such advantage at the very beginning of domestication, when the only object was not to obtain a particular kind but any kind of domestic animal or plant. By this continued selection of interfertile forms, man himself has by now cut off the possibility of obtaining intersterile races.

The following case may illustrate my meaning :

According to my view, our domestic races of fowl, which "without impropriety may, on account of their enormous differences, be compared to natural species," have arisen from a cross in which more than one wild species has taken part. Prof. Ghigi, the well-known ornithologist of Bologna, is of the same opinion, and Dr. Bateson also evidently looks favourably on this view, as he states that he finds it difficult to believe that all races of poultry should have descended from *Gallus bankiva* only. While all races of domestic poultry are, so far as is known, fertile *inter se*, crosses of *Gallus bankiva* and *G. Sonnerati*, or of the former and *G. varians*, give rise, as is well known, to a partly fertile and partly sterile progeny, so that, if our domestic fowl have really arisen from crosses of these wild species, their inter-racial fertility was not primitive, but "acquired" by elimination of the sterile stock.

Thus, according to the views here stated, the starting-point in the formation of domestic races as well as of natural species was the same, to wit, a cross. In those cases in which the product of such a cross was a sterile hybrid, the attempt to originate new races or species was smothered in its birth. Such crosses as gave perfectly interfertile progeny were most acceptable to man, and the cause of the fact that only a very small percentage of the wild species in existence has taken part in the formation of our domestic products may very well be man's partiality for such *ab initio* fertile crosses.

In those cases in which intersterile and interfertile forms arose from a first cross, man selected the interfertile forms, and so obtained the same kind of starting-point for his further efforts as when the first cross had been perfectly fertile from the beginning.

The obtaining of well-defined races from such an interfertile crowd could be attained in one way only, namely, by isolation, and we know that isolation is the alpha and omega of successful breeding.

"Species"-formation in Nature also started from a cross, and Nature's only means of obtaining well-defined form-groups, for example species, also consisted in isolation. Ready-made isolation was presented to Nature by the intersterile forms arisen from a cross ; hence these were favoured, and this accounts for the great percentage of intersterile species in Nature.

To summarise : The starting-point in the formation of races by man and in the formation of species by Nature is the same, namely, a mixed stock of interfertile and intersterile forms arising from a cross.

Man selected the interfertile, Nature the intersterile forms, hence the difference in mutual fertility between domestic races and natural species.

Sterility between species, according to this view, therefore, did not arise from fertility but is the direct result of crossing.

J. P. LOTSY.

Velp, November 28.

Occult Phenomena and After-images.

IF the hand be held against a dark background in a very subdued light, coming from behind the observer and falling on the hand, a diffuse glow will be observed round thumb and fingers, frequently uniting the finger tips. A little patience and a moderately clean hand are all that is required to observe the phenomenon.

Further, however, if a hand be cut out of white cardboard (which is easily done by placing the hand, with thumb and fingers moderately spread, on the cardboard, tracing the outline in pencil, and cutting round with scissors) and feebly illuminated in the way described, a similar but somewhat stronger glow will be observed. In the case of both the flesh and the cardboard the shape of the glow can be modified by slow movement of the hand.

Such radiations are frequently described by writers on the occult sciences as being emitted by the human body. For example, in the chapter on magnetism in M. de Dubor's recently published "Mysteries of Hypnosis," I read of a doctor who was making magnetic passes over a lady. "The subject was wearing a black dress, and the doctor had his back to the light. Suddenly, in the semi-darkness which surrounded him, he observed a greyish vapour, like the fumes of a cigarette, issuing from the tips of his fingers, and, with especial clearness, from the index and the middle fingers. Moreover, the index fingers of the two hands seemed to be united by a luminous arc or semicircle. . . . Other persons, on the doctor's invitation, drew near and observed the same phenomenon. . . . Then the room was darkened. . . . In the darkness, twelve of the witnesses perceived nothing at all, and the remaining six perceived only very little."

M. de Dubor and the whole occult school explain the glow, or aura, seen round the hand as being due to magnetic emanations from the body (using the word magnetic in a superphysical sense). They appear to think that the phenomenon is more rare than it actually is, and do not treat the case of cardboard hands. For the phenomenon as observed with these, there would seem to be two possible alternative explanations. One is, that the cardboard is occult cardboard, and the scissors hypermagnetic scissors, and that I have unwittingly impregnated everything with induced ectoplasmic activity. The other is that the phenomenon is a retinal (and rational) one, which can be observed whenever a white, or whitish, surface is seen in a feeble light, the visual purple from the actual retinal image diffusing into the neighbouring parts of the retina. Accepting, for argument's sake, the latter explanation (which accounts at once for the fact that nothing is seen in the dark), the effect will be intensified by the restless movement of the eye, which undoubtedly takes place when objects are viewed in unfavourable circumstances.[1] The eye shifts the image into an unfatigued part of the retina, and the after image persists as a feeble glow. Such phenomena have been frequently described by Dr. Edridge-Green in a variety of forms, and I do not claim any particular originality for this prosaic explanation.

But a further very interesting phenomenon can be observed with the cardboard hand, which has not, I believe, been described. If it be looked at fixedly, the ends of the fingers will be seen to vanish intermittently, now one, now the other, while the extended thumb and little finger appear to move up and down, producing somewhat the appearance of a hand opening and shutting. The effect is very striking, and is pleasantly diversified by the complete disappearance of the hand at intervals. This is due either to retinal fatigue, combined with eye movement, or else to the ferro-forcificatory magnetism of the scissors, permeated as they must be with psychic influences and what not. I must leave it to the readers of NATURE to repeat the experiments, and judge for themselves.

Seeing that the festive season (I understand that this is the correct way to refer to Christmas) is upon us, I venture to describe a third occult phenomenon, somewhat analogous to that quoted by Dr. Edridge-Green in NATURE of December 9, p. 772. Two heads, facing one another, are cut out of white cardboard in profile, and observed in a very subdued light against a black background as before. (My heads are about two and a half inches in diameter, and the noses about half an inch apart.) By a delicate manipulation of the scissors one of the heads may be given a feminine character, largely by providing it with back hair. On careful observation the heads will be seen to approach and kiss repeatedly, separating with rapturous amaze after each contact. Like the other phenomena, including M. de Dubor's magnetic fluid, this cannot be observed in the dark, nor, I may add, even heard, in the case of the cardboard heads.

All the phenomena seem to be observed even more easily by myopic people than by myself. A morning's experiment has convinced me that with suitable illumination and white cardboard a very creditable *séance* can be arranged, including auræ, movements and levitations, magnetic emanations, and ectoplasm. This method involves no expense and no hymn singing. Even an atmosphere of reverence is not necessary for the production of the phenomena, although, I admit, the morning of my essay in the occult art was a Sunday morning, which may have had some favourable effect.

E. N. DA C. ANDRADE.

Artillery College, Woolwich,
December 11.

[1] See, *e.g.*, Edridge-Green's "Physiology of Vision." (G. Bell and Sons.)

A Relativity Paradox.

IT is with great diffidence that I enter the relativity controversy, since I know little or nothing of the subject. Ignorance, however, is seldom a bar to the expression of opinions. I understand that the fundamental idea underlying the theory of relativity is that no signal can be transmitted through space at a greater speed than the velocity of light. There appears to me, however, to be a method by which, in theory, it might be done, and since we have trains running past embankments with half the speed of light, and shells with observers inside travelling at even higher velocities, perhaps my observer at A (Fig. 1) may be allowed to have two immensely long triangles made of any suitable material; A signals to B by sliding the two triangles together, one over the other, in the direction of the arrows; the point X, where the two sides intersect, moves towards the observer B, who receives the signal when he observes the point of intersection pass over him. If the angle at X is 10″ and the triangles are moved together at a speed of ten miles a second (an absurdly small speed for a relativist), the signal will be transmitted to B with more than twice the speed of light.

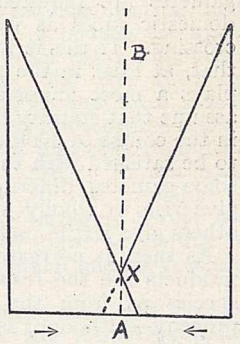


FIG. 1.

C. C.

Is not "C. C." assuming that when A shifts his triangles by tugging at their bases the apices instantaneously start to move? But the impulse would travel from base to apex at a speed far less than that of light, namely, the speed of elastic waves in the material. After the lapse of sufficient time the two triangles would move uniformly and as a whole; and the mechanism provides a good illustration of a recognisable point moving much faster than light. The relativist does not object to this, since the motion of X does not then correspond to anything coming within the definition of a *signal*. The time of signalling from A to B must be reckoned from the moment that A gives the impulse to the mechanism.

A. S. EDDINGTON.

Observatory, Cambridge.

The Track of a Flat Solid falling through Water.

BY using a small crystal of silver nitrate as the "flat solid" and acidulating the water with HCl the track becomes visible, as seen in the reproduction (Fig. 1).

FIG. 1.

It was by no means easy to "catch" the effect, and I have to thank two members of the Chemical Society of this College, G. R. Ellis and C. P. Sayles, for all the patience and care taken in obtaining so successful a result.

E. W. WETHERELL.

Liverpool College, Liverpool.

Water Snails and Liver Flukes.

DR. MONICA TAYLOR states in NATURE of November 25, p. 701, that further inquiry is desirable in respect to the intermediate hosts of the fluke, as in some districts where water snails are rare or altogether absent, yet in these districts sheep are subject to liver-rot disease. May I add another point? In the Swansea valley, county of Glamorgan, farmers state very definitely, as the result of years of experience, that liming the land increases the liver fluke, for sheep can be run on the rough pastures in the area with slight loss from liver-rot disease, before it is limed; but after it has been so treated the loss from liver-rot disease becomes heavy, sometimes serious. Theories regarding this are many and varied, but the fact remains that the loss from liver-rot in any given area of land is definitely increased after liming. Does liming a wet sour pasture make it more congenial to the water snail? R. HEDGER WALLACE.

November 28, 1922.

The Cause of Anticyclones.

THE steady and persistently high barometric pressure that has prevailed over southern England during most of the autumn naturally causes the desire to know how an anticyclone is produced and maintained in such a situation, but the explanations current in meteorological literature are not for the most part efficacious. It is commonly stated that the high pressure is due to a mass of cold and therefore heavy air above it, but for Europe at least this is in direct opposition to observational results, which show that some three-quarters of the whole mass of air over an anticyclonic area is unduly warm. It is the mass of air over the area that is important; its temperature is quite immaterial, and the real difficulty is to explain why the excess of air does not roll off.

A lecturer demonstrating the gaseous laws must provide himself with a closed vessel in which to confine his gas, and if by any means he spills a pound of mercury on his table he will not expect to find it there in a convenient heap the next day or the next week. The meteorologist, on the other hand, having provided his "polar" air does not proceed to explain why it remains *in situ* and does not rather follow the ordinary law of a fluid finding its own level. The difficulty should be faced and not ignored. Doubtless the equivalent of the lecturer's closed vessel is the geostrophic wind surrounding the anticyclone, but one would like to know how the wind is produced and why and how it is maintained.

W. H. DINES.

Benson, Wallingford, December 1.

German Book Prices.

THERE has been much comment recently in England and America on the above subject: see particularly an article by Prof. Noyes (*J. Ind. Eng. Chem.*, 1922, 99), and editorial comments in the same journal, 1922, 475.

The following prices are examples:

	Beilstein, bound.				Stelzner, unbound.		
	Vol. 1.	Vol. 2.	Vol. 3.	Vol. 4.	Vol. 1.	Vol. 2.	Vol. 3.
England, shillings .	40	38	102	110	24	38	100
Germany, marks .	110	110	280	330	70	104	325

The prices charged to members of the German Chemical Society seem so peculiar that I recently wrote to the society pointing out that much dissatisfaction had been expressed at this state of affairs, and received an answer, from which, as it is too long to insert in full, the following curious passages have been extracted: "... Reckoned on the number of pages the prices are much smaller than those of the publications of almost all foreign chemical societies. *The justice of our fixed prices was confirmed a few days ago from Switzerland.* [The italics are mine.] There can be no thought of making foreign and German prices equal so long as we Germans are compelled to spend unnumbered thousands of our depreciated marks to obtain English books ..."

It is amusing to note the proud reference to the bulk of the journal, which enhances its value so much in German eyes. The diffuseness of their publications is considered in most countries to be a disadvantage; recent complaints were about the quality, not quantity. As to the remark about Germans having to spend many marks to purchase foreign books, the obvious comment is that they need not have printed such a lot of paper money.

Was there not an article in the Treaty of Versailles by which Germany undertook not to impose on British subjects any other or any higher direct or indirect fees, dues, or tax, than are imposed on German citizens?

In the circumstances, I am sure most chemists will agree that until treaties with Germany are something more than scraps of paper, money expended in subscriptions to the German Chemical Society is not much better spent than in buying paper marks.

It is to be hoped that the English and American Chemical Societies will soon be in a position to publish a Dictionary of Organic Chemistry at a fixed reasonable price and in a reasonably terse language.

K. C. BROWNING.

16 Bridge Avenue Mansions,
Hammersmith, W.6, December 1.

Medical Education.

IN NATURE for December 9, p. 769, Sir Archdall Reid asks the following question: "But can any one tell us of what utility, practical or intellectual, is the biology which medical students learn—facts about the classification of plants, the vascular system of the sea urchin, the digestive system of the leech, the bones in the cod's head, and so on?"

I am not quite clear whether this question has been propounded to invite answers, or to introduce another of Sir Archdall Reid's favourite discussions on mutations and fluctuations, etc. There is, however, scarcely any need to answer the question. So far as I am aware, the biology offered to medical students *to-day* is very different from that suggested by Sir Archdall Reid in the lines from his letter quoted above.

W. J. DAKIN.

Zoology Department, University of Liverpool,
December 11.

SIR ARCHDALL REID in his letter to NATURE of December 9, p. 769, tells us that medical students in their biology course learn "facts about . . . the vascular system of the sea-urchin, the digestive system of the leech, the bones in the cod's head, and so on."

Now at this university we have nearly finished the three months' course of zoology for medical students held under Prof. Graham Kerr, and not one of our medical students could answer a question on the subjects named by Sir Archdall Reid. It is a pity, as they are interesting subjects, but there is no room for them in a zoology course for medical students. There is none too much time for the students to learn what they really are taught, namely those parts of zoology which will be, or should be, directly useful to them either as anatomists or medical men.

The point which seems clear is that in the first part of his letter Sir Archdall Reid is asking us for information about "facts" which are not facts, as King Charles II. is said to have done with the Royal Society. What then is the value of his comments based upon these "facts"? J. S. DUNKERLY.

The University, Glasgow.

I HAVE no desire to enter into a discussion with Sir Archdall Reid of the value of the "biology of their own" which medical men "are in a position to construct, and for all practical purposes have already constructed," but it is necessary to point out that his description of the "biology which medical students learn" is not correct. He describes the latter biology as consisting of facts about the classification of plants, the vascular system of the sea-urchin, the digestive system of the leech, the bones in the cod's head, and so on.

Whatever may have been the case when Sir Archdall Reid was a medical student at Edinburgh, not one of the animal types he mentions is now included in the syllabus of elementary practical zoology of the medical curriculum in that university, nor are they included, so far as I know, in the corresponding syllabus in any English university. It is surprising that a member of the medical profession, which is not yet emancipated entirely from the empiricism of earlier times, should write so contemptuously of the leech, once so closely associated with that profession. J. T. CUNNINGHAM.

East London College, Mile End Road, E.,
December 13.

Scientific and Industrial Pioneers.

THROUGHOUT the past year it has been my privilege to contribute week by week to these columns a Calendar of Industrial Pioneers. This now comes to an end. This Calendar and the Calendar of Scientific Pioneers, which appeared last year, contain some 930 names, and the lists are believed to be thoroughly representative of that great and ever-increasing army of workers by whom the secrets of Nature are unravelled and natural riches are made available for the benefit of mankind. In selecting the names to be included this year I was assisted by Dr. W. C. Unwin, Professors Eccles, H. C. H. Carpenter and Abell, Mr. F. S. Marvin, and others, and to them I am indebted for suggestions of which I have been glad to make use. EDGAR C. SMITH.

5 Cotehele Terrace, Devonport.

W. H. Hudson Memorial.

AT a meeting of friends and admirers of W. H. Hudson, held at Messrs. Dent's on November 28, it was agreed that a fitting memorial in stone should be placed in or near one of the sanctuaries in the London parks which should be dedicated to his memory, subject to the consent of H.M. Office of Works.

It was also decided that Prof. Rothenstein's portrait in oils of Hudson should be presented to the Nationa Portrait Gallery subject to the permission of the trustees, and that all monies over and above those spent upon these works should be devoted to the preservation of wild bird life. An executive committee was appointed to carry these proposals into effect.

Hudson's works are imperishable, but we need a national memorial to the great Englishman whose Nature writings are inspired by that change of heart towards wild life which is replacing the old indifference and spirit of destruction. There were two sides to his genius, that of the man of letters and that of the naturalist. Both these elements are, we feel, properly represented in the suggestions outlined, and we earnestly appeal to the public to make it possible for them to be finely executed. Donations should be sent to the hon. treasurer, Mr. Hugh R. Dent, Aldine House, Bedford Street, W.C.2.

R. B. CUNNINGHAME GRAHAM.

Human Blood Relationships and Sterility.

IT is not, I think, generally known that the late Alphonse Milne-Edwards made curious and interesting investigations and suggestions with regard to these matters, but did not live to publish them. A record will be found in Sir Ray Lankester's "Secrets of Earth and Sea" (p. 141). Briefly, his view was that the serums of separated species are toxic to one another—as in the tables given by von Dungern and Hirschfeld and in this country by Back and Edwards, and thus prevent the fertilisation of the ovum of one species by the spermatozoon of another. "He proposed to inject one species by 'serums' extracted from the other, in such a way as seemed most likely to bring the chemical state of their reproductive elements into harmony, that is to say, into a condition in which they should not be actively antagonistic, but admit of fusion and union" (E. R. L.). I would suggest that the perplexing sterility of many normal, healthy young married couples is closely linked up with this question, and it may be that a great future is in store for the surgeon who would boldly adopt the suggestion of Milne-Edwards with the view of harmonising the serums of married persons whose relative sterility would appear to be capable of tabulation after the manner of the hæmolytic charts given by Back and Edwards and by the writer of the article in NATURE of December 2. CHRISTOPHER BLAYRE.

So far as I know, the blood groups dealt with in the article on "Human Blood Relationships" in NATURE of December 2 concern only the agglutination (and sometimes lysis) of red corpuscles and not any other of the obscure differences which determine incompatibility between species and subspecies. These no doubt include the qualities of tissues other than blood, and the project to alter them by transferring blood or serum from one species or individual to another seems very unlikely to succeed: the blood is only one tissue among many and its qualities certainly do not dominate those of the body as a whole. In the course of working out the inheritance of the agglutination groups a great deal of germane information has been obtained, but there is no indication that one combination of groups in parents is more likely to be sterile than another. The failure of many normal healthy young married couples to produce children is probably capable of a much simpler explanation.

THE WRITER OF THE ARTICLE.

Emission of Cathode and X-rays by Celestial Bodies.[1]

By Dr. HENRI DESLANDRES.

THE emission by the stars of X- and cathode rays and similar radiations has already been considered and investigated by various writers.[2] The two kinds of radiation, however—X- and cathodic—are not separable, for each, when it meets an obstacle, gives rise to the other, this interdependence having been clearly pointed out by de Broglie. But their properties are different: X-rays move in straight lines, and are much the more penetrating, while cathode rays are easily deflected into helical paths by a magnetic field—or, again, by an electric field. The paths of the electrified particles forming cathode rays, under the influence of a magnetic field like that of the earth, have been revealed by the detailed calculations of Störmer: they are very interesting, and much more varied than the trajectories due to gravitation.

I. In several notes, from 1896 to 1922,[3] I have suggested the emission of cathode and X-rays by the sun, and also by the nuclei of nebulæ. The rays of the solar corona can thus be explained, and also the aurora borealis and the magnetic disturbances of the earth, their connexion with sunspots, and even the lag of these disturbances behind the passage of a spot across the central meridian of the sun's disc—a lag due to the deviation imposed by the outer solar magnetic field. The same idea was put forward also in 1896 by Birkeland, who carried the investigation further: he was able to reproduce, in the laboratory, some of the phenomena of the aurora borealis by means of a small sphere placed in a vacuum, magnetised like the earth, and bombarded by cathode rays. Later, the researches, both theoretical and experimental, of Störmer made a great advance in the investigation, and placed almost completely beyond doubt the emission by the sun of ordinary cathode rays. In terms of these rays, Störmer explains the smallest details of the aurora borealis, so rich in singular phenomena. He has even been able to locate the origin of the rays in the sun, and to determine the value of the external solar magnetic field. This value, which is very small and equal to 10^{-7} gauss, is exactly that which I found in 1911 by another method depending on the radial velocities of the solar prominences recorded at Meudon.

The earth also emits these special radiations. The radio-active bodies in its solid crust and in its atmosphere emit α-, β-, and γ-rays, which ionise the atmospheric gases and explain partly the permanence of the terrestrial electric field. To explain the whole field, it must be assumed that there enter, from the outside, rays which are very penetrating—even more penetrating than any known X-rays. Further, if one ascends in the atmosphere—as did Kohlhörster, who reached a height of 9000 metres—the number of ions formed per second in a closed chamber is found to increase rapidly; at 9000 metres it is eight times as great as at the surface of the earth. The amount of this penetrating radiation therefore increases rapidly with altitude. It proceeds probably from the sun, directly or indirectly, or even from cosmic space,[4] but its exact origin has yet to be determined.

Such are the first results; they are extremely interesting, but still very incomplete. The investigation thus begun should be pursued with every means at our disposal.

II. Researches connected with the atmospheres of yellow stars, carried on at Meudon during 1922 with Burson, have led me to conclude that in these stars there is an extremely penetrating X-radiation, emitted by the interior strata or the nuclei of the stars. These results, which have been stated very briefly in former communications,[5] are now given in detail.

The sun, which is a yellow dwarf star, shows, as is known, in its integrated spectrum,[6] three groups of calcium lines—H_1, K_1; H_2, K_2; H_3, K_3—weak, but very distinct—which represent, respectively, the lower, middle, and upper strata of its gaseous atmosphere or chromosphere. Burson and I have discovered these lines—in particular, the lines H_2, K_2, H_3, K_3 in several *giant* stars which are equally yellow. They have the peculiarity that the lines, when compared with the neighbouring continuous spectrum, are stronger and wider than in the spectrum of the sun. The middle and upper strata of the chromosphere are more luminous and important than the corresponding solar strata.

Stars of the two types, giant and dwarf, have at the surface, however, the same chemical composition, the same temperature, and the same surface brightness. How is the difference in the luminosities of their atmospheres to be explained?

The atmospheric strata are represented by the radiations H and K, which, as is now known with certainty, are emitted by the ionised atom of calcium. If, therefore, we consider, in each type of star, a tube normal to the surface, having unit cross-section and extending from the surface to the outer limits of the atmosphere, the brightness of each stratum in the tube will be proportional, or at least closely related, to the number of ions formed in it per second. The number of ions formed must therefore be greater in the giant stars. Now one of the principal causes of ionisation already pointed out is the intense emission of electrons by the

[1] Translation of a paper read before the Paris Academy of Sciences on October 2, 1922.

[2] X-rays are constituted like the γ-rays of radium, except that the latter have a greater frequency. The ultra X-rays, discussed in this note, have a still greater frequency. In the same way, β-rays resemble cathode rays. As for α- (positive or anode) rays, which play an important part in ionisation in general, they are absorbed very quickly, and move only a short distance from their origin.

[3] *Comptes rendus*, 126, p. 1323, 1898; 134, pp. 1134 and 1486, 1902; 150, p. 65, 1910; 152, p. 1453, 1911; 155, p. 1573, 1912; 157, p. 517, 1913; 171, p. 451, 1920; 172, pp. 405 and 709, 1921; 175, p. 121, 1922. See also "Observations de l'Éclipse totale de 1893" (Gauthier-Villars, 1899).

[4] The earth also probably emits a very penetrating X-radiation—more penetrating than the γ-rays of radium: this has been suggested by some writers. But, if it exists, it is relatively weak, and it has not yet been clearly separated from the very penetrating X-radiation coming from external sources.

[5] Sur la reconnaissance dans les étoiles des couches successives de leur atmosphère et des variations périodiques de ces couches (*Comptes rendus*, 171, p. 451, 1920, by Deslandres). Recherches sur l'atmosphère des étoiles, Reconnaissance d'étoiles qui ont les mêmes brillantes de l'atmosphère que le soleil (*Comptes rendus*, 172, p. 405, 1921); Recherches sur l'atmosphère des étoiles, Reconnaissance de la couche supérieure dans quelques étoiles et comparaison avec le soleil (*Comptes rendus*, 172, p. 479, 1921); Recherches sur l'atmosphère des étoiles, Propriétés des étoiles qui ont les mêmes radiations et les mêmes couches de la chromosphère que le soleil (*Comptes rendus*, 175, p. 121, 1922, by Deslandres and Burson).

Burson and I intend to publish shortly some new results. In particular, we have discovered that, in certain giant stars, the lines H_3, K_3 of the upper stratum are displaced towards the red, and the lines H_2, K_2 of the middle stratum are displaced towards the violet, as in the case of the sun.

[6] The integrated spectrum is that which the sun would give if it were as far from us as the stars.

surface, produced, in the yellow stars, at a temperature of about 6000° C.; but the ionisation from this cause is the same in the two types of star. In order to explain the greater brightness of the giant stars, it is necessary to suppose that they contain another source of ionisation which is peculiar to them, or more important than it is in the dwarf stars. The principal supplementary cause appears to me to be a penetrating radiation emitted by the interior layers of the star; this radiation would be stronger in giant stars, which have greater masses, and therefore higher internal temperatures. In an example cited by Eddington[7] the temperature at the centre reaches 4,650,000° C., the mass being only one and a half times that of the sun. The wave-length of maximum energy for a black body at this temperature is 6 Å.U.—corresponding to an X-ray near the ultra-violet, and not very penetrating; but, according to the theory, the radiation extends much further towards the very short wave-lengths, the penetration of which is much greater; and the intensity of these extreme radiations increases with the temperature of the star. The emission of exceptionally penetrating radiations by giant stars is therefore admissible. Further, in the case of giant stars which are in the phase of increasing temperature, the atoms are dissociated, and their breaking-up is accompanied by an intense emission of α-, β-, and γ-rays. It should be remarked that recently certain rays of radium have been observed, much more penetrating than any previously known, the source of which must be in the very nucleus of the atom.

In the yellow stars, all these radiations, of very high frequency and of great penetrating power, form, in reality, only a very small part of the total radiation; but their remarkable electrical properties assign to them an important rôle in the electrical phenomena of stellar atmospheres. It is not, however, intended to assert that the existence of the radiations is proved, but it is very probable. As a matter of fact, we have a very imperfect knowledge of the properties of the material in the interior of a star near the surface and in the atmosphere; and, as often happens in astronomy, the deductions rest on wide extrapolations. In forming conclusions, great care must be exercised.

There has been a great deal of discussion on the nature of the solar surface. In my opinion, setting aside every theory and every explanation, the solar surface is a simple fact of experience; it is a surface of discontinuity, with a clear-cut boundary, such that the light emitted by the interior is much more intense than that given by the exterior. I give the name "atmosphere" to all that is outside this surface. The word "surface," however, should not be understood strictly in its geometrical sense: it implies, actually, a relatively thin luminous stratum which, at our distance from it, appears to have no thickness. The solar surface has often been described as a cloud, made up of incandescent liquid or solid particles. If this were so, in all the yellow stars having the same temperature, whether giant or dwarf, the pressure of the gases at the surface should be the same; but it has been objected that we have no knowledge of any matter which remains liquid at a temperature of 6000° C. The attractive optical theory of Schmidt also has been advocated: when thoroughly examined, however, it is found not to be applicable to the sun. Let us say simply that, from a cause still imperfectly understood, solar matter, probably gaseous, acquires suddenly, in a stratum called the *surface*, the emissive power of a solid body, and there are good reasons for believing that the pressure of the gas in this stratum varies little from one yellow star to another, so long as the temperature of the strata is the same.[8] These considerations support the idea of the very penetrating emission postulated in the giant stars.

III. These special rays, remarkable for their penetration and their electrical action, have been known or suspected only for a few years; but their importance is already declaring itself, and I think that they will furnish the key to several of the still numerous enigmas presented by the celestial bodies.

The matter of the sun, then, probably emits X-, ultra-X-, and corpuscular rays, with an intensity which increases from the surface to the centre. In the spots, which are in general cavities, the emission is strongest in the centre, and, because of its greater penetration, is able to persist in spite of local absorption and the diminution of the ordinary light. Similarly, if the earth gives rise to a radiation of this kind, its intensity should be greater at the poles than at the equator.

These radiations should be borne in mind especially in considering the nebulæ—in particular, the gaseous and planetary nebulæ. A nebula with a stellar nucleus may be considered as a star the atmosphere of which is extraordinarily developed and contains special gases, such as nebulium. The conditions are then, on a very large scale, those of the yellow giant stars examined above, the atmospheres of which are particularly bright; and the same causes may be held to account for the luminosity in the nebulous atmosphere. Moreover, the nucleus, being of the Wolf-Rayet type, is one of the hottest stars: it is conceivable that the maximum emission takes place, for the nucleus in the X-region, and for the nebula, properly so called, in the visible region. The luminosity is produced by radiations of very short wave-length, but with a habitual tendency towards longer wave-lengths. Lastly, the nucleus may contain a large proportion of radio-active bodies. These ideas were put forward in 1902, and Russell has recently developed similar hypotheses.[9]

If a nebula has no nucleus, we may suppose that there are radio-active bodies disseminated in the space which it occupies. Similarly, in the lower part of our atmosphere, a considerable fraction of the ions formed per second is due to the gaseous emanations of radium and rhodium spread abroad in the air. If there were a greater proportion of radio-active bodies, the gas might become luminous.

To sum up, the penetrating radiations are interesting in the highest degree, and it is important that we

[7] *Astrophysical Journal*, 48, pp. 205-214, 1918.

[8] If the pressure at the surface is less in the giant stars, the average density of which is smaller, we can explain partly the stronger ionisation in these stars by the very interesting theory of M. N. Saha. This theory deals with effects due to temperature alone, and the point of view is different. In a giant star the pressure gradient is evidently less steep, but the average pressure in the middle stratum, and especially in the upper stratum, may be very nearly the same as in a dwarf star. It should be noted that the greater proportion of the positive ions of calcium in the upper atmosphere may also be explained simply by the repulsion due to the positive charge on the star.

[9] Deslandres, *Comptes rendus*, 134, pp. 1134 and 1486, 1902; Russell, Proceedings of the U.S. National Academy of Sciences, 5, No. 10, p. 410.

should study, immediately and as thoroughly as possible, those which are within our reach and are disclosed by Kohlhörster's experiment. The ionisation of gases in a sealed vessel has been measured in our atmosphere up to an altitude of 9000 metres; but it is necessary to repeat the experiment at several places on the earth, and to extend it up to the greatest altitudes reached in exploring balloons. The undertaking, it is true, will be costly; it devolves especially on the countries which have the greatest resources. I proposed, at the International Astronomical Congress, which met at Rome in May last, that there should be international co-operation for the complete study of the electrical phenomena of our atmosphere at great altitudes. The determination of the exact origin of these penetrating radiations is one of the most important problems confronting physical astronomy at the present time.

The Desensitising of Silver Bromide-Gelatin Plates.

By Dr. T. SLATER PRICE.

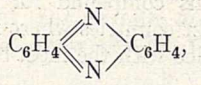
IT is well known that the more sensitive a photographic plate is, the greater the care that has to be taken with respect to the actinic value of the light used in the dark room during the operation of development. The less the amount of light used, the more difficult it becomes to control the result; and it is therefore not to be wondered at that attempts have been made to modify the course of procedure in such a way that the exposed plate could be developed in a fairly good light. During the last few years various so-called "desensitisers" have been put on the market; when the exposed plate is either treated with a solution of these before development, or when some of the desensitiser is added to the developer, the plate can safely be developed in a light which would otherwise give rise to very bad fogging.

At the recent Deuxième Congres de la Chimie Industrielle, M. A. Seyewetz gave an interesting account of the subject, and his paper has been published in *Chimie et Industrie*, 1922, 8, 308-311.

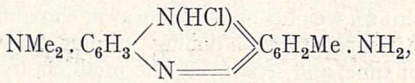
A. and L. Lumière and Seyewetz, in 1907, were the first to notice that a silver bromide-gelatin plate becomes less sensitive when bathed in a solution of a developer such as diaminophenol, quinol, or pyrogallol. The loss in sensitivity varied slightly in different regions of the spectrum, but was most marked in the yellow and green. At a much later date, in 1920, Lüppo-Cramer noticed that the desensitising action was much increased when sulphite was omitted from the developing solution, that is, when the developer was used in such a condition that it readily oxidised in the air. After immersion for a minute in a 0·05 per cent. solution of the developer the plate could be developed in yellow light without fogging. Such a method of desensitisation was insufficient, however, for orthochromatic and panchromatic plates, and moreover, the solutions underwent rapid alteration in the absence of sulphite.

Desensitisation only became a practical proposition when Lüppo-Cramer, in 1921, discovered the pronounced desensitising action of the azine dye, Phenosafranine, and also of other dyes belonging to the same class, on ordinary and panchromatic plates. Contrary to what one would at first suppose to be the case, these dyes do not owe their action to functioning as colour screens; solutions of Phenosafranine transmit red and violet light, and yet they desensitise plates for these regions of the spectrum. Also, the violet safranines desensitise just as do the red safranines, although their absorption spectra are very different. These facts are very similar to those observed with sensitisers, and Lüppo-Cramer has shown that certain optical sensitisers for one haloid salt of silver may act as desensitisers for other salts. For example, Erythrosin, Rhodamine B, Pinachrome, and Pinacyanol, which are the best sensitisers for chloride and bromide of silver, when used in very dilute solutions (1 : 20000) diminish the sensitivity of silver iodide-gelatin plates from 6 to 16 times; Phenosafranine gives a reduction in sensitivity of about 40 times.

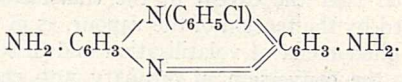
Lumière and Seyewetz have made investigations to see if there is any relation between the desensitising power of a substance and its chemical constitution. They have found, with the safranines, that the presence of the characteristic phenazine grouping,



is insufficient in itself, and that amino-groups substituted in the benzene nuclei must also be present. Thus Neutral Red, which is a Eurhoidine having the formula



has desensitising properties approximating to those of Phenosafranine, which is



Safranines in which one of the amino-groups has been eliminated, as in aposafranine, or in which this group is replaced by oxygen, as in the safranones, are notably less active as desensitisers. If both of the amino-groups are replaced by O or OH, as in safranol, there is no longer any desensitising action. The acetylation of the amino-group, or its diazotisation and copulation with a phenol, destroys the desensitising properties of the safranine, while the replacement by ethyl of the phenyl group attached to the nitrogen has no effect. The Indulines, which are near cousins to the safranines, as also the thiazines and the oxazines, do not act as desensitisers. On the other hand, other colouring matters which have very different constitutions from that of safranine as, for example, picric acid, Indian Yellow, Chrysoidine, etc., are weak desensitisers; Aurantia (1 : 1000) desensitises as actively as safranine for the blue rays, but is noticeably less active towards other parts of the spectrum.

It follows from the above that there does not seem

to be a definite relation between the constitution of the dye and its desensitising properties. The conditions are thus very similar to those which hold in the case of sensitisers.

The great drawback to the use of Phenosafranine is its pronounced staining properties; it can only be removed from the gelatin film by prolonged washing. König has recently put on the market a desensitiser, Pinakryptol, which is claimed to be as active as Phenosafranine, but which neither stains gelatin, celluloid, nor the skin, although it gives a deep green solution.

A satisfactory explanation of the desensitising action of these substances is still wanting. Lüppo-Cramer claims that the phenomenon is connected with the formation of an oxidation product of the dye. Lumière and Seyewetz have shown, however, that if an unexposed plate is bathed in a solution of Phenosafranine it recovers its original sensitivity after being washed sufficiently long to remove the colouring matter. It is probable, according to Lumière and Seyewetz, that any oxidation product of the dye would be adsorbed by the silver bromide and not be removed by washing, so that the recovery in sensitivity would not be explicable on Lüppo-Cramer's theory.

Obituary.

Prof. Georges Lemoine.

M. GEORGES LEMOINE, professor of chemistry at the Polytechnic School, Paris, whose death at the age of eighty-one has just been announced, was born at Tonnere in 1841. He entered the Polytechnic School in 1858, and two years later became *Elève ingénieur* at the École des Ponts-et-Chaussées. He early devoted himself to the study of chemistry, and investigated the compounds of sulphur and phosphorus, one of which, the sesquisulphide of phosphorus, is now largely employed in the igniting composition of the lucifer match in place of ordinary phosphorus. The substitution of this compound for phosphorus—now compulsory in most countries where matches are made—has been attended with the most beneficial results in the industry, the "phossy jaw" of the match-worker, or necrosis of the facial bones, being practically a thing of the past.

Lemoine also studied the reciprocal transformation of the two best-known allotropes of phosphorus. By heating known weights of phosphorus in closed flasks at 440°, the temperature of boiling sulphur, for varying lengths of time, and separating the products by carbon disulphide, he was able to determine the influence of time and pressure on the direction and extent of the change. He showed that the extent of the transformation is determined by the tension of the vapour, as in the case of other phenomena of volatilisation and dissociation. *In vacuo*, the conversion of ordinary into red phosphorus becomes more and more rapid as the temperature is raised. The rapidity of the transformation varies with the amount of phosphorus used. At any given moment the rapidity depends not only upon the quantity of ordinary phosphorus remaining, but also upon the quantity of red phosphorus already formed. The phenomenon is pre-eminently one of vapour tension and depends upon the capacity of the vessel in which the transformation—which is never complete—is effected. These facts are now well known and are uniformly acted upon in the phosphorus industry.

Questions of chemical dynamics had always a certain measure of attraction for Lemoine, and although he was not a particularly prolific contributor to chemical literature, much of his published work is concerned with their investigation. One of the most important of these inquiries relates to the conditions of chemical equilibrium of hydriodic acid. This substance was chosen as suitable for the study of the general phenomena of chemical equilibrium for the reason that the constituent elements are monatomic; they combine, or dissociate, without change of volume (at the temperature of the experiment), and the thermal effects of combination are very slight. The aim of the investigation was to show that under given conditions of temperature and pressure, a mixture of the two constituent gases in given proportions will attain sooner or later a definite state of chemical equilibrium in which only a certain proportion of the hydriodic acid possible is actually formed, varying with the temperature, pressure, and proportions of the gases present, but always the same for the same conditions. The conditions studied were heat, pressure, mass, the action of porous bodies, of oxygen and of light. The main results have long since been incorporated into the general theory of chemical change, and call for no detailed account. At the time of their publication they constituted a notable and novel contribution to chemical dynamics.

It has long been known that mixed solutions of ferric chloride and oxalic acid are decomposed by light with the evolution of carbonic acid (Marchand, Jodin), and that the rate of decomposition depends on the intensity of the light. Lemoine studied this change with a view of determining how far it may be made the basis of an actinometric method. He found that for a given intensity, the evolution of gas is at first uniform, but that when about half the total quantity of carbon dioxide has been evolved, the rate of decomposition gradually diminishes. The greater the volume of the liquid, the longer is the time before decomposition slackens. When the two solutions are separately exposed to light for several hours and then mixed, decomposition takes place more rapidly than if the solutions had not been previously insolated. Dilution with water increases the change, due probably to hydrolysis of the ferric chloride. At ordinary temperatures the mixed solutions are practically unaffected in the dark. On heating, gas begins to be evolved at 50° and increases rapidly in amount as the temperature rises. The general course of the change is, however, very similar to the influence exercised by light and is affected apparently by the same conditions.

Lemoine occasionally worked at subjects of organic chemistry, such as the nature of the paraffin hydrocarbons and the dissociation of haloid compounds of olefines under the influence of heat and pressure, but organic chemistry had evidently few attractions for him, and his work in this special field was very limited and calls for no special comment.

Lemoine, having served the Polytechnic School, in various capacities, from 1871, was elected professor in 1897. He succeeded Friedel as a member of the chemistry section of the Academy of Sciences in 1899.

T. E. THORPE.

HOWARD FOX.

MR. HOWARD FOX, of Falmouth, died on November 15, in his eighty-sixth year. In the intervals of a busy commercial and consular career—the firm to which he belonged were appointed American Consuls by George Washington—he contributed very largely to our knowledge of the natural history of his native county, Cornwall, especially in the domain of geology. The record of his work is to be found in many papers published by the Royal Geological Society of Cornwall, of which he was president during the years 1893 and 1894, the Geological Society of London, the *Geological Magazine*, and other scientific institutions and journals. We can only refer to a few of his more important discoveries.

Mr. Fox traced the distribution of the Radiolarian (Codden Hill) Beds of the Lower Culm Series throughout the west of England; and, in collaboration with the late Dr. G. J. Hinde, studied the characters of these rocks and of their radiolaria. He also discovered the radiolarian cherts of Mullion Island, which belong to a much lower geological horizon. Among other fossils found by him is the notable *Pteroconus mirus*, probably allied to the pteropods, occurring in the supposed Lower Devonian rocks of Bedruthan Steps, north of Newquay, the younger stages of which are sometimes preserved in such a way as closely to resemble graptolites. He also published accounts of other Cornish fossils, relying on the help of specialists for their determination and description.

But Mr. Fox's interest was by no means confined to the fossiliferous rocks. He studied the igneous and metamorphic rocks of the Lizard peninsula and made himself familiar with every nook and corner of that rock-bound coast. By mapping a small portion of the sloping face of a cliff, on a scale much larger than that of any published map, he proved conclusively that the serpentine and hornblende-schist had been intimately interfolded; and, by observations on another portion of the coast, established the fact that certain rocks, apparently belonging to the "Granulitic Series," were intrusive in the surrounding schists. He also made the important discovery that the Man of War rocks, off Lizard Head, are mainly formed of a corrugated igneous gneiss, quite different from any rock occurring on the mainland.

In petrology and mineralogy, as in palæontology, Mr. Fox availed himself of the help of specialists, and all those who were thus brought into personal contact with him were captivated by his geniality and stimulated by his enthusiasm.

LORD SUDELEY, F.R.S.

CHARLES DOUGLAS RICHARD HANBURY-TRACY, fourth Baron Sudeley, whose death on December 9, in his eighty-third year, will be regretted in many circles, was elected a fellow of the Royal Society in 1888, in recognition of his services to science as chairman of the British Commission to the Electrical Exhibition at Vienna in 1883. Of late years, Lord Sudeley persistently advocated in the House of Lords and in the Press the increased use of our museums and picture-galleries for the education and recreation (in the highest sense) of the public. In 1910, struck by the value of a demonstrator engaged by the Science Committee at the Japano-British Exhibition, he urged that similar guide-lecturers should be attached to our national museums. The Natural History Museum was the first to adopt the suggestion, and now, thanks to Lord Sudeley's untiring efforts, all the larger public museums have one or more of these popular adjuncts. Next he actively promoted the production and sale of picture postcards by Government museums. Lastly, as shown by his article in the *Nineteenth Century* for October, he was preparing to move for the appointment of a Royal Commission to consider the better working of the museums of this country.

MR. HERBERT WOODVILLE MILLER, who died on December 4, was one of the pioneers of electric lighting in this country. In 1886 he was appointed to assist Crompton and Co. in working out the system of electric light distribution in the West End of London which they had successfully installed in Vienna. By 1899 it was evident that stations centrally situated in populous districts were unsuitable to meet a growing demand, and Miller therefore designed and carried out the power station at Wood-lane which supplies the Kensington and Knightsbridge Company and the Notting Hill Co. He was engineer and manager of the Kensington Co.; the station beneath the Albert Hall is an excellent example of an accumulator station. He served on several committees of the International Electrotechnical Commission, and his thorough knowledge of electrotechnical subjects made him a most useful member of the editing committee of the British Engineering Standards Association.

THE *Chemiker Zeitung* of November 23 announces the death on November 20 of Prof. August Horstmann, at the age of eighty. Prof. Horstmann was the first to show the applicability of the laws of thermodynamics to chemical problems, his first paper on this subject being published in the *Berichte* in 1869. His other work was mainly in this direction, and was concerned with problems of dissociation, the determination of vapour densities and vapour pressures, specific heats, and heats of reaction. He was therefore the pioneer in a branch of physical chemistry which has since been developed particularly by Van't Hoff and Nernst. For some years Horstmann was professor emeritus of theoretical chemistry in the University of Heidelberg.

WE learn from *Science* with much regret of the death, on November 1, of Dr. R. W. Willson, emeritus professor of astronomy at Harvard University, at the age of sixty-nine years.

Current Topics and Events.

BROADCASTING has now been carried on for some time at the Trafford Park works of the Metropolitan-Vickers Electrical Co., Ltd., on behalf of the British Broadcasting Company, and on December 15, representatives of the Press were invited to inspect the equipment of the station and to listen to a short, typical broadcasting programme. The present arrangements are of a somewhat temporary nature, made with the view of gaining experience, and it is expected in course of time to improve both the technique of transmission and reception, and the quality of the programmes. In a short address, Mr. A. P. M. Fleming expressed his view that wireless telephony has an important future as an educational and social feature of daily life, and he hoped that the public would not take the present transmissions as the best the Broadcasting Company expected to be able to give them. Research is being carried on actively to improve the faithfulness of reproduction of music and speech. It has been found necessary to select carefully the kind of voice which is best suited to the vagaries of the microphone, and it was foreshadowed that a special wireless studio technique will have to be developed, for which special training of the performers will be required. There is no doubt that the transmission of some items leaves much to be desired, but if a microphone or a substitute for it could be developed, having no prejudice for any particular sound, a considerable improvement would be effected. The simplest sounds, such as in solo pieces, give the best results, and it would seem that when a number of voices or instruments are operating simultaneously, the microphone is not able to deal faithfully with the various sounds.

THE annual exhibition of scientific apparatus organised by the Physical Society of London and the Optical Society will be held on Wednesday and Thursday, January 3 and 4, from 3 to 6 P.M. and from 7 to 10 P.M., at the Imperial College of Science, South Kensington. Mr. W. Gamble will lecture on "Reproduction of Colour by Photographic Processes" at 4 P.M. on January 3 and at 8 P.M. on January 4; Prof. E. G. Coker will lecture on "Recent Photo-Elastic Researches on Engineering Problems" at 8 P.M. on January 3 and at 4 P.M. on January 4. All the lectures will be illustrated by experiments. More than fifty firms are exhibiting apparatus and a number of experimental demonstrations have been arranged. Invitations to attend the exhibition have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Faraday Society, the Wireless Society of London, and the Röntgen Society. Members of these societies should apply to the secretary of the society to which they belong for admission tickets. Others interested should apply direct to Mr. F. E. Smith, hon. secretary of the Physical Society, Admiralty Research Laboratory, Teddington, Middlesex.

A JOURNEY of more than seven thousand miles from Peking to India was completed early in December when General Sir George Pereira arrived at Calcutta. The *Times* gives some details of his route. Leaving Peking nearly two years ago, Sir G. Pereira went by rail to Taiyuen. From there he made for Hoyang, crossing the Hoang-ho, and reached Sianfu, the ancient Chinese capital in the Wei valley. The route was thence across the Tsinling mountains to Chengtu, in the Szechwan basin, and up the valley of the Min into the Kansu province. Passing through Siningfu and Tenkar, Sir G. Pereira entered Tibet on a little known route. The track lay at an altitude of about 12,000 ft. through an arid country in which supplies were scanty and the weather conditions somewhat trying. The Yangtse was crossed at Giergundo and eventually Lhasa was reached in October. From Lhasa to Darjeeling a fairly well known route was followed. One of the most interesting facts mentioned in the *Times* article relates to the so-called Amnemachin range in the bend of the Hoang river in north-eastern Tibet. This is a solitary snow-capped mountain and not a range. Its height has not been measured, but Sir G. Pereira suggests that it may prove to be the highest mountain in the world. About half the entire journey was done on foot, and even in the most brigand-infested regions the travellers were never attacked.

THE Munro lectures in anthropology and prehistoric archæology for 1922 in the University of Edinburgh have been delivered in November and December by Prof. R. A. S. Macalister, of University College, Dublin, on the subject of "Rock Carvings and Inscribed Symbols of the Neolithic and Bronze Ages." Starting with certain Spanish stones presenting linear devices that could be proved to be degenerate copies of the human figure and other concrete objects, Prof. Macalister developed the thesis that an explanation of this kind would account for the enigmatical devices, such as concentric rings, found so often in Great Britain and Ireland on exposed rock faces, standing stones, and slabs built into dolmens and chambered cairns. British monuments were brought into relation with similar objects in wider archæological areas; by the extended use of the comparative method, much light has been thrown on symbols and devices the meanings of which have been the subject of much vague conjecture. The female figure carved in some French neolithic tomb chambers is a goddess of death, and representations of her, which might degenerate till only two eyes or even a single one remained, can be recognised on stones forming part of funereal structures in our own islands. Such structures, as Irish folk-lore bears witness, were visited for superstitious purposes by the living, and the cup marks common on the stones forming them were intended for real or simulated libations offered to the spirits of the place. Such cup marks on exposed rock faces in the open might be explained on the hypothesis that religious sanctuaries of perishable materials had once existed in their vicinity. The same system of interpretation was applied to other marks and devices of a similar kind.

THE application of eugenic principles to the improvement of the human race is discussed by Dr. J. G. Adami in an address before the International Eugenics Congress in New York, published in the *Eugenics Review* for October 1922. Dr. Adami points out that eugenic measures hitherto suggested or adopted have been chiefly negative in character, aiming at preventing a progressive increase in the number of defectives in the population. He advocates an important measure of practical positive eugenic value, which the Eugenics Education Society would do well to consider seriously. Dr. Adami's suggestion arises out of his experience as a member of the scientific committee of the Advisory Council of the Ministry of National Service during the war—a committee which analysed the physical state of the manhood of Britain during the last year of the war, examining the records of nearly two and a half million men. That a high percentage in many industrial areas were found to be physically unfit is well known. The eminent services of American psychologists in applying intelligence tests successfully to American recruits are now also widely recognised. Dr. Adami's suggestion is based upon these two results. It is, that eugenists organise centres throughout the country where young persons of eighteen could be given voluntary tests of physical fitness and intelligence, the lists of those who attain standard A being published. In this way a true aristocracy of mental and physical fitness would arise which would be of the utmost value to the nation.

IN the second of his Chadwick public lectures on "Relative Values in Public Health," delivered on December 14, Sir Arthur Newsholme referred to the relative weight of mortality of different diseases in relation to their degree of preventibility. He stated that tuberculosis caused ten deaths for every three due to the acute notifiable diseases. Tuberculosis is a too little recognised cause of death in childhood, and its prevention is an essential part of child welfare work, the foundation of all public health work. The amount spent on public health in large English and American towns averages about 5*s*. *per capita* per annum, or in England, from 4 to 8 per cent. of the total rates collected *per capita*. Sir Arthur Newsholme is of opinion that the greatest and quickest return in health for money expended—outside the ordinary sanitation of a city—is in respect of work on maternity and child welfare, and on the prevention and treatment of tuberculosis and venereal diseases.

A CONFERENCE on Industrial Fuel will be held next spring in Paris under the patronage of M. Le Trocquer, Minister of Public Works, and with the support of the Société d'Encouragement pour l'Industrie Nationale. The proposed agenda include discussions on the assay of various fuels, rules for testing boilers, producers, and furnaces, standard methods of making measurements required in controlling the use of fuel, construction of furnaces, use of pulverised fuel and of low-grade fuels. Any communications concerning the conference should be addressed to the Président de la Commission d'Utilisation du Combustible, Ministère des Travaux Publics, 246 boulevard Saint-Germain, Paris. Notices and reports concerning the conference will be published in *Chaleur et Industrie*.

ACCORDING to a statement in the *Meteorological Magazine* for November, daily weather charts of the Northern Hemisphere are now being prepared by the Meteorological Office each day. The charts are exhibited in a ground-floor window in the Air Ministry, Kingsway, and show barometric pressure and wind for an area covering roughly the temperate zone from the Pacific coast of America in the west to the western borders of Asia in the east. In an adjoining position, at the Air Ministry, a large blackboard map of weather conditions in north-west Europe is shown. These maps giving the existing weather conditions over such a large area of the earth's surface will doubtless aid in the improvement of weather forecasting.

No. 24 of the Reprint and Circular Series of the National Research Council, Washington, which has been received, is a pamphlet by C. J. West and H. Gilman dealing with "Organomagnesium Compounds in Synthetic Chemistry." It contains a bibliography of 1485 papers, as well as an exhaustive index. Monographs of this type are very useful to investigators, and the National Research Council in America is doing valuable work in arranging for their publication. The Research Information Service of the Council is prepared to supply information about scientific methods and results, and their applications in engineering, industry, and education. No charge is made for replies to inquiries which do not necessitate a special search for information (there are extensive files already assembled); those requests for data which would necessitate the expenditure of a considerable time for accumulation are acknowledged, with an estimate of the cost. The Service has a staff of specialists, and is in touch with current scientific work of all kinds. It is clear that such an organisation must be of very great service to investigators in the United States, and the Scientific and Industrial Research Department in this country might consider the formation of a similar organisation in this country.

THE Mann Juvenile Lectures of the Royal Society of Arts will be delivered on Wednesdays, January 3 and 10, by Mr. C. R. Darling, who will take as his subject "The Spectrum, its Colours, Lines, and Invisible Parts, and some of its Industrial Applications." Admission is by ticket only.

THE Dorset Field Club is offering the Cecil medal and prize of 10*l*. for the best paper on "Recent Advances in Chemistry as applied to Agriculture, with special reference to Dorset Conditions." The competition is open to persons aged between 17 and 35, either born in Dorset, or resident in that county for one year between May 1, 1921 and 1923. Further particulars may be obtained from Mr. H. Pouncy, Midland Bank Chambers, Dorchester.

DR. R. A. HOUSTOUN, of the University of Glasgow, has in the press, for publication by Messrs. Longmans

and Co., "Light and Colour," a book intended for the general public, and dealing in a popular way with the discovery of the spectrum, the nature of light, the Einstein deflection of light, the quantum, invisible rays, spectroscopy and the constitution of the atom, the primary colours, colour blindness, colour photography, artificial illumination, photochemistry, phototherapy, and the psychology of colour. Another book in the same publishers' announcement list is "Gas Manufacture," by Dr. W. B. Davidson, in which the subjects of gas engineering and gas supply are fully dealt with from the chemical standpoint. The book aims at meeting the demand of the gas engineer for a more intimate acquaintance with the chemistry and physical chemistry of gases than he may already possess, and is intended as a textbook for the young student of gas engineering.

THE first part of Messrs. Wheldon and Wesley's illustrated catalogue of recent purchases of rare books now offered for sale, which is issued this month, is remarkable for the number of rare and interesting books on herbal and garden literature which it contains. There are also books on early medicine, birds, shells, and other subjects, which are, in many cases, fully illustrated. The transcription of the titles has been very carefully done and the bibliographic details will be of value to lovers of books. The collection contains a first edition of Peregrinus "De Magnete" published in 1558 and also the first English edition of Harvey's account of his discovery of the circulation of the blood, with the title "Anatomical exercises concerning the motion of the heart and blood." In addition, the collection contains first editions of Jenner's accounts of his discovery of vaccination, in regard to which it is said that he was advised not to publish them in the Philosophical Transactions lest they should injure his reputation as author of a paper, already published therein, on the cuckoo.

Our Astronomical Column.

RELATIVITY AND SPACE.—The *Irish Ecclesiastical Record* of November 22 contains an article on the subject by Rev. H. V. Gill, S.J. It is intended for general readers, and opens with an explanation of the reasons for the introduction of time as a fourth dimension. From this the author goes on to consider the nature of space, and comments on the difficulty of conceiving that a mere vacuum can be modified by adjacent matter, and also how matter could exert its influence over remote matter across a vacuum without involving "action at a distance" which Einstein rejects. He then quotes Einstein's "Sidelights on Relativity," an English translation of two lectures delivered in 1920 and 1921. Many of Einstein's followers in England have been inclined to abandon the conception of the æther, but he himself states "according to the general theory of relativity, space is endowed with physical qualities; in this sense, therefore, there exists an ether . . . space without ether is unthinkable . . . there would be no propagation of light. . . . But it may not be thought of as . . . consisting of parts which may be tracked through time." It is useful to direct attention to this clear statement of Einstein's view, and it would help matters if those who reject the æther conception were to indicate how they surmount the difficulties that are pointed out.

THE MASS AND PROPER MOTION OF 40 ERIDANI.—This interesting triple system was discovered by Sir W. Herschel in 1783. A is of magnitude 4·5, B 9·4, C 10·8. The distance AB is 83″ and BC is 3″. All three have the great proper motion of 4″ per annum in position-angle 213°. Prof. G. Abetti makes a study of the system in vol. 30 of the Proceedings of the Academia dei Lincei. He adopts the parallax 0″·219, which makes the absolute magnitudes 6·2, 11·1, 12·5. Using Doolittle's elements, which give a period 180 years to BC, the masses in terms of the Sun are found to be B = 0·20, C = 0·12. C is the least massive star yet measured; this position was previously held by the companion of Krüger 60, mass 0·19. B is a very anomalous star, since it appears to be of spectral type A in spite of its small luminosity; recent photographs at the Lick Observatory indicate that C is of type M*d*, with the H_β line bright.

The velocity of the system at right angles to the line of sight is 88 km./sec.

It is of interest to compare this system with σ Coronæ, also investigated by Prof. Abetti. The combined mass is here 5·57 times that of the Sun. The evidence as to relative masses is contradictory; he provisionally assigns equal masses, and deduces for the densities 0·34 and 0·99 in terms of the Sun. The spectral types of both are F9.

DISTRIBUTION OF STARS OF SAME SPECTRAL CLASS.—The study of the distribution of stars of similar spectra is very important, especially if it leads to some definite law regarding their grouping with regard to the Galaxy. The special case of the B-type stars is discussed in a recent circular (No. 239) of the Harvard College Observatory, by Dr. H. Shapley and Miss A. J. Cannon. It was thought at first that very few B-type stars, fainter than the seventh magnitude, existed, and that these formed quite a local system. The authors find that, while the former does not now hold good, the bright B stars do indicate the existence of a local star cloud. The results of the discussion are plotted in four figures showing the galactic distribution of the stars, the figures being confined to stars brighter than 5·26 magnitude, stars between magnitudes 5·26 and 6·25, between magnitudes 6·26 and 7·25, and finally between magnitudes 7·25 and 8·25. The result of the investigation clearly shows that the fainter the B stars are the more they are situated along the galactic equator. Quite a considerable number of stars are used for each figure, namely 346, 367, 564, and 719. Forming median galactic latitudes for each thirty degrees of longitude the highest values in each figure are −15°·5, −15°·0, −11°·5, and −3°·5. More than 90 per cent. of the fainter B stars are within ten degrees of the galactic equator. A table is given showing all known B stars to the apparent magnitude 8·25 which are in higher galactic latitude than 50°.

Research Items.

MAMMALS AND BIRDS FROM HAITIAN CAVES.—A small collection of bones of mammals and birds were obtained in 1921 by Mr. J. S. Brown and Mr. W. S. Burbank during geological studies under the U.S. Geological Survey for the Republic of Haiti, from two caves situated between 3 and 4 kilometres N.E. of St. Michel and 600 metres above sea-level. These bones have now been described respectively by Mr. G. S. Miller, junr., and Mr. A. Wetmore (Smithsonian Miscell. Coll. vol. lxxiv. Nos. 3 and 4). Rodents were the more plentiful among the mammals, the most abundant being *Isolobodon portoricensis*, Allen, which also occurs in Porto Rico and the Virgin Islands. Two new genera are established: Alphætreus, with *A. montanus*, n.sp., as genotype, which is allied to Plagiodontia and Isolobodon; and Ithydontia, genotype *I. levir*, n.sp., allied to Isolobodon. *Brotomys voratus*, Miller, was also present as well as a ground sloth, doubtfully referred to the genus Megalocuus, and a few unidentified mammals, while man was represented by the head of a femur and an implement made of chert. Early man, however, though known to have used these rodents as food, does not appear in this case to have been responsible for the presence of their remains in the caves. Their importation would seem to be due to a huge extinct barn owl, which Mr. Wetmore names *Tyto ostologa*, n.sp. Possibly the *Chæmepelia passerina*, *Crotophaga ani*, and *Tolmachus gabbii*, also present in the caves, were further victims of the owl.

AN INDIAN POND-SNAIL.—Dr. N. Annandale and Maj. R. B. Seymour Sewell have published (Rec. Ind. Mus. xxii. pp. 215-292) a memoir on the banded pond-snail of India (*Vivipara bengalensis*). The latter author contributes an account of the anatomy and bionomics; Dr. Annandale deals with the systematic features and with the histology of the edge of the mantle and the external ornamentation of the shell. Spiral rows of horny chætæ and fine spiral ridges on the periostracum are present, and, indeed, best developed in the fully formed embryo, and disappear, as a rule, in the full-grown shell. In those shells ornamented with bands of dark pigment, the latter are periostracal in origin and, with the test sculpture, correspond in position with the rows of chætæ and the spiral ridges. The free edge of the mantle bears at least three digitiform processes,—other secondary ones may be present,—and the processes correspond in position with and are concerned in moulding the periostracal sculpture, the colour pattern and the sculpture of the test. In the systematic account eleven races of the species are recognised. The parasites and incolæ met with are recorded and include spirochætes and ciliates in the alimentary canal, rarely sporocysts and developing cercariæ, but frequently encysted cercariæ of two species.

MEADOW GRASSES.—In an article on the comparative morphology and development of *Poa pratensis*, *Phleum pratense and Setaria italica*, in the *Japanese Journal of Botany*, vol. i. No. 2, pp. 53-85 (1922), Makoto Nishimura has devoted special attention to the phenomena attending the germination of these grasses in comparison with *Agrostis alba*. In *Poa pratensis* the percentage of germination was lowest, 50 per cent., and the process extended over the longest time, while in Setaria 95 per cent. of the seeds were viable, and started into growth very rapidly. Absorbing hairs were developed on the coleorhiza at an early stage, and continued functioning until long after the elongation of the roots; similar hairs were also produced from the epiblast. The various stages of development during the first two seasons of growth have been followed out, being characteristic in each case. Setaria shows the greatest depth and spread of roots, but the other species exhibit more branching of a larger number of extra nodal roots, thus attaining the same end. Each bud derived from the stool is usually associated with two crown roots, in which case the bud development is normal, but when only one crown root is present the bud fails to grow out. In all three species the inflorescence is a spike, and the embryos are of the usual type. In *Poa pratensis*, however, polyembryony is frequent, and arises in various ways, the various types of abnormality apparently being due to the sting of an insect. A useful bibliography and a series of clear plates add to the value of this communication.

BRAZILIAN METEOROLOGICAL SERVICE.—Yearly volumes of meteorological observations at Rio de Janeiro and at numerous stations in Brazil for the three years 1912, 1913, and 1914, under the superintendence of Señor Sampaio Ferraz, have recently been received. Each volume contains about 100 pages of tabular matter. The observations at Rio de Janeiro are similar in detail to those made at European observatories, hourly values being published of rainfall and sunshine, and detailed monthly results of general meteorological phenomena. In many cases the results are compared with the mean results for more than thirty years. The observations for the provinces are on a uniform scale and the monthly and yearly results can be combined or compared with others in different parts of the world. Wind frequency is regularly recorded and also the mean velocity, so that knowledge of surface winds is readily available for aircraft; the results are in every way a valuable addition to the world's meteorology. Each volume contains tables and maps showing the rainfall for the first six months and second six months of the year, and for the year as a whole, at stations covering Brazil, the various falls being shown in the maps by degrees of shading. Generally the two halves of the year have very different rainfalls. In each of the three years the total rainfall reached 118 inches at one or more stations; in 1914 there were four stations with a rainfall exceeding 118 in., the maximum being 3596 mm., or 142 in., at Remate de Males, Amazonas; this place had the heaviest rainfall in two of the three years. The total annual rainfall at Rio de Janeiro ranged from 36 to 38 inches in the three years.

HEAT CONDUCTIVITIES OF METALS UNDER PRESSURE.—Volume 15 of Contributions from the Jefferson and the Cruft Laboratories of Harvard University is dedicated to Prof. E. H. Hall, who for more than forty years has been a member of the Harvard faculty. The volume is a reprint of 31 papers by the staff and students which have appeared in scientific and technical journals and proceedings of societies during 1921 and 1922. Eight of these papers are by Prof. Duane and his pupils and deal with various properties of X-rays. Six are by Prof. Bridgman, and one of these deals with high-pressure experiments. The heat conductivities of eleven metals have been measured up to pressures of about 12,000 atmospheres by the bar or by the cylinder method. The rate of change with increase of pressure is fairly uniform for each metal, the total change for the maximum pressure being an increase for lead of 21 per cent., tin 15 per cent., zinc 2·5 per cent., and a decrease for iron of 0·3 per cent., copper 9 per cent., silver 4 per cent., nickel 14 per cent., platinum 2 per cent., bismuth 38 per cent., and antimony 25 per cent. Between these results and those obtained previously by Lussana there are serious differences. The ratio of the thermal to the electrical conductivity is considerably changed by pressure, a result not in accord with the electron theory of conduction.

Photosynthesis.

GREAT interest was taken in the joint discussion on photosynthesis between the sections of Chemistry and Botany during the British Association meeting at Hull. The discussion was presided over by Prof. H. H. Dixon, who was supported by Principal J. C. Irvine.

The discussion was opened by Dr. F. F. Blackman with a paper entitled "The biochemical problems of chloroplastic photosynthesis." Dr. Blackman said that as the next two speakers were to take up the special aspects of photochemistry and energetics he would restrict his remarks to certain other aspects. He would deal with the active system of photosynthesis and its organisation in the living cell and bring together the evidence which supported the thesis that here we have to do, not with a simple photochemical reaction, but with a complex system in which other components, that might be described provisionally as protoplasmic components, play an essential part.

The first point developed was that there are numerous lower plants which obtain all their carbon by the reduction of CO_2 in the dark without the intervention of radiation, and synthesise all their organic compounds from this source. Here there is utilised the chemical energy of the oxidation of nitrogen, sulphur, or their compounds. In these chemosynthetic organisms there is not a gain of energy, but only an exchange of oxidation potential: the gain to the organism is substance for growth. It may be asked whether this power is entirely absent in the higher plants and what connexion the chemical machinery of it has with the chemistry of photoreduction of CO_2.

The second point was the fact, now thoroughly investigated, that the seedlings of many plants at a stage when they have developed chlorophyll to a full green colour may be quite incapable of reducing CO_2 in light, and give out as much CO_2 from respiration in light as in darkness. Some other component or property lags behind the chlorophyll in its development, and the slow, steady rate of its development is the same in darkness or light.

A third point of interest is the efficiency of photosynthesis in the golden-leaved varieties of certain shrubs. Here the amount of chlorophyll may be as low as 4 per cent. of the normal green form and yet under medium conditions the reduction of CO_2 may be as great as in green leaves. The fact has been established that the golden leaf needs more light than the green to carry out the same rate of reduction of CO_2. It looks as if with these extreme variations of chlorophyll what counted was the cube root of the amount of chlorophyll present—a single dimension of the colloid micellæ and not the total mass—which may be taken as an indication of the organisation of the system.

A fourth point considered was the relation of photosynthesis to temperature. It is established that for a high rate of photosynthesis it is not sufficient to have intense radiation and concentrated CO_2, but a high temperature is also essential. For each temperature there is a specific maximum of activity which cannot be exceeded unless the temperature is raised. The specific maximal values increase rapidly for rising temperature, having a temperature coefficient of about 2 for a rise of 10° C. This temperature relation is quite different from that of a pure photochemical reaction, and it provides a further indication that we have to deal with a complex system in which dark reactions may play a controlling part.

The fifth point to be raised had to do with the organisation of the active system. Warburg in investigating the action of the narcotic phenylurethane upon the rate of photosynthesis finds that the process undergoes great depression of rate with perfect recovery on removal of the narcotic. The relation of the depression to the external concentration of the drug gives a typical adsorption isotherm, indicating that the narcotic acts by adsorption on a surface from which it displaces temporarily some reactant substance of the active photosynthetic system.

Taking all these pieces of evidence together, Dr. Blackman considered that we are forced to conclude that the chloroplast contains an active system of several components related together in a complex organisation.

Prof. E. C. C. Baly then presented the results of experimental work on photosynthesis carried out at Liverpool. The conversion of a substance A into substance B might, he said, be represented as the sum of the three equations:

$$\begin{aligned} A + E &= A' \\ A' &= B' + F \\ B' &= B + G \end{aligned}$$

where E, F, and G are quantities of energy and A′ and B′ represent the reactive forms of A and B. The reaction is exo- or endo-thermic according as $F + G - E$ is positive or negative. In any case a quantity of energy, E, must be supplied in order to start the reaction, and this may be done by means of (1) heat, (2) light, or (3) a material catalyst. Now the energy can only be supplied in "quanta," and if E is large, only the use of radiation of short wave-length makes the number of "quanta" to be introduced sufficiently small to be practicable. For the conversion of a molecule of carbonic acid into formaldehyde and oxygen 150,000 calories are necessary, and this can be supplied in a single quantum by radiation at wave-length 200$\mu\mu$. Carbonic acid has an absorption band at this frequency and formaldehyde ought therefore to be produced when a solution of CO_2 in water is exposed to ultra-violet light. This has now been shown to take place.

In order to bring about the reaction by means of *visible* light it is necessary to have present a coloured substance with basic properties, and Malachite Green has been found to fulfil the conditions. There seems little doubt that the formation of formaldehyde in the leaf takes the following course:

i. Chlorophyll A + H_2CO_3 + light = Chlorophyll B + CH_2O.
ii. Chlorophyll B + Carotin = Chlorophyll A + Xanthophyll.
iii. Xanthophyll + light = Carotin + Oxygen.

The photosynthesised formaldehyde is extraordinarily reactive and is best represented by the formula CHOH. It is polymerised rapidly to a mixture of carbohydrates, in which are found hexoses (20 per cent.), cellulose, and cane-sugar. In the presence of nitrite it is converted into formhydroxamic acid and hence into amino-acids and a mixture of cyclic bases in which pyrrole, pyrrolidine, pyridine, coniine and glyoxaline have been detected. The active (energised) forms of the aminoacids are the immediate source of proteins.

Mr. G. E. Briggs described some experiments to determine the relation between the radiant energy absorbed and the carbon dioxide assimilated by the green leaf (*Phaseolus vulgaris*) in different parts of the visible spectrum. For three different parts of the spectrum the carbon dioxide assimilated was measured, and the energy absorbed by chlorophyll *a*

and chlorophyll *b* was estimated from data obtained, due allowance being made for the energy diffusely reflected by the leaf. The results were of the following order: for the yellow-red (570-640$\mu\mu$), 15 calories per c.c. of carbon dioxide, for the green (510-560$\mu\mu$), 7, and for the blue (430-510$\mu\mu$), 22+, these being maximal values.

Mr. Briggs pointed out that since the heat of formation of the most probable products of assimilation ranges from five to six and more calories per c.c. of carbon dioxide, the indications are that both chlorophyll *a* and chlorophyll *b* take part in the photochemical reaction. Referring to Prof. Baly's suggestions as to the part played by the different pigments in the photosynthetic process, he said that since the quantity of each pigment underwent relatively little change during prolonged assimilation no energy was supplied from this source, and, further, that since as much oxygen was evolved as carbon dioxide absorbed in the red and the green parts of the spectrum—regions where no energy is absorbed by the xanthophyll—as well as in the blue, it was not necessary to postulate a photochemical reaction involving xanthophyll in order that oxygen might be liberated.

Prof. I. M. Heilbron and Mr. C. Hollins put forward some speculations on photosynthesis. The large number of plant products in which the predominant carbon nucleus is C_5 or a multiple of this suggests that this unit has a special significance. The photosynthesised reactive hexose may be supposed, in addition to its further condensation to sugars, cellulose, glucosides, etc., to furnish by dehydration ω-hydroxymethylfurfural. This by oxidation and decarboxylation can give a stabilised C_5 compound, which, either as the furan derivative or (by opening of the ring) as dihydroxyglutaconic dialdehyde, may be a source of pentoses and of condensation products of these. Simple schemes were suggested showing how two, or three, molecules of a "pentose" can give rise by ordinary condensation reactions to anthocyans (C_{15}), terpenes (C_5, C_{10}, C_{15}, etc.), coniferyl alcohol (C_9), and the numerous related compounds, coniine (C_8) and the phonopyrrolecarboxylic acids (C_8, etc.). The degradation of hexose into "pentose" represents the respiration of the plant. Against the suggestion of Robinson (British Assoc., 1921) that anthocyans result from the condensation of two hexose and one triose molecule are to be set the absence of nonoses in Nature and the failure of all attempts to obtain benzene derivatives from hexoses.

Papers were also contributed by Dr. F. C. Eve and Prof. M. C. Potter.

Prof. R. Robinson thought that the accumulation of active formaldehyde and formhydroxamic acid scarcely accounted for the almost inexhaustible variety of plant products. The alkaloids were probably produced from hexoses rather than built up atom by atom from formaldehyde. He was unable to accept the suggestions of Prof. Heilbron and Mr. Hollins as to the significance of the C_5 unit. The anthocyans he preferred to consider as $C_6+C_3+C_6$ rather than $C_5+C_5+C_5$. Although nonoses had not been found in Nature, E. Fischer had obtained a nonose which was fermentable.

Dr. E. F. Armstrong emphasised the importance of cane-sugar in the carbohydrate metabolism of green leaves.

Prof. Baly briefly replied to some of the points which had been raised, and the discussion was then closed by a few remarks from the chairman, Prof. Dixon.

Progress in Engineering.

THE James Forrest lecture delivered in 1903 by Dr. W. H. Maw dealt with some unsolved problems of engineering; his presidential address, read before the Institution of Civil Engineers on November 7, directs attention to the progress which has been made towards the solution of certain of these problems. In ordinary researches the conclusions arrived at often remain untested for more or less long periods, and when they are tested it is not unusual for such tests to develop facts which, if known earlier, would have decidedly affected the character of the research carried out. During the war, especially in aeronautical researches, immediate results were wanted, and reasonable suggestions arising from research were, as a rule, tested without delay. As a result conclusions were arrived at and advances made much more promptly than would have been possible under other conditions.

For many years past there has been steady growth in the demands for larger structures and machines. In the case of bridges there are three ways in which increases of span may be made commercially attainable: First, by improvements in the structural designs; second, by the reduction of the so-called factors of safety now adopted; third, by the use of improved structural materials and constructive details. Dr. Maw does not think that there is much chance of obtaining material aid by the first of these methods; it does not appear likely that any new type of design will be evolved possessing striking advantages as compared with those already known and investigated. The prospects from the second method are better; there are two classes of allowances, namely, (*a*) stresses due to wind pressures, changes of temperature, and so on, which depend upon local circumstances and other matters of individual judgment, so that a reduction cannot be calculated upon, and (*b*) allowances which depend upon the quality of all the materials used and the soundness of the workmanship. The allowances under the latter head might be materially reduced as compared with those considered necessary even ten years ago. During that period, vast improvements have been made in our steel manufacturing processes, especially in the direction of ensuring uniformity of quality, while the facilities for thorough testing and inspection have been enormously increased.

In reference to the third way, there are no indications that we have reached the limits of progress in the use of improved structural materials. In long span bridges, the importance of the "specific tenacity" of the material (*i.e.* the ultimate strength in tons per sq. inch divided by the weight in pounds of one cubic inch) is exceedingly great, since the weight of the structure itself forms the larger portion of the total load supported. The successful manufacture, on a commercial scale, during recent years, of various high-quality alloy steels has quite changed the aspect of affairs and has materially enlarged the limits of the practically permissible spans of different types of bridges. At present, the most hopeful line of progress appears to lie in still further improvements in alloy steels and their treatment. Research work bearing on this subject is being vigorously prosecuted by our leading steel makers and affords every ground for expecting substantial advances.

Improvements in metallic alloys have been rendered possible by the revelations of microscopical research. Prior to the development of this type of analysis,

we knew that steel subjected to a certain heat treatment had its mechanical qualities altered. Microscopic investigation, aided by improvements in the preparation and treatment of the samples to be examined, has enabled us now to trace out, step by step, the changes which take place at various stages of the treatment, as well as the effect—in the case of alloys—of modifications in the proportions of the constituents. Microscopic research also promises to be of value in providing definite information as to the changes of structure in different metals when injured by fatigue, or are just on the point of fracture, and Sir Robert Hadfield has made some valuable experiments in this direction.

During the last few years a most important addition has been made to our methods of discovering defects in materials or workmanship by the application of the X-rays. Great progress has been made, and there is every promise of further developments in the early future. At present steel or iron can be searched to depths of about 3 inches, aluminium and its alloys to about 6 inches, and timbers of various kinds from about 15 to 20 inches.

Researches on the thermal efficiency of the steam engine during the last few years have related chiefly to the development of the steam turbine. Prior to 1903 the best economical result obtained with a steam turbine was that of a 1500-kilowatt alternator built by Messrs. Parson in 1902; this machine had a steam consumption corresponding to about 13·5 lb. per indicated horse-power per hour. A test carried out in 1918 on a 10,000-kilowatt unit by the same makers gave a consumption of 7·75 lb. per horse-power per hour—a reduction of about 43 per cent. on the 1902 performance. The corresponding thermal efficiency is nearly 27·7 per cent. Bearing in mind certain points in the design of this turbine and making allowance for them, it appears that a thermal efficiency of 30 per cent. for a steam motor is within our reach.

Mechanical gearing in turbines has proved in a number of cases to be unsatisfactory. The question of how to prevent the defects which have occurred forms probably the most important problem which has demanded the attention of mechanical engineers for many years past. The failures have been variously attributed to the use of unsuitable metal for the gears, to irregularity in the gear cutting, to disturbance in the alignment of the shafts and to other causes. The whole subject deserves more systematic and thorough investigation than it has received hitherto.

The development of the steam turbine has been the result of an enormous amount of strenuous and original work, both theoretical and constructional. On the theoretical side, the determination of the laws controlling the discharge of steam through orifices of various shapes is yet very far from being complete, and there are many other problems, such as the critical speeds of shafts, the best number of stages to be adopted under different conditions, and so on. On the constructional side may be mentioned the selection of suitable materials for the blades and the mode of fixing the latter, devices for preventing steam leakage, securing efficient lubrication, and methods of governing and of obtaining the high vacua so essential for securing economic performance.

The pistons of reciprocating engines have speeds ranging from 600 to 800 feet per minute. In steam turbines the blades are being run successfully at 600 feet per second. A small turbine (150 horse-power), made recently by Messrs. Ljungström of Stockholm, runs at 40,000 revolutions per minute and has a blade speed of 952 feet per second—more than 11 miles per minute.

In conclusion, Dr. Maw directed attention to one fact which appeared to him of far greater importance than all the others: in none of the researches referred to, varied and extensive as they have been, is there the slightest trace of finality. Much as has been discovered and great as has been the progress made, it is most certain that we have at present effected only the preliminary opening up of the mine of knowledge and that the real wealth of its contents is as yet unknown to us. We can only say that the "impossible" of yesterday has become the "possible" of to-day, and in the early future many of these possibilities bid fair to become accomplished facts. Surely this is a great inheritance, which should invite our coming generations of engineers to make most strenuous efforts to secure greater—and still greater—developments, so that they may in their turn leave behind them a heritage more glorious still.

Radio-Telephony and Broadcasting.[1]

By A. P. M. FLEMING, C.B.E.

IN considering the development of radio-telephony, it is frequently overlooked that the earliest methods of communication, such as by sound and light, do not involve the use of wires; the negative and non-descriptive term "wireless" has, therefore, been displaced by the term "radio." Radio waves are electro-magnetic in character, being pulsations in the æther of space, and they differ among themselves and from radiant heat, light, and X-rays, only in their amplitude and wave-length. Some waves change and diminish gradually in amplitude, and are said to be "damped"; others maintain their amplitude and are "continuous." Radio waves exist and are used which vary in wave-length from a few yards to ten or twelve miles; they are the longest electro-magnetic waves.

Given the means whereby electrical waves can be produced and detected, it is comparatively simple to arrange to send signals by the morse code, and this is done every day in ordinary radio-telegraphy. Radio-telephony is in some respects analogous to ordinary telephony. The ordinary telephone circuit of microphone transmitter, line, and receiver contains a battery which sends a continuous current round the circuit and through the telephone receiver. If speech is made in the microphone, the vibration of the microphone diaphragm varies the pressure on carbon grains in the microphone. This varies the resistance in the battery circuit, and the current, instead of flowing steadily, rises and falls according to the sound waves impinging on the transmitter diaphragm. The fluctuating current varies the pull on the diaphragm in the telephone receiver, and this sets up sound waves similar in character to those originally spoken into the transmitter. In radio-telephony there is a generator capable of producing very high-frequency oscillating current which can be radiated from an aerial, just as heat and light are radiated from a fire or lamp. This radiated oscillation is known as a "carrier wave." Near the generator is a modulator receiving the speech and modifying the amplitude of the high-frequency oscillation, and imparting changes in the carrier waves in

[1] Substance of a lecture delivered at a meeting of the North-east Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, on Friday, December 15.

accordance with the speech vibrations, which result in a fluctuating current radiated to the receiver.

At the receiving end the oscillating current is changed into a uni-directional current, and made suitable for reception for hearing in an ordinary telephone receiver. It is an essential condition of reception that the receiving set be "tuned" to respond to the wave-length of the station it is desired to hear. Electrical waves emanating from a transmitter travel in all directions through space, and can be picked up by any number of receivers, provided these are tuned to receive the particular wave-length used.

Broadcasting stations comprise transmitting-room, studio, green-room, offices, listening-in room, and workshop. Programmes are designed to operate throughout the whole evening, and all tastes and ages are catered for. It is usual for artistes to operate at the station, but by means of ordinary telephone transmission it is possible to transmit a political speech or entertainment from a central hall in a city to the broadcasting studio, and to radiate it from the station to listeners.

The pioneer work in broadcasting as a means of public entertainment and instruction was undertaken by the Westinghouse Co. of Pittsburgh, U.S.A., in December 1920. The Metropolitan-Vickers Co. of Great Britain has close technical association with this company and has the advantage of this pioneer experience. There are now more than 500 broadcasting stations in the United States, and their growth without proper co-ordination has caused some confusion.

To avoid this confusion in Great Britain, the Government insisted that manufacturers of radio apparatus should co-operate in forming a Broadcasting Company to control broadcasting. Three stations of the eight contemplated are in operation, London, Manchester, and Birmingham, and it is intended that Newcastle shall have a station. The revenue of the Broadcasting Company for maintaining stations is provided by the manufacturers, but the Government assists by remitting a proportion of the licence fee.

Care should be taken in selecting a set suitable to the local conditions. A good crystal set costing about four or five pounds will receive satisfactorily over ten or fifteen miles. A two-valve set would pick up over fifty or one hundred miles, and in addition to this, a further two-valve amplifier could be arranged to increase the distance to 300 miles, or would permit the use of a loud speaker up to fifty miles. Sets sold by reputable manufacturers are very efficient and simple to operate.

The development of radio-telephony will have a very profound influence upon social life. It will overcome the isolation of the rural worker, the invalid, and those who are confined indoors, and it has unique potentialities for entertainment, instruction, and the development of public taste.

Excavations at Borg en Nadur, Malta.

AT a meeting of the Royal Anthropological Institute held on November 21, Prof. F. G. Parsons, vice-president, in the chair, Miss Murray gave an account of some excavations carried out by her at Borg en Nadur, Malta, during the past summer. The excavation was purposely limited to a small area to the west of the so-called "dolmen" of Borg en Nadur in a terraced field which had been made over this site, as high as the cap-stone of the dolmen, and completely covering the remains of the ancient buildings. The principal building found was an apsidal structure of the type peculiar to Malta. From the small size of the stones and the primitive style of the building, Miss Murray is of the opinion that Borg en Nadur is considerably older than Mnaidra and Tarxien. The principal results of the excavation are (1) the discovery of types of pottery transitional between the neolithic and bronze age; (2) the finding of painted pottery showing Cretan influence, perhaps of the Middle Minoan era, thus connecting prehistoric Malta with another ancient civilisation.

In the discussion which followed the reading of the paper, Prof. J. L. Myres said the pottery of Malta presents a puzzling problem. Evidence is needed as to which of the large number of types are contemporary. The pottery from the "window tombs" of the lower levels of the ravines with flat alluvial bottoms, which form the characteristic watercourses of Malta, presents certain affinities with the "Sikel" pottery of Sicily. Miss Murray distinguished between "neolithic" and "bronze age" pottery; but, whereas she found the latter at ground level in the apsidal building, at Hal Tarxien the lower occupation layer, resting on ground level, contained no metal, and the bronze age interment had been found over a sterile layer of some thickness imposed upon the neolithic stratum and at a considerable height up the great stones of the temple. The painted pottery, for which a Cretan affinity had been suggested, is of the type found in Sicily and Southern Italy for which Prof. Peet had traced a Thessalian rather than an Ægean relationship. Prof. Myres also expressed his opinion that the Borg en Nadur building was of late and degenerate type rather than early and primitive. Mr. H. J. E. Peake said that Miss Murray's suggestion of a type of pottery transitional between the neolithic and bronze age types was new and needed substantiation. The restricted distribution of the "bronze age" type suggested that it might be an intrusion, of which Miss Murray's transitional type was an attempted copy.

University and Educational Intelligence.

BIRMINGHAM.—Dr. Dorothy Margaret Patrick has been appointed assistant lecturer in physiology, Grade III.

Mr. T. V. Barker, of the department of mineralogy at Oxford, has been invited to deliver a course of lectures, during the spring term, on chemical crystallography.

The annual meeting of the Court of Governors will be held on Thursday, February 8.

The vice-chancellor (Sir Gilbert Barling, Bart.) is to represent the University at the celebration of the 800th anniversary of the foundation of St. Bartholomew's Hospital in June next.

The new hall of residence for men students is to be known in future as Chancellor's Hall.

GLASGOW.—The University has received a gift of 25,000*l.* from Mr. Henry Mechan, of Mechans, Limited, engineers and contractors, Glasgow, for the foundation of a new chair of public health.

LONDON.—At a meeting of the Senate on December 13, a resolution was adopted accepting a bequest of 3000*l.* made by the late Sir William Meyer, fellow of University College and High Commissioner for India, to be applied at the discretion of the Senate "with special reference to the encouragement of proficiency in European History, and in the History and Geography of India." An offer from the council of the Society of Antiquaries to continue the Franks studentship in archæology, of the value of 100*l.* per annum, for a further period of five years was accepted with thanks.

A grant of 15*l.* from the publication fund of the University has been made to the hon. editor for zoology of the *Annals of Applied Biology* in aid of the publication in that journal of the M.Sc. thesis entitled "The Life-History and Bionomics of the Turnip-Gall Weevil," by Mr. P. V. Isaac.

The degree of D.Lit. has been conferred on the Rev. G. H. Dix, an internal student, of King's College, for a thesis entitled "'The Angel of Jahweh': A Study in the Origin and Development of a Religious Folk-Legend, with special reference to the Messianic Expectation of the Hebrew Race."

THE general meeting of the Association of Women Science Teachers will be held at University College, Gower Street, on Saturday, January 6, 1923. The programme includes an address by the retiring president and a lecture on relativity by Dr. Dorothy Wrinch. The hon. secretary of the association is Miss E. M. Ridley, 10 Gresley Road, N.19.

THE annual meeting of the Geographical Association will be held in Birkbeck College, London, E.C.4, on Thursday and Friday, January 4 and 5, 1923, Sir John Russell will deliver his presidential address on the subject of "The Influence of Geographical Factors in the Agricultural Activities of a Population" on the opening day of the meeting. Among lectures to be given during the meeting are: "Types and Materials of Houses in England," Mr. H. Batsford; "The Place of Geography in the Education of the Adolescent," Dr. Olive Wheeler; "Geography and Business Life," Prof. W. S. Tower; "The Coming Industrialisation of China," Prof. P. M. Roxby.

THE second annual general meeting of the Association of Heads of Departments in Pure and Applied Science was held on Saturday, December 9, at the Woolwich Polytechnic. The members were welcomed by the chairman of the Governors, Mr. C. H. Grinling, who delivered an address upon the desirability of "association" in all branches of society, whether trade or professional, commercial or political. He emphasised the importance of a new association taking a long view of the range of their activities and of developing into a body of national, or better still, of international, rather than of merely parochial importance. The meeting decided later to extend the activities of the association by the admission of members from the provinces. Mr. C. E. Larard, of the Northampton Polytechnic, was elected as chairman, and Dr. W. A. Scoble and Mr. R. T. Smith, of Woolwich Polytechnic, as joint secretaries for the ensuing year.

THE report for 1921–22 by Dr. Cranage on the Cambridge University Local Lectures shows that the revival which took place in 1919–21 has been maintained as regards the number of courses (92, of which 15 were on scientific subjects), but that the average attendance per lecture dropped from 142 in 1920–21 to 127, and per class from 38 to 33. The Summer Meeting (July 29 to Aug. 18) was attended by 544 students of whom 444 were women and 46 from foreign (chiefly Scandinavian) countries. The corresponding figures for 1912 are 565, 377, and 226. Considering that board and lodging were about twice and rail fares about three times as expensive as before the war, the popularity of the Summer Meeting is remarkable. Next July there will be held at Cambridge in connexion with the jubilee of the local lectures a conference on extra-mural teaching, the Chancellor presiding at the first meeting.

FROM the annual report for the year 1921–22 issued by the Rhodes Trust, it appears that the number of Rhodes scholars in residence during the year was 300, of whom 156 came from the British Empire and the remainder from the United States. Of the total, 66—more than one-fifth—took natural science, a term which includes those studying medicine; in addition, forestry and mathematics each had five scholars, agriculture three and anthropology one. During the year, 72 took up their scholarships for the first time. The current academic year commenced with 262 scholars in residence. The value of the Rhodes scholarship has been temporarily increased by an annual bonus of 50*l.*, but applicants are warned that even thus, they must be prepared to find another 50*l.* a year. Appointments to the 1924 scholarships will be made during the year 1923; further information can be obtained from the offices of the Rhodes Trust, Seymour House, Waterloo Place, London, S.W.1.

THE Universities Bureau of the British Empire has published an abridged report of the proceedings of the annual conference of the universities of Great Britain and Ireland held last May. Four subjects were discussed: (1) the urgent need for enlarged opportunities for advanced study and research in the British universities; (2) the increase of residential accommodation for students; (3) specialisation in certain subjects of study by certain universities; (4) the organisation of adult education as an integral part of the work of the universities. Mr. H. A. L. Fisher, then president of the Board of Education, attended the conference and took part in the discussion of subject (3), which he considered to be pre-eminently a subject for conference and co-operation among the universities, especially in regard to the financial requirements of new specialised departments, the application to the best advantage of existing trust funds in universities, and the migration of research students. The Report (pp. 32, price 1*s.*) is obtainable from the Universities Bureau, 50 Russell Square, W.C.1.

THE eleventh annual conference of Educational Associations will be held at University College, Gower Street, W.C.1, on December 28–January 6, under the presidency of Sir Michael Sadler, Vice-Chancellor of the University of Leeds. The inaugural meeting will be held at Bedford College for Women, Regent's Park, on the afternoon of December 28, when Sir Michael Sadler will deliver his presidential address. There will be two joint conferences of all the societies during the meeting—one on the methods of carrying out in schools the recommendations of the reports on the Teaching of Classics, Modern Languages, English and Science, on December 30, and the other, "How can the Links in the Chain of Education be strengthened?" on January 5. The College of Preceptors will also hold a discussion, opened by Sir Michael Sadler, on the growth of bureaucracy in education. Among the papers which have been promised are: four to be delivered to the National League for Health, Maternity and Child Welfare—on physical development and its food requirements, by Dr. E. Pritchard, on physique and growth, by Dr. James Kerr, on child psychology and psychotherapy, by Dr. William Brown, and on health education, by Prof. H. Kenwood; three lectures on reform and tradition in education, by Mr. Frank Roscoe, to the College of Preceptors; a paper on the child and the cinema, by Dr. C. W. Kimmins, at the British Psychological Society (Education); another on the co-ordination of the teaching of mathematics with handicraft, by Mr. A. Romney Green, at the Society for Experiment and Research in Education; one on hygiene as applied to physical training, by Prof. M. E. Delafield, at the Incorporated British Association for Physical Training; and one on relativity, by Dr. Dorothy Wrinch, at the Association of Women Science Teachers.

Calendar of Industrial Pioneers.

December 24, 1872. William John Macqueen Rankine died.—The author of a series of valuable engineering text-books, Rankine was a distinguished engineer and physicist, and with Clausius and Kelvin helped to found the modern science of thermodynamics. A student first at Glasgow Academy and then of the University of Edinburgh, he gained practical experience in railway engineering under M'Neill and Locke, and in 1855 succeeded Gordon in the chair of civil engineering in Glasgow University.

December 25, 1868. Linus Yale, Junior, died.—The son of Linus Yale, senior (1797–1857), a successful inventor of locks, Yale was born in 1831 and began life as a portrait painter. Joining his father in 1849 he contributed much to the success of the firm, and during 1860–64, by the adoption of an old Egyptian device, worked out his well-known pin-and-tumbler lock for the production of which the Yale Manufacturing Company was organised at Stamford, Connecticut.

December 27, 1883. Andrew Atkinson Humphreys died.—Humphreys graduated from the United States Military Academy, served in the Bureau of Topographical Engineers and the United States Coast Survey, and made a long study of the problem of controlling the waters of the Mississippi, his work on which raised him high among hydraulic engineers.

December 27, 1890. William John died.—Trained as a naval constructor under the Admiralty, John was regarded as one of the ablest and most original constructors of his day. He wrote on stability, the strength of iron ships, and other subjects, and from 1881 to 1888 was manager of the Barrow Shipbuilding Works.

December 27, 1896. Sir John Brown died.—One of the first to develop successfully the Bessemer process, Brown introduced into Sheffield the manufacture of steel rails, and at the Atlas Works, in 1863, rolled an iron armour plate twelve inches thick and fifteen to twenty feet long.

December 27, 1900. Sir William George Armstrong, Baron Armstrong of Cragside, died.—A solicitor, who became a great engineer, Armstrong was a pioneer in the use of hydraulic machinery, the rival of Krupp as an improver of artillery, and an organiser of outstanding ability. Born in Newcastle in 1810 he practised as a solicitor there; in 1846, he invented his hydraulic crane, and the following year became the first manager of the Elswick Engineering Works. In 1854 he brought out a breech-loading rifled gun, in 1859 founded the Elswick Ordnance Works, and in 1880 built a six-inch wire-wound gun. He was assisted by Rendel, Noble, Vavasseur, and others, and the Elswick Works were afterwards amalgamated with those of Mitchell and Swan and of Whitworth.

December 28, 1907. Coleman Sellers died.—A distinguished American mechanical engineer, Sellers was for many years connected with the firm of William Sellers and Co., of Philadelphia. Retiring in 1887 he became a consultant, and was actively engaged in the pioneering schemes for the utilisation of the power of the Niagara Falls.

December 30, 1910. Fredrik Adolf Kjellin died.—Known for his original work on electric smelting, Kjellin was trained at the Technical High School of Stockholm and became metallurgical chemist at the Gysinge works of the Aktiebolaget G. Benedicks, where, in 1899, he constructed the first induction furnace. E. C. S.

Societies and Academies.

LONDON.

Geological Society, December 6.—Prof. A. C. Seward, president, and afterwards Mr. R. D. Oldham, vice-president, in the chair.—H. A. **Baker**: Geological investigations in the Falkland Islands. The stratigraphical succession comprises rocks of Archæan, Devono-Carboniferous, and Permo-Carboniferous age. There is only one exposure of Archæan rocks, namely, in the cliffs of Cape Meredith, the southernmost point of West Falkland. Overlying these old rocks, and separated from them by a strong unconformity, are coarse sandstones and quartzitic rocks, nearly horizontal. This unfossiliferous series is of great thickness, probably about 5000 feet. It occupies the southern part of West Falkland and the islands lying to the west of this area. It is regarded as of Devonian age. The succeeding series of rocks, of Devono-Carboniferous age, occupy the remainder of West Falkland (except for small areas of Permo-Carboniferous rocks) and the northern half of East Falkland. The Middle and Upper Series each include about 2500 feet of strata. Terrestrial deposits of Permo-Carboniferous age follow. They occupy a synclinorium extending over the whole of the southern half of East Falkland (Lafonia) and Falkland Sound. They include a thickness of strata exceeding 9000 feet. A sandstone formation (Lafonian Sandstone) of no great thickness follows, and is, in turn, succeeded by more than 6000 feet of terrestrial deposits. Several thousand feet of these Upper Lafonian Beds consist of a monotonous alternation of thin sandstones and shaly beds. Doleritic dykes are of frequent occurrence; their age is post-Upper Lafonian. The marine fauna will probably prove to be of Upper Devonian age. The Falkland Islands appear to owe their existence to the fact that they occur at the crossing-place of two sets of folding movements.—A. C. **Seward** and J. **Walton**: On a collection of fossil plants from the Falkland Islands. A Devonian age is suggested for the oldest plant-bearing beds. Numerous examples of Glossopteris leaves were collected, especially in Lafonia, of species which are not confined to one geological series in the Gondwana System. Many specimens of Equisetaceous stems were also obtained from the Glossopteris Beds: of these several are identical with Falkland examples described by A. G. Nathorst and by T. G. Halle, while others are compared with an Upper Triassic or Rhætic species *Neocalamites carrerei* (Zeiller). A comparison of petrified wood, most of which has been assigned by various writers to the genus Dadoxylon, from different parts of Gondwanaland, points to the prevalence, in the southern botanical province, of trees differing in anatomical characters from contemporary plants in the northern province. The Permo-Carboniferous flora seems to agree most nearly with the Damuda and Beaufort Series of India and South Africa respectively. The stems compared with Neocalamites favour a reference of the beds at Cygnet Harbour and Egg Harbour to a somewhat higher position; and, on the other hand, the leaves described as *Glossopteris indica* Schimper (cf. *G. decipiens* Feistmantel) from North Arm, although they represent a type which has a wide range both in space and in time, suggest a possible correlation with the Ecca Series of South Africa and the Talchir Series of India.

CAMBRIDGE.

Philosophical Society, November 27.—Mr. C. T. Heycock, president, in the chair.—C. T. R. **Wilson**: On some α-ray tracks. (1) The track of an α-particle from an atom of thorium emanation, together with

that of the α-particle emitted immediately afterwards by the resulting thorium-A atom. Some remarkable features on these tracks were explained as due to the action of previously formed tracks in robbing the air of its excess of water vapour. (2) Photographs of α-ray tracks showing short-range β-rays radiating from them—Bumstead's δ-rays, of which photographs were obtained by him in hydrogen. From the range of the longest δ-rays their velocity reaches values twice that of the α-particle. The δ-rays do not appear on the last two centimetres of the α-ray tracks. In the neighbourhood of the initial portions of the α-tracks minute detached cloudlets are visible —probably the tracks of β-particles produced by soft X-rays (K-radiations from atoms traversed by the α-particle).—A. B. **Appleton**: The interpretation of the pelvic region and thigh of Monotremata. An extensive comparison of thigh musculature forms an essential preliminary to the tracing of changes in the form of the femur and pelvis among Tetrapoda. The destination of nerve-fibres and their course in regard to pelvic-girdle and muscles provide the best guide to the identification of muscles. The myology and nerve-distribution of various mammalian and other tetrapod groups has been carried out as a preliminary to the identification of Monotreme muscles. Monotremata exhibit most of the characteristics of the mammalian thigh. A somewhat divergent evolution has taken place with retention of certain reptilian features. The lesser trochanter of mammalia is a different structure from the internal trochanter of reptilia.—A. B. **Appleton** and F. **Goldby**: Observations on the innervation of the pubi-tibialis (sartorius) muscle of Reptilia. In some species of Lacertilia it is innervated from two nerve-trunks, as in Sphenodon. This is regarded as due to fusion of two muscle-elements. Certain Mammalia, Monotremata and certain Carnivora almost reproduce this form. In most other Mammalia, the pubi-tibialis muscle is represented only by the sartorius muscle (possibly also by the gracilis muscle), and the function has changed.—W. **Burnside**: The axioms of elliptic geometry.—W. M. H. **Greaves**: The periodic solutions of the differential equation for the triode oscillator.—C. G. F. **James**: Complexes of cubics in ordinary space.

EDINBURGH.

Royal Society, December 4.—Prof. J. W. Gregory, vice-president, in the chair.—Sir J. A. **Ewing**: The atomic process in magnetisation: further notes. A modified form of atomic model has been made which reproduces the distinctive features of both ferro- and paramagnetism. Taken in conjunction with Langevin's theory of diamagnetism, the new model appears to offer a general clue to the process of magnetisation in any solid body, whether ferromagnetic, paramagnetic, or diamagnetic. It is now generally recognised that the electrons, in consequence of orbital motion or otherwise, are in some way magnetic di-poles. If their grouping is not rigid and allows individual electrons to have their magnetic axes reversibly deflected against a strong controlling force, we find the phenomena of paramagnetism. As regards ferromagnetism, the group might be initially unsymmetrical, having a resultant moment, so that it could serve as the Weber element in a ferromagnetic process. In that case the phenomena of hysteresis are found when the group as a whole turns from one position of stability to another. The control under which such irreversible turning takes place is probably partly in the mutual action between the outer shell of electrons of any one atom and those of its next neighbours in the space-lattice, as well as in the mutual action from atom to atom of the groups which constituted the Weber elements. The magnetic axes of the groups tend to orient themselves in rows. At first, the group of electrons in each atom is deflected reversibly through a small range, after which there is a break away, and new rows are formed with a more favourable orientation. The control which causes the range of reversible deflection to be very narrow (as, for example, in iron) is ascribed to the forces (not exclusively magnetic) between electrons in juxtaposition in the outer shells of atoms. The contiguous atoms are regarded as turning simultaneously under the influence of the applied field, first reversibly through a small angle, and then irreversibly into new lines, which, in an iron crystal, are inclined at 90° or 180° to the old ones. When all the groups are turned in one direction, the magnetism is what is called saturated, but there may be a further increase of the magnetism through the reversible turning of the individual electron axes within any group.—A. P. **Laurie**: Experiments with a model to illustrate the combination of two atoms consisting of magnetons round a positive nucleus. If two atoms composed of rings of magnetons placed radially round a positive nucleus approach each other, then the magnetic lines of force between the two atoms are such that there must be two places of equilibrium for the two nearest magnetons—one in which they are when the atoms approach, and the other the position at right angles to this holding the two atoms together by means of the outer electrons. A model to illustrate this (Figs. 1 and 2) was constructed with four fixed coils to represent two of the outer magnetons of two separate atoms

FIG. 1. Two atoms before combination.

FIG. 2. Two atoms after combination.

and with two moving coils, each able to turn on its own centre and on a common centre between them. On passing an electric current through the system the moving coils always arranged themselves in one position or another at right angles according to the placing of the four fixed coils. This suggests a new theory of valency—a valency not depending on the number of magnetons in the outer shell, but on the number of groups of three magnetons. There would be primary, secondary, and tertiary valencies, the combination of two atoms at once producing fresh groups of three electrons which lead to new valencies. An explanation of chemical combination is offered. —A. E. M. **Geddes**: Observations on the structure of the hydrogen lines H_α and H_β. Sommerfeld's theory demands a constant frequency separation of the components of spectral lines. The results obtained tend to indicate a gradual decrease in the separation. This appears to support M'Lennan's idea that the frequency separation gradually diminishes and vanishes at the limit of the Balmer series.—D. M. Y. **Sommerville**: Division of space by congruent triangles and tetrahedra. The various ways in which it is possible to divide the plane into congruent triangles, and space of three dimensions into congruent tetrahedra, is discussed.—Sir Thomas **Muir**: The theory of alternants from 1896 to 1917.—H. W. **Turnbull**: Double binary forms. The (m, n) form $\Sigma\binom{m}{h}\binom{n}{k}a_{hk}z^{m-h}z_1^{n-k}$, $0 \leqslant h \leqslant m$, $0 \leqslant k \leqslant n$ is binary in both independent variables z, z_1. Relative to the independent linear transformations from z to z_1,

w, w_1 an invariant theory can be constructed. This theory has been studied principally by Peano, Kasner, and Forsyth, but only for values of m, n, not exceeding 2. The present paper is preparatory to a proof of Gordan's theorem—that the complete invariant system of the (m, n) form is finite. It is the algebraic theory answering to geometrical inversion.

PARIS.

Academy of Sciences, November 27.—M. Emile Bertin in the chair.—Marcel **Brillouin**: Einsteinian gravitation. Statics. Singular points. The material point. Various remarks.—E. **Fournier**: Experiments on the guidance of dirigible balloons through fog by the method of W. A. Loth: their consequences. The electrical method of M. Loth, originally designed for the guidance of ships into port in foggy weather, is equally applicable to aeroplanes and balloons. The guiding cable may be either aerial or buried in the earth. The latter method might be employed in establishing aerial communications across the Sahara.—L. **Guignard**: The existence of certain proteid bodies in the pollen of various Asclepiadaceæ.—Charles **Richet** and Mme. A. G. **Le Ber**: Studies on lactic fermentation. The action of very small doses of substances apparently inoffensive. Substances such as urea or milk, not considered poisonous, can exercise, even at very great dilutions, a distinct influence on the activity of the lactic ferment. It follows that bacteria, since they react to such slight influences, are never found under identical conditions of development.—A. **de Gramont**: Ultimate lines and spectral series.—P. **Fatou**: Certain uniform functions of two variables.—Spyridion **Sarantopoulos**: The number of roots of holomorphous functions in a given curve.—Alf. **Guldberg**: Mean values.—Jacques **Rueff**: Theory of the phenomena of exchange. Two principles are enunciated giving the relations between rates of exchange and purchasing power of money in different countries, excluding countries practising continuous inflation. The principles are verified by constructing curves of the purchasing power of the franc in England, the United States, Italy, and Spain, over a series of years.—A. **Buhl**: The secular movement of the perihelion of Mercury.—Rodolphe **Soreau**: The laws of variation with altitude, in the troposphere, of the characteristics of standard air.—Henri **Fabre**: Hovering flight in the Mediterranean. The flight of a bird (probably the puffin) has been studied; it rarely flies in calm weather, and when forced to do so its flight resembles that of a duck. But as soon as the wind velocity and height of the waves reach certain definite values, the bird flies with motionless wings. The explanation of this flight is based on the hypothesis that vertical air-currents are produced by the wind striking the waves. There must be both ascending and descending air-currents, but the bird utilises only those ascending currents the direction of which is controlled by the direction of the crests of the waves.—W. D. **MacMillan**: Can the mean density of the Universe be finite?—Emile **Borel**: Remarks on the preceding communication.—Ch. **Maurain** and Mme. **de Madinhac**: Evaluation of the intensity of the vertical electric currents traversing the soil in France.—R. **Boulouch**: The aplanatic telescope.—R. **Jouaust**: The application of pyrometers to high frequency measurements. The Féry pyrometer can be utilised in some measurements necessary in radiotelegraphic installations. Two examples are given, the calibration of high frequency ammeters and the measurement under working conditions of the resistance of the oscillating circuit of a lamp generating station.—L. **Gaumont**: A new sound amplifier. The vibrating part of this apparatus consists of a silk cone on which is coiled a spiral of fine aluminium wire; the cone is fitted between the poles of an electromagnet, similarly shaped. The telephone currents pass round the spiral wire on the cone, which is set in vibration by the action of the magnetic field. The sound is magnified without distortion, and one apparatus had a range of hearing of 300 metres.—P. **Lemay** and L. **Jaloustre**: Some microbiological consequences of the oxidising properties of thorium-X. Earlier researches showed that the radioactive elements behave as oxidising catalysts. This suggested that thorium-X should favour the growth of aerobic organisms and slow down the development of anaerobic organisms. Experimental proof of the correctness of this view has been obtained, using *B. lacticus* and *B. butyricus* as the test organisms.—P. **Loisel** and **Michaïlesco**: The radioactivity of the springs of the Baths of Hercules in Roumania. The waters from four of seven springs examined show marked radioactivity, in amounts varying with date of collection.—Léon **Guillet** and Marcel **Ballay**: The vapour pressure of some copper-zinc alloys in the solid state. The vapour pressure of zinc in brass (zinc 44·8 per cent.) varied between 3·0 mm. at 535° C. and 19·32 mm. at 630° C. In the presence of air, the loss of zinc was smaller than in nitrogen, hydrogen, or carbon monoxide.—MM. **Dervin** and **Olmer**: Ammoniacal silver fluoride. This compound has the composition $AgF . 2NH_3 . 2H_2O$. On careful heating it loses water, ammonia, and ammonium fluoride, leaving an explosive nitride, Ag_3N.—J. **Valentin**: The solidification of the system $MgCl_2 . KCl . BaCl_2$.—Paul **Pascal**: Magnetic analysis of the stannic acids. Measurements of the magnetic susceptibility of stannic oxide in various states of hydration give no evidence of the formation of any definite stannic acids.—F. W. **Klingstedt**: The ultraviolet absorption spectra of toluene and the xylenes. The three xylenes possess very different absorption spectra.—Louis **Grenet**: A possible modification of the iron-cementite diagram.—L. J. **Simon**: The influence of the structure of organic compounds on their oxidation by chromic and sulphuric acids. The combustion of organic compounds by the chromic-sulphuric acid mixture is not always complete, and from the data given, there would appear to be a relation between the amount of carbon escaping combustion and the molecular structure of the compound.—André **Brochet**: Some properties of the active nickel employed as catalyst in organic chemistry.—Marcel **Delépine**: The iridio-dipyridino-tetrachlorides $M[Ir(C_5H_5N)_2Cl_4]$.—M. **Faillebin**: The hydrogenation of aldehydes and ketones in the presence of pure and impure platinum black. The reduction of aldehydes and ketones to the corresponding alcohols by hydrogen with pure platinum black as a catalyst gives bad yields: there is a tendency for the formation of hydrocarbons, and the catalyst becomes rapidly fatigued. If the platinum black is made from a solution of chlorplatinic acid containing ferric chloride, the impure catalyst. gives excellent yields of alcohols.—G. **Delépine** and V. **Milon**: The presence of Waulsortian reefs in the carboniferous limestone of the Laval basin.—L. **Barrabé**: The presence of transferred strata in the eastern Corbières.—F. **Roman**: The quaternary terraces of the upper valley of the Tagus.—Albert **Nodon**: Researches on solar action at a distance.—V. **Schaffers**: Lightning and trees.—E. **Roger**: The periodic return of severe winters. In 1860 Renou noted that severe winters recur periodically. The author gives additional data in support of this, and puts the period as 41 years.—E. **Fichot**: The constitution of oceanic areas in basins of resonance, originating from continental masses under the action of the tides.—G. **Hamel**: Some peculiarities

of the algologic flora of Saint Malo.—P. **Mazé**: The practical conditions for using calcium cyanamide as a manure. The best way to apply calcium cyanamide to the soil is to mix it with peat.—Ch. **Brioux**: The comparative assimilability of calcium phosphate and the phosphates of iron and alumina. Plants can assimilate phosphorus from the phosphates of aluminium and iron, and from the experiments described the facility of assimilation of phosphorus from the phosphates of aluminium, calcium, and iron is in the order given. From this it follows that in determining the useful phosphorus in manures the solvent employed should attack not only the phosphates of the alkalies, lime and magnesia, but also phosphates of iron and alumina.—A. **Pézard** and F. **Caridroit**: The action of the testicular hormone on the relative valency of the allelomorphic factors in sheep (Dorset and Suffolk).—H. **Barthélemy**: Maturation *in vitro* and activation of the eggs in the general cavity and conduits in *Rana fusca*.—Paul **Portier** and Marcel **Duval**: Osmotic pressure of the blood of the "wiped" eel as a function of modifications of the salinity of the external medium. The mucus abundantly secreted at the surface of the skin of the eel has a marked influence on the isolation of the internal medium. The partial or complete removal (by wiping the surface) of this protective medium causes an increase in the osmotic pressure of the blood serum when the salinity of the external medium is increased.—Ed. **Le Danois**: The prediction of the value of the herring catch in winter. The prediction is based on the study of the 14° C. isotherm at 50 metres depth in August, and the assumption that the movements of the herring are governed by the temperature of the water. The fishing results this winter have confirmed this view.—Louis **Roule**: The ecology of the sturgeon (*Acipenser sturio*) in the Atlantic regions of France.—H. **Hérissey**: The biochemical synthesis of *d*-α-mannoside starting from mannanes.—Emile F. **Terroine**, E. **Brenckmann**, and A. **Feuerbach**: The identity of composition of organisms of the same species after death by starvation.—G. **Marinesco**: The rôle of oxidising ferments in the production of fevers and inflammations.

BRUSSELS.

Royal Academy of Sciences, October 14.—M. A. Lameere in the chair.—C. **Cesàro**: The blue crystals of disthene found at Katanga. Facility of the g_1 cleavage. The angle of extinction on g_1 and in the other faces of the vertical zone. Corresponding faces. The results of a detailed crystallographic examination of small crystals of disthene, collected in Katanga sands. The same sand contained a single crystal of euclase, a mineral not hitherto found in the Congo.—Leon **Fredericq**: New Belgium. The colony of arctic-alpine animals and plants found on the Baraque Michel plateau is exceptional and is not found to the same extent on the other high plateaux of New Belgium, notably at Losheimergraben. This phenomenon appears to be connected with the local anomaly of temperature which characterises the climate of the Baraque Michel.—Maurice **Nuyens**: The trajectory of an electrified point in the field due to an electron.—H. **Buttenbach**: Note on kasolite. The results of a crystallographic examination of kasolite, found along with pitchblende in the Katanga copper mines.—Charles **Fraipont**: Observations on the large Pleistocene Felidæ.

November 4.—J. **Neuberg**: Geometry and mechanics.—N. **Saltykow**: The development of the theory of partial equations of the first order of a single unknown function.—Paul **Brien**: Researches on the embryogeny of *Salpa maxima*.

SYDNEY.

Linnean Society of New South Wales, October 25.—Mr. G. A. Waterhouse, president, in the chair.—R. J. **Tillyard**: Mesozoic insects of Queensland. No. 9. In the Protorthoptera a large number of fragments of the peculiar *Mesorthopteron locustoides* Till. enables a full restoration of the wing to be made. Two new genera and species are described in the Orthoptera, one related to mantids, the other a very elongated locustoid type. In the Odonata a practically complete wing of an Archizygopteron forming the type of a new family is discussed. In the Hemiptera a large number of new types are dealt with, including the first Triassic record of representatives of the Cryptocerata or water-bugs, and several new Homoptera belonging to the Scytinopteridæ, Tropiduchidæ, Cixiidæ, and Ipsviciidæ.—A. J. **Turner**: Some Australian moths from Lord Howe Island. Ship traffic plays an important part in the introduction of Australian species of Lepidoptera into Lord Howe Is., Norfolk Is., and New Zealand.—Vera **Irwin-Smith**: Notes on nematodes of the genus Physaloptera. Pt. iv. The Physaloptera of Australian Lizards (contd.). Two new species and a larva found encysted in the body cavity of *Hinulia tæniolatum* are described. The cyst-forming habit was not known before in the genus, and Physaloptera have never been recorded, hitherto, outside the alimentary canal.—G. D. **Osborne**: The geology and petrography of the Clarencetown-Paterson district. Pt. ii. The larger faults are connected with the folding movements which produced asymmetric plunging folds as the outcome of thrusting due to the subsidence of the sub-oceanic segment of the Pacific. The age of the faulting and folding is probably post-Upper Marine and pre-Triassic. A comparison between the plan of the outcrop of the Bolwarra conglomerate in the Permian Series and that of the Paterson toscanite in the Kuttung Series gives evidence of differential crumpling of these two series.

Official Publications Received.

British Astronomical Association. Handbook for 1923. Pp. 38. (London: Eyre and Spottiswoode, Ltd.) 2*s*.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1922. Edited by Prof. Alexander Meek. Pp. 105. (Cullercoats.) 5*s*.

Madras Fisheries Department. Bulletin No. 13: Administration Report, 1919–20, by the Hon. Mr. A. Y. G. Campbell; Remarks on Canning and Manufacture of Fish Oil and Guano, by Sir F. A. Nicholson. (Reports Nos. 1, 2 and 3 of 1921.) Pp. 266. (Madras: Government Press.) 3.2 rupees.

Diary of Societies.

THURSDAY, DECEMBER 28.

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at Bedford College for Women), at 3.—Sir Michael Sadler: Presidential Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars. (1) The Distance of the Stars. (Juvenile Lectures.)

FRIDAY, DECEMBER 29.

EUGENICS EDUCATION SOCIETY (at University College), at 3.

Y.M.C.A. (at University College), at 3.—Sir Arthur Yapp and others: The Y.M.C.A. and Adult Education.

NATIONAL LEAGUE FOR HEALTH, MATERNITY, AND CHILD WELFARE (at University College), at 5.30.—Dr. E. Pritchard: Physical Development and its Food Requirements.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. F. Morgan: Brewery Engineering.

SATURDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars. (2) The Discovery of the Planet Neptune. (Juvenile Lectures.)