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Co-operation of State and Industry in Scientific Research*

ONE of the most valuable features of the annual report issued by the Department of Scientific and Industrial Research is what may be termed the map of research throughout Great Britain which it provides, in addition to the many impressive illustrations contained in the report of the way in which scientific research serves both industrial and social needs. This map of research is of special interest at the present time. Not only does the report indicate the direction which research upon urgent problems as housing and building, road transport, fuel supply and the like is taking, but it also indicates, as few if any other public documents do, the manner in which the resources of the State and of industry are being mobilised for the support of such research.

From its inception, the work of the Department has been conditioned by the support it receives from industry. Grants to the research associations have largely been on a pound for pound basis with contributions from the industry, and a good deal of work has been undertaken on specific problems for which appropriate fees have been paid by the industry or firm concerned. The report of the Advisory Council for the year 1933–34 pays special attention to the various problems of co-operation presented in the work of the Department and to the methods by which effective and sustained research on fundamental and long-range problems is to be encouraged.

Research work of this type is encouraged by the Department in several ways. In the first place, there is a system of research grants to students, a scheme by which the Department is brought in direct contact with some of the fundamental scientific work at the universities. A major advantage of this method is the assistance afforded to promising students to complete their training by a course of post-graduate study and research, and it is accordingly of considerable significance in regard to the recruitment of scientific staff by industry.

In the second place, under the research association scheme various problems of fundamental importance are being investigated, and it is with the object of encouraging such long-range investigations that the Advisory Council is recommending, where circumstances warrant it, and conditional upon support from the industry,

* Department of Scientific and Industrial Research. Report for the Year 1933–34. (Cmd. 4787.) Pp. iv+192. (London: H.M. Stationery Office, 1935.) 3*s*. net.

substantial block grants for periods such as five years. In this way, by stabilising the finances of the research associations, it is hoped to facilitate intelligent planning and prevent the crowding out of vitally important researches, which may not be immediately productive, by *ad hoc* inquiries.

It is not, of course, suggested that even this scale of operations is one with which the industries should be content, and the Advisory Council has indicated its readiness to encourage further expansion by grants based on income in excess of a specified figure up to a prescribed limit. There are, however, practical as well as financial limits to the expansion of the work of a research association, and in the majority of industries it will probably be found that, while the research work carried out by individual firms tends to increase, the activities of the research association tend to be limited to the more fundamental problems and to problems which are of interest to other industries also.

The size of the average industrial unit naturally has some bearing on the future and final functions of a research association, but even when an industry maintains numerous research departments in its individual units and when the invaluable educational work of the research association has been achieved, there should remain a well-defined field of activity for the association, resembling in some respects the field of activity of a number of the research boards of the Department at the present time.

Apart altogether from the suitability or necessity of the research association scheme for every industry, there is a third way in which the Department encourages scientific and industrial research —in actual financial co-operation with industry. The co-operation we are now discussing is distinct from those special investigations or tests which individual firms or organisations ask the Department to carry out in its research stations and notably at the National Physical Laboratory, as a repayment service. The current report refers to the extensive use made of the facilities of the stations of the Department by industrial undertakings in this way, but we are now referring to the encouraging growth in the volume of work undertaken by the Department as a demonstration to industry of the value of co-operation in the conduct of researches or investigations which are either too expensive or too lengthy to be attempted save by some large industrial association or by a group of firms.

The cost of researches of this type is largely defrayed by contributions made by the co-operating firms, either directly or through some industrial organisation, and the balance of the cost is provided by public funds. The expenditure, in contrast to that on a research association, is directed to specific researches, and in this way are handled many problems needing attention which could not be dealt with through a research association. As an example of this type of co-operation the current report cites the researches at the National Physical Laboratory for the practical development of steels for use at high temperatures, financed as to at least one half from funds raised by the British Electrical and Allied Industries Research Association and the British Iron and Steel Federation. Other examples are to be found in the work of the Steel Structures Research Committee, and the investigations to discover British sources of materials which could be used in place of natural pozzolanas to increase the resistance of concretes and mortars to certain forms of chemical attack.

That there is a definite field for this type of co-operative research, even when the industries concerned are run on scientific lines and are conducting independent research on an extensive scale, is indicated by the support of the investigations last mentioned by such firms as Imperial Chemical Industries, Ltd., the Anglo-Persian Oil Co., Ltd. and the Associated Portland Cement Manufacturers, Ltd. The unconditional cash contributions made to the general work of the Department in special fields by industrial firms or associations may be regarded as another indication of the way in which the Department is regarded by progressive industry as supplying the essential staff work of research in fields which are important to many industries but the particular concern of none.

It is, of course, difficult to disentangle work of this type, which finds a permanent place in our national structure of research, from more educational work, which will become less and less necessary as a scientific outlook is developed in all sections of industry and the support of research on an adequate scale becomes general. The encouraging fact that the current report is able to quote three examples of researches which during the year have been transferred to the supervision of industry on the ground that their value to industry has now been fully demonstrated, while illustrating the success of the educational work of the Department, should not be taken as evidence that the need for co-operation between industry

and national research stations in this way will tend to disappear.

There is a further aspect of the work of the Department which should not be overlooked. Among the contributions received against the gross expenditure on the National Physical Laboratory, for example, are large sums from the Air Ministry and other Government departments. As the report shows, the Department is responsible for a good deal of scientific work on problems put before it by various Departments of State.

The Advisory Council's report indicates, moreover, that the influence of the Department is not limited to securing industrial and departmental co-operation in research in Great Britain only. In certain fields such as those of food investigation, both storage and transport, and timber research, it has from the start encouraged scientific co-operation with the Dominions overseas, and in many ways the resources of the Department are freely available for Dominion and Colonial Governments. To this policy may be traced the considerable developments in research organisation in South Africa, Canada, Australia and India, and contributions amounting to nearly £10,000 which have been received from the Empire overseas indicate the way in which the value of this co-operation is appreciated. Every effort is being made to secure scientific co-operation between workers at home and abroad so that ideas and results in parallel inquiries may be freely pooled.

It is clear from this brief review of the essential functions of the Department that its work fills a definite and permanent place in our national research organisation. The relative importance of the research associations and the research stations under the Department and of *ad hoc* investigations in co-operation with industry may vary as the work of encouraging a scientific outlook in industry and the prosecution of research on an adequate scale succeeds, but each has its own definite place in the national economy.

What is equally clear from any survey of the activities of the Department is the uneven distribution of research through the industries of Great Britain. While industries can be found where expenditure on research may approach in magnitude the whole budget of the Department, there are other industries the expenditure of which in this matter is grossly inadequate and out of all proportion with their expenditure on such matters as telephone or postage. For many years yet, it is highly probable that by means of the research associations and in other ways the Department must continue its work of fostering the support of research by industry itself, both through the evidence afforded of the value of scientific research to industry in the past, in assisting the application of existing knowledge to industrial problems, and by encouraging the use of the scientific method in all branches of industrial activity.

The fullest use cannot be made of the national structure of research, however adequate, unless a scientific outlook and the vigorous and continuous examination of manufacturing practice in the light of available technical knowledge are characteristic of industry everywhere. The assertion of the Advisory Council in its report three years ago has lost not one whit of its force under the conditions obtaining to-day: "Scientific research has in the past made striking contributions to industrial progress and it will make them in the future. But the nation which will enjoy the benefits of science in the day-to-day progress of its industries is the nation which habitually applies scientific method and scientific knowledge; and it is that nation which will be able to seize the more spectacular achievements of science in the industrial sphere".

Reviews

Viewpoint and Vision

New Pathways in Science. By Sir Arthur Eddington. (Messenger Lectures, 1934.) Pp. x+333+4 plates. (Cambridge: At the University Press, 1935.) 10*s*. 6*d*. net.

THIS book is, from one point of view, a revision of the author's "The Nature of the Physical World" (1929); from another, it is a sequel thereto. The subjects treated are, in the main, the same, but the treatment is brought up to date and the underlying philosophy is re-presented so as to face more directly the attacks of criticism. In a brief review, only passing mention can be made of the purely scientific aspects of the book, interesting though they are; the general outlook demands chief attention.

The first thing that springs to notice is the extreme stability of the author's attitude. His citadel has been attacked by men of science, philosophers of various schools, rationalists, religionists and nondescripts, and after making all due allowance for mutual cancellation in such a variety of onslaught, we should have thought that

sufficient unanimity of direction remained to cause, if not a breach in the walls, at least a modification of the method of defence. It is not so. Whatever change appears is a development of physical or astronomical theory ; the philosophy remains the same. This raises an interesting problem. How comes it that a man, undoubtedly of exceptional insight, of universal interests coupled with wide and varied knowledge, a master alike of the most abstract processes of generalisation and the minutest details of application, and one gifted with extreme facility and grace of expression—how comes it, we ask, that such a man, having reached deliberate and apparently final decisions on fundamental matters, should find himself either misunderstood or opposed by almost every contemporary thinker who has considered the same problems ? To this question the present book suggests a possible answer.

We should perhaps have said 'answers', for there is a subsidiary reason ; namely, the highly figurative language employed. We are not insensitive to the charm of Sir Arthur's style—the music of the spheres is wonderful ; but the words are a little indistinct. We are carried on through image and metaphor and simile and anecdote by the most perfect of guides, and the experience is so delightful that we could scarcely wish it otherwise ; but there are moments when we sigh for just one simple, dry-as-dust footnote to tell us what it all means. His defence of this practice is that in non-technical books one should aim at using inexact language—a defence which might be less ineffective if he had anywhere expressed his philosophy except in such books. In answer to a critic who pointed out that in "The Nature of the Physical World" the word 'space' occurs with four different meanings, he pleads that the word *has* those meanings—as though words had inherent meanings independent of the ideas they are to convey. "We call it 'pain'," said the Frenchman ; "We call it 'brot'," said the German ; "We call it 'bread'," said the Englishman, "and it *is* bread."

This point is not so trivial as it may appear, for it exemplifies a very general characteristic which we believe lies close to the main source of Sir Arthur Eddington's nonconformity. The late advances in physics which have greatly clarified the outlook of most philosophers of science with regard to fundamentals, seem to have led him into greater obscurity. Accordingly he takes a viewpoint from which familiar distinctions are invisible and surface features have profound meaning. We will try to make this clear.

In the nineteenth century the philosophical man of science, however obvious it seemed to him that his subjective experience was the source of all his knowledge, was forced by the character of the physics he professed to admit an objective external world of which his experience was only one aspect. That world was therefore at once the source and the creation of experience. Thanks to relativity, this unsatisfactory position is now unnecessary. We start with experience, pick out those elements which are common to all observers, represent them by concepts defined in such a way that, by the aid of whatever suitably defined subsidiary concepts are necessary, they relate together as many as possible of the common experiences, and the resulting logical network is the 'external world'. In brief, we have all experience as our starting point, and a builder (reason) who incorporates as much experience as he can into the ever-growing structure of the physical world ; that is all.

Now how does Sir Arthur Eddington view the matter ? Instead of thus resolving the nineteenth century dilemma, he makes confusion worse confounded. From his summary on pp. 257–58 of the allegorical first chapter, we extract the following ordered set of independent entities :—(i) consciousness ; (ii) phenomena of observation ; (iii) nerves ; (iv) theoretical physics ; (v) the basal entities of physics (electrons, etc.) ; (vi) the nature of the basal entities (which, however, plays no part in the drama, being 'essentially unknowable'). With this extremely complicated machinery to manipulate, it is small wonder that he finds himself remote from ordinary thinkers : their problems scarcely concern him—his seem remote from them. He is like a man in Arizona who, looking horizontally at ground level, misses the Grand Canyon but sees an ant-track fundamentally cleaving the universe. Let us see some examples of this anomalous valuation.

Sir Arthur's attitude to the basal physical entities affords a conspicuous one. Their degree and kind of 'reality', he tells us, are identical with those of sticks and stones. He does not believe, however, "that the twoness of two electrons is a bit like the twoness of two apples", and while the preservation of individual existence by photons between emission and absorption "is a very obscure question" (p. 38), he regarded, we recall, the similar question relative to the moon (p. 226 of the earlier book) as meaningless. These are not inadvertences ; if they were we should be captious to mention them. He would reaffirm these statements but declare that the differences in question were insignificant. We are not surprised to find later (p. 226) that his search for a physical standard of length, "idealised, if you like, but not to the extent of having a different relationship to human experience from that which a physical object has", ends in the choice of "the radius of curvature of space-time". It is not asserted, be it noted, that

this entity can ultimately be expressed in the same terms as a physical object; it has the same "relationship to human experience". If Dr. Johnson had only thought of kicking the radius of curvature of space-time, what a refutation of Berkeley we should have had!

The same characteristic appears in a very different setting in his treatment of the following problem, given as an example of a certain principle: "If *A*, *B*, *C*, *D* each speak the truth once in three times (independently), and *A* affirms that *B* denies that *C* declares that *D* is a liar, what is the probability that *D* was speaking the truth?" A solution is outlined which appears not to be self-consistent; but we need not consider the solution —it is the attitude to the question that concerns us. Let us, then, eliminate superfluities and restate the second datum as "*A* says that *D* lies". Sir Arthur's treatment effectively combines the knowledge of *D*'s moral character with that of *A*'s. But is it not clear that such combination is purely fictitious? From our knowledge of *D* the probability is $\frac{1}{3}$; from our (independent) knowledge of *A* it is $\frac{2}{3}$. The results are inconsistent because the data are independent; we are effectively defining probability in different ways. On form a certain horse becomes favourite at 5 : 1; his probability of success is $\frac{5}{6}$. Statistics show that the favourite wins, say, once in ten times; his probability of success is $\frac{1}{10}$. What meaning can there be in combining the two results? Yet such distinction of definition does not exist for Sir Arthur.

On the other hand, distinctions which to most of us seem trifling, or even fantastic, are for him vital. Perhaps the most striking instance is the question of the objectivity of "time's arrow". The whole trouble arises because Sir Arthur has more than one independent world, and he wants them to correspond. Hence, feeling time's progress in consciousness, he must seek its counterpart in the physical world. To realise the problem, he pictures a state in which immediate consciousness of earlier and later is lost and we must experiment to find whether we are getting older or younger. Abolition of memory is not what is supposed, for that would leave us without consciousness that time *could* go on: we must be aware that time has this property, but not know which way it goes. We must be reduced, in short, to a state of idiocy compared with which the mental outlook of Caliban would be clairvoyance.

It is not to be supposed, however, that the problem with which Sir Arthur grapples so manfully does not exist. It is certainly real, but how different it appears from a normal point of view! Since the external world is built out of experience but does not contain the whole of experience, the going-on of time may or may not be in it. We find on examination that it is; that is, phenomena in which it is an essential element belong to that part of our experience which we share with others. If ever progression were so cruel as to desert experience, it would go out of the physical world also: we should deal with it exactly as we have dealt with absolute motion. From this viewpoint the problem is simple, and there is no need to invent a Gilbertian situation to give it meaning.

The relevance of this for our purpose, however, is not that change of viewpoint simplifies the problem, but that it does not destroy it. For in this respect it agrees with all other such transformations in declaring that Sir Arthur has no hallucinations. He may miss distinctions which exist; he may magnify distinctions which are shallow; but he never sees distinctions which are not there. At the present time this has profound significance.

Sir Arthur has lately placed before the scientific world a theory connecting relativity with quantum mechanics. In common, we believe, with most, if not all, of our betters, we have failed to understand it, and the account in the present book does little to illumine the darkness. We live in the hope that it will ultimately be transformed to natural co-ordinates. Nevertheless, if we were forced to express an opinion on whether it represented one of the greatest advances of a generation or a piece of sheer illusion, we should unhesitatingly choose the former alternative. This decision would be made purely on external evidence. Sir Arthur's past record and his consistent freedom from delusions, combined with his conviction that he has really unearthed something fundamentally important (a conviction which, unless we are greatly mistaken, is at the opposite pole from that which proceeds from self-deception) are positive indications which seem to us to outweigh the purely negative evidence arising from his inability to make the theory comprehensible. Such evidence, indeed, is largely discounted by the consideration that one who looks at everything abnormally would scarcely be expected to describe, in terms intelligible to others, something which only he as yet sees. The question, of course, remains open, for such considerations as these are negligible compared with the evidence which the theory itself should yield; but while the theory yields nothing generally intelligible, they may at least serve to suggest an attitude towards it.

In the meantime, we can enjoy to the full the more familiar fare which the present book provides. It is unfortunate that Nature, having endowed a man with almost incomparable vision, should set him at an angle so widely divergent from that of other spectators of her drama. But

science does wonders in these days, and who knows but that ere long mental distances will be traversed with as much ease as physical ones? With this prospect in view we hope that in six years time the paper of the present volume will not have become so yellow as that of "The Nature of the Physical World": such books are worthy of better incarnation. HERBERT DINGLE.

Standardised Drugs

The British Pharmaceutical Codex, 1934: an Imperial Dispensatory for the Use of Medical Practitioners and Pharmacists. Pp. xxv+1768. (London: The Pharmaceutical Press, 1934.) 35*s*. net.

THE materia medica in use throughout the British Empire can be divided into two groups, those admitted to, and those excluded from, the "British Pharmacopœia", 1932. The second group is, on the whole, the more interesting, if only for the reason that the pharmacopœial drugs should be approaching the stage at which there is little more that can be said about their nature, composition and therapeutic value, though this is obviously not the case with such drugs as ergot and digitalis, whilst the unofficial drugs at the worst are declining into objects of historical medical interest, and at the best may be destined to attain pharmacopœial eminence in due course, or may even be the harbingers of therapeutic revolutions.

It was a public-spirited desire to provide authoritative information regarding this newer materia medica which led the Pharmaceutical Society to publish the first "Codex" in 1907 and to issue new editions in 1911, 1923 and 1934. Drugs steadily become more varied and more complex and, in preparing this fourth edition, it has been necessary to distribute the work among six committees of experts. The success with which the work of these committees has been blended into a harmonious whole is especially noticeable in the monographs on crude vegetable drugs, which are now brief but clear and well-balanced statements, giving all the information the practising pharmacist is likely to require. In spite of the recent activity in the chemical examination of vegetable drugs there remain a surprisingly large number with ill-defined components, or of which the activity cannot yet be assigned to any definite constituent.

Though the Food and Drugs (Adulteration) Act requires a drug to be of the nature and quality demanded by the purchaser, it provides no standard by which the quality is to be determined. In these circumstances, the "Pharmacopœia" has become a presumptive standard for each of the drugs recognised in it, and it is no doubt hoped that the "Codex" will gradually acquire a similar position for the extra-pharmacopœial drugs it describes. Both the "Pharmacopœia" and the "Codex" are already accepted as legal standards in certain parts of the British Empire. Much work has obviously been done by the expert committees in providing the new "Codex" with standards "which experience has shown to be desirable as criteria of purity" and which "may be attained without undue difficulty or expense".

There are numerous appendixes, and special mention may be made of those on the determination of foreign matter in powdered vegetable drugs, hydrogen ion concentration, colloidal solutions and sterilisation, all subjects of outstanding importance in modern pharmaceutical practice.

The old "Pharmacological and Therapeutic Index" is replaced by a "Pharmacological Index" (Appendix xiii) divided into drugs arranged in accordance with (*a*) their pharmacological action, (*b*) their use for a specific effect in certain diseases, the latter including most of the modern drugs evolved by chemotherapeutic investigations, the recent contributions to vaccine and serum therapy and those due to biochemical work on vitamins, hormones, etc.

The most casual perusal of the volume impresses the reader with the amount and variety of analytical work now required in the manufacture and control of the enormous number of drugs and chemicals used in medicine, and it is not surprising that the Council of the Pharmaceutical Society should have considered it necessary to institute a post-graduate diploma in pharmaceutical analysis, for which, according to the official *Journal*, the first examination has been held recently.

The proofs have been read carefully, and there are very few printer's errors. The paper and the type have been improved, and the book opens fully and remains open, a desirable and not too frequent characteristic of books which, like this one, are intended mainly for reference.

T. A. H.

Vitalistic Biology and Education

Education and Biology. By J. A. Lauwerys, with the assistance of F. A. Baker. Pp. xvi+207+4 plates. (London: Sands and Co., 1934.) 5*s*.

MANY thoughtful biologists, both in schools of various grades and in colleges and universities, are becoming increasingly disturbed in their minds concerning the relation of their teaching to the ideals and wider issues of education. This unease is not merely a state to be resolved by the more widely spread inclusion of biology in the curriculum, desirable though this be: it has

its roots in questionings of the philosophic perspectives of the subject itself and its presentation to the pupil. Mr. Lauwerys attempts to clarify the situation by considering the general problem and its practical issues, and as he is lecturer in the methods of science at the London Institute of Education, is deeply interested and widely read in the philosophic aspects of science, and has come under the humane influence of Sir Percy Nunn, his book is of absorbing interest. His point of view throughout is that biology possesses its own concepts, technique and methods; the biologist must perceive the living organism as a concrete sensual whole with time and space relations; he must interpret his observations and results in biological concepts, and he must formulate a vitalistic philosophy of biology using "dynamic type" as a central concept. For the teaching biologist this would involve not the abandonment of the usual subject matter but a fundamental alteration in the usual mode of presentation.

The author first attempts to sketch out his own vitalistic philosophy of biology, proceeds to a consideration of certain difficult problems which all teachers must face, such as the treatment of sex and the 'doctrine of evolution', and then discusses the subject matter of the syllabus and actual methods of teaching. The last chapter deals with the laboratory and practical part of the course and contains particular applications of the earlier discussions. Appendixes consist of an interesting plan showing the interrelationships of topics, a number of examples worked out to show the application to particular subjects of the method of approach discussed in the text and, finally, a number of bibliographies containing startling sins of omission and commission.

Biologists will gain if they accord the author a respectful interest, even if this is not always a sympathetic one, for he has something definite to say and says it unusually well. Many biologists, however, may find their patience wearing thin when reading certain portions of chapter iii, especially the discussion on evolution, where the author, both in text and references, seems to know little or nothing of twentieth century work. Further, in many places, he seems to be writing from the point of view of a particular religious denomination, but it is to be hoped that this will not obscure the reader's view since, in the wider reaches of education, religious influences are still of primary magnitude, and in the immediate issue the author's vitalistic approach and philosophic attitude have no necessary connexion with religious tenets. The book is a sincere attempt to deal with a very difficult and urgent problem, and it merits serious consideration by all who are interested in the teaching of biology.

W. B. B.

Short Notices

Gmelins Handbuch der anorganischen Chemie. Achte Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. *System-Nummer 59: Eisen.* Teil A, Lieferung 6. Pp. xxi+1167–1420. 41.50 gold marks. Teil A, Lieferung 7. Pp. xxvi+1421–1634. 36 gold marks. (Berlin: Verlag Chemie G.m.b.H., 1934.)

ALTHOUGH the definite compounds which iron forms with other elements comprise the subject-matter of vol. A on iron, many elements play such important parts in the chemistry of steel and cast-iron that it has been found advisable to deal separately with such associations of iron and non-metals as can conveniently be termed alloys. This plan has involved very little overlapping. For example, whereas iron carbonyls are properly included amongst the compounds, iron carbide will be found in the present volume on account of its peculiar significance in relation to cast-iron and steel, and we find the phase-systems iron-sulphur, iron-selenium, iron-tellurium. iron-boron and iron-carbon successively described and illustrated with diagrams. Naturally greatest importance is attached to the last-named system. The iron-carbon diagram is set forth very clearly in the familiar compact form, but it has also been enlarged to cover two full pages in order to show the varying readings, sometimes amounting to more than 100° C., of numerous investigators. This is followed by several pages of explanatory notes and references to the literature, so that an enormous amount of significant detail upon this very important and complex problem has been assembled in a fashion that should be invaluable to specialists. The properties of iron carbide, which is so conspicuous a component of these mixtures, are then recorded in great detail in order to prepare the ground for the remaining sections, which deal with problems of solidification and crystallisation of molten steels and with special processes such as annealing, decarburisation, rolling, hardening, tempering and case-hardening.

The next part of vol. A is an elaborate compilation of the magnetic and electrical properties of both pure iron and the commercial varieties. Among the topics discussed we find theories of magnetism, magnetic properties of the atom, magnetic intensity, permeability, hysteresis, etc., as well as electrical resistance, thermo-electric effects, dielectric constants and electrophotophoresis. The literature of this section has been reviewed to June 1934, and a most useful feature in both parts is the incorporation in every section of a bibliography of general literature.

Über den Geschmackssinn der Biene: ein Beitrag zur vergleichenden Physiologie des Geschmacks. Von K. v. Frisch. (Zeitschrift für vergleichende Physiologie, herausgegeben von K. v. Frisch und A. Kühn, Band 21, Heft 1.) Pp. 156. (Berlin: Julius Springer, 1934.) 19.80 gold marks.

PROF. VON FRISCH'S studies on the senses of sight and smell in bees and on the means of communication between bee and bee in the hive are well known. His earlier reports on the sense of taste are here presented in greater detail.

The method used was to determine the 'threshold value' of solutions of sugars which were attractive to bees. This value varied with the age of the bee and the availability of other sources of booty.

The number of sugars and allied compounds tested which are sweet to bees, is less than in the case of vertebrates. Such substances as saccharin are either neutral or repellent. An attempt was made to correlate chemical constitution with taste but without marked success. The high concentration of sugars in their natural food has made bees relatively insensitive to sweet taste. Conversely, those plants which have afforded the more profitable nectar of higher concentration have been more thoroughly pollinated, giving a bigger yield of seed.

Substances distasteful to bees were tested in a solution of cane sugar of known attractiveness. The repellent action of acids did not depend solely on the titration acidity. The theory is advanced that weak acids, not being fully dissociated, have a reserve of hydrogen ions, which replace those used up in the taste process. This makes them appear more effective than strong acids of the same hydrogen ion concentration. This phenomenon is more marked with higher concentrations of acid.

The author concludes that bees can distinguish the four flavours, sweet, salt, acid and bitter. D. M.

Modern Acoustics. By Dr. A. H. Davis. Pp. xi+345. (London: G. Bell and Sons, Ltd., 1934.) 26*s.* net.

DR. DAVIS'S treatise on modern acoustics has more than fulfilled the expectations aroused by the announcement of its early appearance. The author has, very wisely, interpreted the title of the book strictly and, by saving space which might otherwise have been devoted to fundamental dynamical theory and to such classical problems as the vibrations of bars and strings, has been able to provide us with very full, lucid and well-documented accounts of the remarkable advances in acoustics made in the present generation. Modern methods of measurement of intensity, frequency and reverberation, the development of the notion of acoustical impedance, the ear and hearing, the acoustics of auditoriums, noise, its measurement and its suppression—this list by no means exhausts the topics treated in a volume which no advanced student of the science can afford to ignore.

The book, so far as the mathematical side is concerned, deals with results rather than with mathematical developments, and such matters as a detailed consideration of recent extensions of Rayleigh's principle scarcely fall within its purview. A. F.

The Flow of Water in Pipes, Sewers and Channels, over Weirs and off Catchments. By G. B. Williams. Pp. 76. (London: Chapman and Hall, Ltd., 1934.) 10*s.* 6*d.* net.

THE author of this publication, who was formerly Chief Engineer in the Public Health Department of the Government of Bengal, has embodied the results of his Indian experience and practice in diagrammatic form, using the coefficients which he has found most suitable for adoption with the classical formulæ of Manning and Kutter for discharges and velocity of flow in pipes and open channels, and the Francis formula for weirs. There are 41 full-page diagrams, approximately 9 in. by 6 in., dealing with this part of the subject, and thereafter five more diagrams relating to rainfall intensity, the relationship between rainfall and run-off and to flood discharges from catchment areas in India up to 1,000 square miles in extent.

It is impracticable within the limits at disposal to describe in greater detail the information obtainable from the tables; they will undoubtedly be of service to the practising civil engineer who has to deal with questions of water supply, land drainage and sewage disposal, especially in circumstances similar to those in the author's experience. The graphs are easy of interpretation and will save a great deal of calculation, being capable of supplying results for a wide range of conditions. It has been the author's object to supply a need which he has felt for a tabular reference compilation of this kind not to be found in technical treatises on the subject generally. B. C.

Das Brillenglas als optisches Instrument von den wissenschaftlichen Mitarbeitern an der Optischen Werkstätte von Carl Zeiss, Jena. Von Prof. Dr. Moritz von Rohr und Dr. Hans Boegehold. Mit einem Beitrage von Dr. Hans Hartinger. Völlige neubearbeitung des Buches "Die Brille als optisches Instrument". Pp. x+281. (Berlin: Julius Springer, 1934.) 25.80 gold marks.

PROF. VON ROHR has directed the Jena school of opticians for many years, and the treatise now before us is a completely revised edition of his book, "Die Brille als optisches Instrument". It is therefore of great interest to all interested in ophthalmic optics. Apart from some introductory remarks on spectacle lenses for special purposes, the book is divided into four main parts. The first deals with anastigmatic lenses, some attention being paid to toric and to prismatic lenses. The second portion treats the problems of astigmatic lenses, and the third those of chromatic aberration. The mathematical treatment is easy to follow and graphs are effectively used. The last main section discusses problems of the alterations in field conditions produced by lenses.

Throughout the book the authors add delightful short sections on the historical aspects of the problems treated, and they fittingly conclude this excellent work with an account of the development of our knowledge of the spectacle lens and some notes on the training of opticians.

Possible Value of Inhalation of Carbon Dioxide in Climbing Great Altitudes

By SAMUEL B. CHILDS, Jr., HANNIBAL HAMLIN and PROF. YANDELL HENDERSON, Laboratory of Applied Physiology, Yale University

MOUNTAIN sickness is a form of asphyxia due to the diminished partial pressure of oxygen at great altitudes. The functional disturbances in this disorder are, however, not merely anoxial, but are largely the expression of a secondary and almost equally important deficiency of carbon dioxide in the blood and tissues. Deficiency of oxygen induces hyperpnea and acapnia: that is, overbreathing and the resulting deficiency of carbon dioxide. Acapnia in turn induces subnormal respiration and a continued or even increased deficiency of oxygen. Haldane, Priestley and Douglas[1] demonstrated the correctness of Miescher's somewhat poetical formulation: "Over the oxygen supply of the body carbon dioxide spreads its protecting wings."[2] Henderson[3] confirmed the importance of the relation between the two gases in respiration when he found that it was possible to produce so great a deficiency of carbon dioxide by over-ventilation of the lungs that thereafter an animal may die of lack of oxygen with no effort to breathe.

On Pike's Peak in 1911, Douglas, Haldane, Henderson and Schneider[4] made a number of observations on muscular work in which these relations were strikingly illustrated. One of them was as follows: a member of the party whose respiratory centre was peculiarly sensitive (as indicated by the fact that he acclimatised more rapidly than any of the others) exercised by walking as rapidly as possible for a quarter of a mile up the cog railway, grade 1 in 5. While walking, he experienced an almost intolerable panting; but when he stopped to get his breath, he very quickly stopped breathing entirely for a few seconds, and then developed alternating hyperpneas and apneas. Insufficiency of oxygen was clearly the condition inducing the excessive breathing and pumping out of carbon dioxide, and the consequent apnea. The apnea in turn intensified the anoxia and induced another period of overbreathing.

As the work of climbing would not have been an excessive exercise for this individual at sea-level, it is probable that the amount of carbon dioxide produced was insufficient to maintain a continuance of vigorous breathing, except during the time that it was reinforced by acute oxygen deficiency.

The cause of the overbreathing was indicated by another observation. Merely squeezing a rather stiff rubber bulb with one hand as vigorously as possible, without other exercise, until the muscles of the forearm were tired, induced such excessive breathing that cessation of the manual activity was followed by apnea and then by alternating periods of overbreathing and apnea. This observation accords with the classic investigations of Geppert and Zuntz[5] on animals. It indicates, as they concluded, that some respiratory stimulant, other than carbon dioxide, is formed in vigorously active muscles, or under a deficiency of oxygen, and is carried by the blood to the respiratory centre, or the closely connected sinus caroticus. For reasons that we will not now stop to discuss, we do not believe that this substance, 'respiratory X'[6], is lactic acid, but rather that it is some specific hormone that increases the sensitivity of the respiratory centre to carbon dioxide.

Recently, Winterstein[7] has suggested that inhalation of a small amount of carbon dioxide might be helpful in maintaining respiration and promoting oxygen absorption at great altitudes. In order to test this idea, two of the writers of this article, both vigorous young men, spent a few days on Pike's Peak during the summer of 1934.

As the time on the Peak available for this investigation was short, the observations were confined to the subject of the acapnia which is the result of oxygen deficiency, and which in turn aggravates that deficiency. For this purpose small cylinders were provided, charged with enough liquid carbon dioxide to form 400 litres of gas. The flow of the gas was controlled and adjusted by a small, but accurate and light, reducing valve and flow gauge. The whole apparatus* weighed only 4 kgm. and was carried at one side suspended by a strap across the opposite shoulder. The flow was usually set at 2 litres per minute, and was conducted through a rubber tube to an open mask with wide holes to the outside through which the wearer breathed the outside air without the slightest impediment. During expiration the gas was thus blown away and wasted; but during inspiration it mixed with the inspired air. The amount of carbon dioxide inspired was therefore only about 1 litre per minute. If the wearer of the apparatus breathed 50 litres of air per minute, the carbon dioxide was thus diluted to 2 per cent. With a respiration of 20 litres per minute, the dilution would come to one in twenty or 5 per cent.

* We are much indebted to the Ohio Chemical and Manufacturing Company for placing this very efficient apparatus at our service. It proved ideally convenient.

The two members of our party had been on the Peak for only a couple of days, but were sufficiently acclimatised to be comfortable. Three young men, who were employed in the hotel on the summit of the Peak (14,100 ft.) and were fully acclimatised, also performed the tests. Each of these five men made four experiments, wearing the apparatus and walking a distance of 250 yards up the cog railway, grade 1 in 5, in two minutes. The work amounted to lifting the man's body and the 8 lb. apparatus 150 ft. vertically. On one day the tests with inhalation of carbon dioxide were made first, and an hour later exactly the same exertions were made while wearing the apparatus with the gas shut off. On the next day the control exertions were made first, and those with inhalation of carbon dioxide were made an hour later.

The results on all five of the men were closely similar. None felt either the exertion of the respiratory strain to be at all increased by the inhalation; but rather the contrary. All noted the greater regularity of their breathing with the gas on than with it turned off. This subjective evidence was also in accord with objective findings from pulse counts and measurements of arterial pressure made immediately after the climbs. The average pulse rate was the same after the ten climbs in which carbon dioxide was inhaled than it was after the ten climbs without the inhalation: 126 heart beats per minute. Without the inhalation the average rise of systolic arterial pressure was 67 mm., namely 108–175. With the inhalation it was only 50 mm., namely, 110–160. Diastolic arterial pressure, instead of rising, was slightly lower after the exertion than before—lower by an average of only 1 mm. without inhalation and 3 mm. with the inhalation. The alveolar carbon dioxide was lowered 0·5 per cent in the control test without inhalation; but was 0·5 per cent higher after the exertion than before when the inhalation was used.

These effects are not large, but on the whole the evidence indicates that the exertion was made with somewhat less strain on the heart and respiration with inhalation of carbon dioxide than without. The reason appears in the fact that excessive loss of carbon dioxide was prevented. On the contrary, the alveolar carbon dioxide was raised. The supply of oxygen was thus protected and its utilisation aided by the influence of the carbon dioxide upon the Bohr-Haldane[1] relations of the blood gases.

In addition to these experiments, observations were made upon thirty tourists who were more or less affected with mountain sickness and who, out of several hundred visitors to the Peak, submitted to be treated and examined. All had made the ascent either by the cog railway or by automobile. In most of these cases cyanosis or pallor, dizziness, headache and nausea had developed when they walked about on the summit or came into the warmer air of the lunch room. In extreme cases, periodic breathing, confusion, muscular cramps and twitchings, and low blood pressure or even fainting occurred before the inhalation was administered.

The inhalation was usually continued for only 2–3 minutes at a time. The effects were in most cases subjectively beneficial. None felt the worse for it. The colour of their lips was distinctly improved. Respiration was in all cases changed from irregular, or even intermittent, to a regular and deep rhythm, but was seldom increased in rate. Systolic arterial pressure was not altered significantly, that is, only from an average of 105 mm. to 103 mm. The average diastolic pressure, on the contrary, was raised from 62 mm. to 69 mm., while the pulse-rate was decreased from an average of 92 to 82 per minute. Considering that these figures were the averages on thirty subjects, they are, we think, significant of distinct benefit from the inhalation.

The only persons whose conditions changed disadvantageously were two men who had ascended the peak on foot, arriving in a state of exhaustion, who developed conditions verging on collapse just as the inhalation was started. Their condition appeared so serious that instead of continuance of inhalation, arrangements were made for them to be immediately conveyed down the mountain. It is probable that their collapse was due to their exhaustion and that it would have developed anyway, as is often the case, as soon as they stopped climbing. It seemed safer, however, not to continue the inhalation, lest it should be blamed for their subsequent condition.

Our conclusions are that, at least up to an altitude of 14,000 ft. (barometric pressure 450 mm.) inhalation of a small amount of carbon dioxide with the inspired air is distinctly beneficial in protecting against both acapnia and anoxia during and after vigorous physical exertion. As the effects were even better on those who had made no great exertion, we suggest that such an inhalation might be of considerable value also for passengers travelling by air at altitudes up to at least 14,000 ft. Tests at greater altitudes on mountaineers and aviators are deserving of trial. For this purpose, carbon dioxide has one advantage over oxygen: much less is required.

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Light-Waves as Units of Length

By DR. W. EWART WILLIAMS, King's College, London

THE standard of length measurement in any age gives us a fairly true picture of the general requirements of the time. King David of Scotland (*c.* A.D. 1150) ordained that the Scotch inch should be the mean measure of the thumbs of three men, "an merkle man, an man of measurable stature and an lyttel man", the thumbs being measured at the root of the nail. The history of the transition to our present-day standards was admirably related by Sir Richard Glazebrook in his Guthrie lecture to the Physical Society in 1931.

For more than a century, scientific men have been attracted to the idea of establishing the unit of length on the basis of some natural standard, as in the famous dream of Arago[1], "une mesure susceptible d'être reproduite quand même des tremblements de terre, des cataclysmes épouvantables viendraient à bouleverser notre planète et à détruire les étalons prototypes gardés aux Archives". The metre was originally intended to be one millionth part of a meridional quadrant of the earth, and the yard, if ever lost, was, according to the Weights and Measures Act of 1824, to be replaced by reference to the length of a pendulum (in vacuum) beating seconds at sea-level in London. Various difficulties finally led to the adoption of purely arbitrary units, and the metre and yard became the distances between marks on bars kept at Sèvres in France and at the Standards Office of the Board of Trade in London.

The idea of employing a light-wave as the standard of length was frequently proposed during the nineteenth century. Clerk Maxwell[2], in an eloquent address to the British Association at Bradford in 1873, pointed out that: "Each molecule therefore throughout the universe bears impressed on it the stamp of a metric system as distinctly as does the metre of the Archives at Paris or the double royal cubit of the temple at Karnac". Pierce[3] in 1879 attempted a precision measurement of the wave-lengths of the sodium lines, and with improved diffraction gratings the work was repeated by Bell[4] in 1887. The first description of a method that would ensure sufficient accuracy was given by Michelson and Morley[5] in 1887 and in more detail in 1889.

With the assistance of Dr. Gould, the American representative on the newly-formed International Committee of Weights and Measures, Michelson[6] was able to use his new type of interferometer, and in collaboration with Benoit, succeeded in making a direct determination of the number of waves of the red radiation of cadmium contained in the metre. In the usual Michelson interferometer, the light first falls on a half-silvered mirror so that the reflected and transmitted beams, of approximately equal intensity, are mutually perpendicular. The beams are then reflected back on their own paths by two fully silvered mirrors. With equality of optical paths and a slight tilt of either mirror, white light fringes can be observed in the beam emerging from the semi-silvered plate.

For the purpose of the metre determination, one of the fully silvered mirrors was replaced by an 'étalon' consisting of two parallel mirrors, one above the other in a stair formation; nine such units, with mirror separations ranging from 0·39 mm. to 10 cm., were constructed so that the labour and uncertainty of counting a large number of fringes might be avoided. The exact details need not be entered into here, but it should be clearly emphasised that although only the number of fringes in the smallest unit had to be actually counted, the method was such that the number of wave-lengths in the (double) path of the largest étalon was obtained to within a few hundredths part of one fringe. A mark on this étalon was placed in line with one of the fiduciary marks of the working standard metre by means of a travelling microscope, and white light fringes were obtained in the upper étalon mirror by suitably adjusting the reference mirror of the interferometer. When the unit was moved until the fringes appeared in its lower mirror, it meant that the étalon had been displaced by exactly its own length; this procedure was repeated, in all ten times, so that any error in the determination of this basic étalon is increased tenfold. Finally, the small difference between the alignment of the second metre mark and the new position of the étalon mark is measured by means of a travelling micrometer. This distance, of the order of a few hundredths of a millimetre, is so small that any uncertainty in the previously known value of the wave-length can have no influence on the result. It should be mentioned that the working standard metre has also to be compared with the available national standards, and these in turn have been similarly compared with the prototype metre itself by means of travelling microscopes in an arrangement that is termed a line comparator.

The fringes given by a Michelson interferometer are invariably broad, however monochromatic the source may be; in effect, we have two virtual sources, so that the bright and dark portions have equal width.

Hamy[7] in 1897 discovered the important fact that multiple reflection made it possible to obtain considerably narrower fringes with a corresponding increase in the resolving power. He constructed an interferometer consisting of a thinly silvered plate mounted in front of, and parallel to, a fully silvered mirror. When the fringes are observed by transmission through two semi-silvered surfaces instead of by reflection, the arrangement constitutes the Fabry-Perot interferometer, which has found wide application in the study of the structure of spectral lines.

Benoit, Fabry and Perot[8] used the latter instrument as the basis of an entirely distinct method of standardising the metre in terms of wave-lengths. The order of interference of the circular fringe system of an étalon with a plate separation of approximately 6·25 cm. was first determined by means of Benoit's fractional part method, since the wave-lengths of a number of lines were already known with sufficient accuracy for this purpose. This order of interference is the number of waves contained in the double path of the étalon.

The next step was to obtain the path difference (in wave-lengths) between a single reflection in a similar unit of twice its size, and a double reflection in the basic unit the value of which is already known. This was accomplished by arranging the units in line, so that a beam of white light could be passed through both and the well-known Brewster fringes obtained. The exact difference was found by introducing a previously calibrated wedge into the beam. The process was repeated with successively larger units until the 100 cm. standard had been reached.

Instead of attempting to set the cross-wires of the microscope comparator on the silvered edges of the plates when comparing it with the working metre, the measurements were made to rulings on the edges of the plates close to the surface and similar in character to the marks on the metre. By means of a subsidiary experiment, probably the most ingenious and beautiful example of fine experimental work in the whole field of metrology, the correction factor, which is the total distance from these marks to the effective reflecting planes, was determined with the greatest possible precision.

The now classical work of Benoit and his collaborators, completed in 1907, was generally considered to be so accurate that a further determination was felt to be unnecessary. The wave-length of the red radiation of cadmium then found has been accepted and still remains the spectroscopic standard of length of the scientific world.

As a step towards the eventual adoption of a wave-length as the fundamental unit of length, the International Committee of Weights and Measures[9] urged the various national laboratories to carry out similar investigations using their own national standards.

The first results were those of Watanabe and Imaizumi[10]. Their apparatus, constructed by Hilger, was almost identical with that of Benoit, Fabry and Perot. A difference of 0·002 A. was initially observed between the values of the wave-length of the red line as determined from the two Japanese standards No. 10 and No. 20. Agreement was obtained when these prototypes were later compared with the International sub-standards at Sèvres, and fresh values were found for their exact individual length.

The results of a determination carried out at the Physikalische Technische Reichanstalt, Berlin, have been given by Kösters[11]. The details of the method have not yet been given, but presumably, in view of the earlier intercomparisons of the cadmium and krypton wave-lengths described by Weber and Lampe[12], the method is based on Kösters's application of the Twyman and Green[13] interferometer. This consists of a modification of the Michelson instrument, in which the straight localised fringes are observed by using a point source at the focus of a lens, the eye replacing the eyepiece of the telescope.

Sears and Barrell[14], of the Metrological Department of the National Physical Laboratory, have recently published the preliminary results of a systematic investigation of the problem extending over the last ten years. A description of the actual apparatus has been previously given[15]. As will be seen in a later section in which the various results are analysed, the work is of the greatest importance; and not only the authors but also the Laboratory and its directorate deserve to be congratulated on the initiation and planning of such a comprehensive programme, the first stage of which has been completed.

The authors have approached the problem from an entirely different angle; instead of setting themselves the problem of finding the number of waves contained in the metre, they have primarily determined the number contained in standard gauges of approximately one metre length. This they can find with an accuracy far exceeding that possible in a direct metre determination, so that the lengths of various other gauges (in terms of wave-lengths) can be ascertained with a precision hitherto considered impossible.

The first part of the method is basically that of Benoit, Fabry and Perot. The number of waves in a $\frac{1}{12}$ or a $\frac{1}{9}$ metre étalon is determined and the unit is used for direct comparison with a $\frac{1}{3}$ metre étalon by means of Brewster's fringes. The step-up of four or three times instead of the

double step formerly used only involves a slight reduction in the clearness of the fringes. The calibrated wedge is omitted and the exact multiple of optical paths is obtained by tilting the larger unit, a method due to Fabry and Buisson[16].

An X-section gauge, the ends of which are optically parallel, is mounted inside the third étalon, which has to be slightly longer than a metre in order to accommodate the metre gauge. The Brewster fringes, given by three reflections in the intermediate standard and one in the larger unit, are observed in turn through each of the four channels or apertures formed by the X-section. Thus the mean length A of the largest étalon in wave-length units becomes known. The ends of the X-gauge do not touch the half-silvered étalon surfaces; the path differences B and C between the polished ends of the gauge and the silvered surfaces are determined by means of the circular Hamy fringes using Benoit's fractional part method. The *optical* length of the gauge is therefore A–B–C wave-lengths, and its mechanical length is also known provided the phase change on reflection at the gauge surfaces is determined by a subsidiary experiment. This has been the primary purpose of the investigation.

In order to obtain the number of waves in the metre, an auxiliary gauge approximately half an inch shorter is employed, together with two further half-inch end gauges at the centres of which fine lines are engraved. If a half-inch gauge is wrung in contact with the auxiliary, a metre end standard is obtained which can be compared directly by interferometric methods with the X-section gauge. When both blocks are wrung, one on each end of the auxiliary, the composite gauge forms a metre line standard which can be compared with the national standard in a line comparator. By taking observations with the blocks contacted in all possible ways, the effects of slight irregularities and differences in the blocks and their bisecting lines are eliminated.

In the determination of the yard, the same étalons were used but the X- and the auxiliary gauges were 36 and 35·5 in. respectively, so that the differences B and C were therefore much greater.

Reference should also be made to the determination of the yard by Tutton[17]. The method involved the actual counting of the number of fringes in a distance of $\frac{1}{16}$ in. By an ingenious system of multiplication, the number of wave-lengths in the yard is determined by means of the Tutton wave-length comparator. The basic unit is, however, too short to yield sufficiently accurate results. This can be seen from the fact that temperature and pressure corrections for the basic unit are negligible, while they are applied to the greater lengths determined in terms of this unit. On the other hand, the accuracy is considerably greater than the one part in fifty thousand which a casual inspection of the method seems to imply.

For the sake of completeness, it might be recorded here that the writer[18] has proposed an entirely different method whereby the length of a metre gauge in the wave-lengths may be directly obtained from two observations. A suitable reflection echelon is to be used and any errors due to optical multiplication are eliminated.

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(*To be continued.*)

Obituary

PROF. M. I. PUPIN

BY the death of Michael Idvorsky Pupin in New York on March 12 at the age of seventy-six years, we lose a mathematical physicist who has played an important part in engineering progress since the end of last century. The son of Serbian peasants, he emigrated at the age of sixteen years to New York, where he started to earn his living with only five cents in his pocket. After many struggles, during which he supported himself by manual labour, he gained free tuition at the entrance examination to Columbia University in 1879 and distinguished himself by winning many prizes both for his studies and at athletics. After graduating, he became a naturalised citizen of the United States.

Pupin was the first holder of the John Tyndall fellowship at Columbia. He elected to complete his training at Cambridge, England, being attracted by the prospect of studying under Clerk Maxwell and learning about his electromagnetic theory of light. Marion Crawford, the novelist, gave him a letter of introduction to Oscar Browning of King's, but he was away on his summer vacation. Pupin also had a letter of introduction to W. D. Niven, a tutor of Trinity College, who asked him what was his object in coming to Cambridge. He replied that he wanted to study under Clerk Maxwell, and was very surprised to learn that Maxwell had been dead for four years.

Before settling down at Cambridge, Pupin went to

his native village, Idvor, in Hungary, to see his parents. On the way he stayed at Lucerne and was lucky enough to climb to the top of Titlis without accident. When he returned to Cambridge he entered King's College and studied mathematics under Routh. The present writer remembers seeing him there, and was impressed by his striking but un-English appearance. Although he enjoyed Routh's lectures tremendously, Pupin had gone to Cambridge to study physics, and in his interesting autobiography entitled "From Immigrant to Inventor", published in 1923, he says that he thought Prof. J. J. Thomson was too young to teach him much, and he was suspicious of Lord Rayleigh because of his title. Later on, he had the greatest admiration for them both.

After a two months holiday at Corrie in the Isle of Arran, where he read Faraday's "Experimental Researches", Pupin went to the University of Berlin and studied under Helmholtz and Kirchhoff, obtaining a Ph.D. degree. On his return to New York he was appointed to a teaching post at Columbia University, was afterwards appointed adjunct professor of mechanics, and then professor of electro-mechanics in 1901.

In 1896 Pupin discovered secondary X-ray radiation and invented in the same year means for short exposure X-ray photography, by interposing a fluorescent screen before the photographic plate. He invented also improvements in multiplex telegraphy and in methods of tuning for electrical resonance. His most important invention was in connexion with long-distance telephone communication. By means of inductance coils placed at pre-determined intervals of the transmitting line, he greatly extended its range. In almost every country in the world 'Pupin coils' are used, and the enormously rapid development of long-distance telephony during this century has been due mainly to the use of these coils. His first paper on the subject was published in the *Journal of the American Institution of Electrical Engineers* of March 22, 1899.

Although an American citizen, Pupin will long be remembered by thousands of his former countrymen in Serbia—now Yugoslavia. He founded the Serbian House in New York, and fathered and cared for thousands of poor immigrants. He gave princely contributions to the Serbian Red Cross, to refugee funds and to many others, and his ample fortune, made mainly from his tele-communication inventions, was sorely diminished. At Columbia University he was much esteemed and held in affection by the students. He was a member of the executive committee of the National Research Council, a fellow of many scientific societies and an honorary doctor of Columbia and Johns Hopkins Universities.

A. R.

PROF. H. A. GILES

WE regret to record the death on February 13 of Prof. H. A. Giles, formerly professor of Chinese in the University of Cambridge. Herbert Allen Giles was born on December 8, 1845, the son of Dr. John Allen Giles, well-known to many generations of students of the classics as a translator. He was educated at Charterhouse and in 1867 joined the consular service in China, being appointed to Tientsin after a probationary year at Peking. He retired from the service in 1893, returning to England, and in 1897 was appointed professor of Chinese at Cambridge. He held this chair until 1932 when he retired, having done much to foster the study of the Chinese language in the University, and secured its recognition in the 'Little go' in place of Latin or Greek for natives of Asia.

Giles laid the foundations of his scholarship in Chinese during his probationary year in Peking. Within a few years of his appointment to Tientsin, his knowledge of China had progressed so far as to enable him to write with authority on many sides of Chinese life and culture in the *Celestial Empire*. He had also begun work on his monumental Chinese-English dictionary. This indeed was to prove his *magnum opus*. It appeared in parts and in this form was completed in 1892. A new edition, revised and enlarged, appeared in 1912. It won him world-wide recognition as the first European authority on the Chinese language, and in 1911 was awarded the Prix St. Julien of the French Academy. Its pre-eminence in scholarship, however, should not be allowed to obscure the fact that Giles's knowledge of every side of Chinese life and culture was profound. Nowhere, perhaps, does this come out more clearly than in Giles's lighter works, and his "Strange Stories from a Chinese Studio" and "Quips from a Chinese Jest Book", no less informative than they are amusing, with their instructive notes and comments, might well serve as an introduction to most aspects of the many-sided Chinese mentality.

From 1870 onward, Giles was busily engaged, in such leisure as his consular duties afforded, in studying and in writing on the life, art, religion, language and history of the Chinese people. A long list of substantial and authoritative works stands to his credit, of which the best known, next to his dictionary, is "A Chinese Biographical Dictionary". His achievement was recognised by many honours, among which may be mentioned the Order of Chia Ho, conferred by the Chinese Government, the award of the triennial gold medal of the Royal Asiatic Society and honorary degrees from the Universities of Oxford and Aberdeen.

WE regret to announce the following deaths :

Prof. J. J. R. Macleod, F.R.S., regius professor of physiology in the University of Aberdeen, formerly professor of physiology in the University of Toronto, on March 16, aged fifty-eight years.

Prof. B. M. Wilson, professor of mathematics in University College, Dundee, formerly lecturer in pure mathematics in the University of Liverpool, on March 18, aged thirty-eight years.

Major-Gen. Sir Richard M. Ruck, of the Royal Engineers, known for his scientific work in submarine mining, chairman of Council of the Royal Aeronautical Society from 1912 until 1919, on March 18, aged eighty-three years.

News and Views

Centenary of the Geological Survey of Great Britain

THE Geological Survey of Great Britain is the oldest national geological survey in the world, having now been in active existence for a hundred years. It owes its inception to the private enterprise of the late Sir Henry Thomas De la Beche, who became its first director. Geological material was quickly accumulated and De la Beche was compelled to ask for museum accommodation. This was provided in a house in Craig's Court, Charing Cross, where it was opened to the public in 1841, as the Museum of Economic Geology. In 1851, the Museum was transferred to Jermyn Street, where it has continued until recently. For many years past, however, the space available has been inadequate, and it has been impossible to display to full advantage the very extensive collections of rocks, fossils and minerals in the possession of the Survey and Museum. In 1912, the Bell Committee recommended the transfer of the Museum and Survey to a site in South Kensington next to the Natural History Museum, but no action was taken until the Museums Commission met in 1927. The Government then agreed to the transfer, and the new building was completed by H.M. Office of Works in 1933. Occupation by the Geological Survey was, however, delayed by its utilisation as the meeting place of the World Economic Conference, 1933.

Opening of the New Museum of Practical Geology

IT is now announced that the new Museum of Practical Geology will be formally opened next July. Advantage has been taken of this to arrange a joint celebration of the centenary of the Geological Survey and the opening of the new Museum. In the new Museum at South Kensington ample accommodation has been provided to display the exhibits in a building specially designed to meet modern museum requirements. New material has been acquired from many sources and the extent and scope of the exhibits has been enlarged. For the past three or four years, geologists of the Survey and Museum have been mainly engaged in rearranging and bringing up to date the collections, their normal field work being subordinated to the needs of the Museum. At the back of the Museum new offices have been provided for the Geological Survey, together with modern laboratories for the prosecution of petrological and mineralogical research. Enlarged accommodation has been provided for the Library and collection of maps which, as in the past, will be available for consultation by the public. The Museum is to be opened by the Duke of York on July 3. On July 4 there will be a morning reception of delegates to the Centenary, followed by an address by the Director of the Survey on the history and functions of the Geological Survey of Great Britain. On the evening of July 4 there will be an evening reception by H.M. Government. Excursions to several of the classic areas of British geology follow immediately after the meetings. It is expected that a large and representative gathering of geologists from all parts of the world will be present for the celebration.

Dr. J. Chadwick, F.R.S.

DR. JAMES CHADWICK, fellow of Caius College, Cambridge, and assistant director of research in the Cavendish Laboratory, has been appointed to the Lyon Jones chair of physics in the University of Liverpool as from October 1 next, in succession to Prof. L. R. Wilberforce, who retires at the end of the present session. Dr. Chadwick is one of the most distinguished of the younger physicists in Great Britain. His early work on α-, β- and γ-radiation led to the experimental proof of Moseley's deduction that the charge on the nucleus was equal to the atomic number. Then, in association with Lord Rutherford, he carried out investigations on the anomalous scattering of α-particles by light elements, which gave information on the size and structure of the nucleus of the atom, while another line of work demonstrated the artificial transmutation of certain lighter elements by α-particle bombardment. Improvements in the technique of counting such particles led to the discovery of definite nuclear α-particle and proton levels. The obscure effects observed by M. and Mme. Curie-Joliot when beryllium was bombarded with α-particles were investigated by Dr. Chadwick, and immediately he recognised that they could be explained by assuming the ejection of a particle having mass but no charge. This assumption he quickly proved in a brilliant series of experiments, and a new elementary particle, the neutron, which has proved of wide importance in investigations on atomic structure, was made available to the physicist. The value and originality of Dr. Chadwick's work has been recognised by his election to a fellowship of the Royal Society, by the award of the Hughes Medal of the Society in 1932 and other distinctions.

Racial History of Britain

A LETTER to *The Times* of March 13 puts forward on behalf of the Royal Anthropological Institute proposals for a comprehensive survey of the racial history and physical constitution of the inhabitants of Britain—a matter in which action is long overdue. It is a remarkable fact, and one which was not generally appreciated until necessity arose during the War, that so little should be known of the physical characters of the British population as a whole. The racial character of the British peoples in prehistoric and early historic times, as preserved in skeletal remains in museums, has received attention from time to time, but piecemeal; and more or less extended investigations of the present population have been carried out in parts of Scotland, Wales, England and Ireland; but no organised attempt has been made to correlate this material or to extend it systematically. The proposals now put forward

provide for both the examination of the skeletal material preserved in museums and anatomical collections and the measurement by trained observers of groups of the existing population all over the country. Arrangements will also be made for the reduction and digestion of the material when collected, and for its publication.

THE projected survey is an object which is deserving of strong public support. Not only will the results be of the greatest scientific importance, as they will fill a gap in our knowledge of the composition of the British people which is much to be deplored, but they will also afford data of great significance, and from some points of view essential, in the consideration of a number of social and medical problems. The survey will involve expenditure on instruments, travelling for purposes of observation and publication, towards which contributions are invited from the public in an appeal supported by, among other signatories, Lord Onslow, Lord Raglan, Lord Meston, Sir Richard Gregory, Sir Henry Wellcome and the Rev. Edwin Smith, president of the Royal Anthropological Institute. Contributions should be addressed to the Treasurer, Royal Anthropological Institute, 52 Upper Bedford Place, London, W.C.1.

Expedition to New Guinea

PLANS for the exploration of the country in the neighbourhood of the Sepik River in the mandated territory of New Guinea, which have been in preparation for some time, are now approaching completion; and Mr. G. M. Dyott, the leader, will leave shortly with two other members of the expedition for Australia, where he will be joined at Sydney by Mr. H. L. Williams, the Australian anthropologist, who will complete the personnel of the party. For some time past, the exploration of the Sepik River country has been an object of ambition of anthropologists and geographers alike. The greater part of it is entirely unknown. Last year, Mr. E. W. P. Chinnery, in the course of an official tour of duty as Government anthropologist, penetrated to the eastern boundary of the unknown territory. He reached the summit of Mount Hagen, and in his reports records how from a lofty plateau there he was able to look out over this country.

MR. CHINNERY came into touch with hitherto undescribed peoples having many remarkable features in their culture, who were still living in the stone age (see NATURE, **134**, 328; 1934). In the account of his experience which he has since published, he describes signs of occupation in the unvisited tableland below, which point to a system of cultivation differing from anything previously recorded in New Guinea. Mr. Dyott's expedition, in addition to making a plane-table survey of the country traversed, will devote special attention to the culture of the peoples in the Sepik area. It is also hoped to obtain conclusive evidence of the existence of the so-called 'devil-pig', a cloven-footed graminivorous animal, of which Mr. Monckton, formerly a resident magistrate in New Guinea, claimed to have observed the tracks, but of which knowledge otherwise rests on the report of the Papuans. They fear it greatly. The expedition is supported by the Australian Commonwealth Government and the Royal Geographical Society. The collections which the expedition hopes to make will be divided between the Pitt Rivers Museum, Oxford, and certain institutions in Australia.

Vertical Take-off with the Autogiro

SEÑOR DE LA CIERVA, lecturing before the Royal Aeronautical Society on March 15, made the first public announcement of the fact that he has produced a type of his autogiro that has achieved direct lift off the ground without any forward run. This was shown by the exhibition of cinema films in which the machine was seen to rise without displacing chocks placed in front of the wheels. Combined with its already proved ability of alighting with a practically negligible run, this makes it possible to visualise aircraft of this type operating from aerodromes of much smaller area, and less carefully kept surface, than hitherto. Sea-going operations, either from rough water or ship decks, are also facilitated by the absence of the need of horizontal run.

THE combination of vertical lift followed by horizontal flight at the desired instant is attained by altering the pitch angle of the horizontal rotating lifting surfaces of the autogiro. These are set at the angle of no lift while the rotor is speeded up by a torque applied from the engine. When the speed of rotation is considerably greater than that necessary for normal horizontal flight, the rotating mechanism is declutched, and simultaneously the angle of the surfaces is set to that for high lift. Thus a lift in excess of the weight of the machine is created, and it rises. When this impulse is expended, the machine would normally begin to descend, but in the meantime the full engine power has been changed back to the normal airscrew, and a thrust sufficient for horizontal flight is operating. This takes charge and the machine continues in horizontal or normal climbing flight at the will of the pilot. The machine appears to leap only three or four feet in the films shown. Señor Cierva suggests that while jumps of the order of 60–100 ft. are theoretically possible without needing prohibitive accelerations, an initial height of about 20 ft. is all that practical considerations demand.

Television

THE recent publication of the report of the Postmaster-General's Committee on Television has aroused considerable interest in this subject not only among those technically interested in radio communication and broadcasting, but also among the general public, who now definitely envisage the prospect of being able to 'look' as well as 'listen'. This interest has naturally given rise to a demand for literature, both technical and popular, on the subject. During the past year or so, however, progress in the technique of television at both the transmitting and receiving end has been so rapid that most of the books at

present available are useful only in explaining the fundamental principles of television or of illustrating the historical development of the subject, which dates back some sixty years. With the object of temporarily filling this gap in the literature, the issue of the *Wireless World* of March 8 incorporated as a supplement a "Television Guide", comprising a 30-page booklet giving a simple explanation of the subject adequately illustrated by diagrams and photographs. This guide assumes a knowledge of electricity and the principles of radio communication on the part of the reader; the principles involved in television are clearly explained, together with the use and limitations of mechanical scanning systems. The manner in which the cathode ray oscillograph tube has been introduced into the art is described, with the resulting accelerated progress towards high definition television. The most recent developments of picture transmission technique are dealt with, including Zworykin's iconoscope and Farnsworth's image dissector as alternative scanning systems, and the use of the intermediate cinematograph film for the broadcasting of current events. The trend of this supplement to the *Wireless World* is definitely to explain the principles of the subject to the future owner of a television receiver, and as such, it may be said to form a useful appendix to the report of the Postmaster-General's Committee.

Safe Passing Speeds for Motor-Cars

EVERY driver of a motor-car who desires to pass another car going in the same direction has to consider the problem of whether it is possible or not. Apart from the question of whether there is another car coming round the bend of the road in the opposite direction, he has to consider whether there is sufficient clear space ahead. According to a Science Service message, Dr. H. C. Dickinson, of the U.S. Bureau of Standards, has completed tests to find out how much clear space is necessary. Assuming a speed limit of 45 miles an hour and that cars travelling 50 miles an hour are tolerated, he finds that a distance of 900 ft. is required for safe clearance. The time required to pass on a level road depends only on their relative speed of five miles an hour, and is nearly six seconds. If the vehicle ahead is moving at 20 miles an hour the distance required is 650 ft., 200 ft. being required for the actual passing and 450 ft. being the necessary allowance for a car approaching at 50 miles an hour. The Highway Research Board of the U.S. National Research Council points out that, considering the number of roads in the country where clear stretches of 900 ft. are rare, there is often a serious risk when passing another car at high speed. In mountainous country, winding and hilly roads would come under this category. Dr. Dickinson's figures apply to a car passing only one car ahead; when long lines of cars 'pile up' on the road, greater distances are required for safe passing.

Library of the University of the Witwatersrand

THE University of the Witwatersrand was the scene of a disastrous fire three years ago, when the greater part of its library, including the Gubbins and the Hoernle anthropological collections, was destroyed. Appeals for help led to a very substantial measure of replacement, gratefully acknowledged by the University in a letter to the Appeal Committee in London, which has now issued its final report. In this, the chairman, Sir Frank Heath, observes that, while it is impossible to mention individually all the contributors, including learned, technical and scientific societies in England and America, universities and colleges throughout the British Isles and Canada, industrial firms, industrial research associations, British Government departments and the leading missionary societies having stations in South Africa, very special thanks are due to the British Association, the London School of Economics and Imperial Chemical Industries, Ltd. New College, Oxford, and the Imperial College of Science and Technology helped to defray expenses of collection, packing, transportation and insurance. The Union-Castle Steamship Co. undertook the transport of books at a discount of 50 per cent on the ordinary freight charges, and the High Commissioner for the Union of South Africa lent an office rent-free. The Universities Bureau of the British Empire placed its council room at the disposal of the Committee for its meetings. Besides books and manuscripts, a large quantity of pictures, coins, etc., was collected which will form the nucleus of a Johannesburg municipal museum. Some 32,000 volumes in all were dispatched by the Committee.

A Giant Tortoise

A FINE specimen of Porter's black tortoise (*Testudo nigrita*) has just been added to the Tortoise House of the Gardens of the Zoological Society of London. This is one of several species attaining a relatively gigantic size, which, a hundred and fifty years ago, swarmed in the Galapagos Islands, the Mascarene Islands, the Aldabras and the Seychelles. Then they attracted the attention of mariners, who forthwith began to visit these islands and carry away their victims by the boat-load. Exploitation of this kind, whether of tortoises or whales, inevitably ends in extermination. On only a very few of these islands are any survivors to be found to-day. But it fortunately happened that many species were taken to other islands, where they bred. This was the case with the species which has just come to the Zoo. For Capt. Porter, on his voyage from the Galapagos, in 1813, distributed several young tortoises from his stock among the chiefs of the Fiji Islands. Many of these escaped, and bred there. The great size of these animals is shown by the fact that the shell of the various species ranged from three to six and a half feet along the curve. Until its death, a few years ago, the largest living tortoise known was owned by Lord Rothschild. This was a specimen of *Testudo daudini*, of the South Island of Aldabra, taken, with six others, in 1895. The length of the shell was 55 in., or 67½ in. over the curve. The total weight was 560 lb. But even this was a mere pigmy compared with the extinct fossil tortoise (*Colossochelys atlas*) from the Lower Pliocene of the Siwalik Hills, India, which had a shell eight feet in length.

Leukon Synthetic Resin

A NEW synthetic resin known as 'Leukon' was exhibited in granular thermo-plastic moulding form at the British Industries Fair by Imperial Chemical Industries, Ltd. The main physical properties of the material are stated to be as follows: density 1·2 at 20° C., impact strength 4 kgm. cm. (Charpy units), tensile strength up to 10,000 lb. per sq. in., cross breaking strength 80/85 lb. cantilever, Young's modulus 227 tons per sq. in. The material flows before breakdown under high pressure. As regards the chemical properties of the material, it is said to be insoluble in water, alcohol and aqueous media, to be unaffected by acids or alkalies up to concentrations of 40 per cent in the case of sulphuric acid and caustic soda at atmospheric temperature, and to be unaffected by many high boiling organic esters. It is soluble in certain of its forms in a number of organic solvents, including acetone, chlorinated hydrocarbons and benzene. The material machines easily, can be die-stamped at 120°–140°, has very good insulating properties and low thermal conductivity. A property which is emphasised is the capacity of the material for colour, in transparent, translucent or opaque forms.

The Prehistoric Society of East Anglia

AT the recent annual meeting of the Prehistoric Society of East Anglia, held at the Norwich Castle Museum, it was resolved that in future the title of the Society shall be "The Prehistoric Society". Dr. J. G. D. Clark, in proposing the change, directed attention to the fact that the Society is no longer predominantly East Anglian either in membership or scope of work, and emphasised the point that the recognition of the Prehistoric Society as the only society operating on a national basis exclusively in the sphere of prehistoric archæology will be a contribution towards the much-desired rationalisation of the subject in Great Britain. The Prehistoric Society of East Anglia was founded in 1908 by the late Dr. Allen Sturge and the late W. G. Clark of Norwich. From very small beginnings it has grown until the membership now approaches 400 and includes the leading prehistorians in this and many other countries. Prof. L'Abbé Henri Breuil, the retiring president, is succeeded by Prof. V. Gordon Childe, with Mr. M. C. Burkitt as vice-president, Dr. J. G. D. Clark as editor and Mr. G. Maynard, curator of the Ipswich Museum, as honorary secretary.

The Philosophy of Sir James Jeans

IN the December number of *Adult Education*, Prof. L. Susan Stebbing subjects Sir James Jeans's recent presidential address to the British Association to searching criticism. She complains that he has rated the intelligence of his hearers and readers too low by presenting them with contradictory statements concerning Nature, space and time, and knowledge. Some of the questions raised were referred to in our leading article on the address which was published in NATURE of September 8 last, but Prof. Stebbing makes no attempt to penetrate to the vital ideas which were expressed, however imperfectly, by Sir James Jeans; she contents herself with pointing out the imperfections. As destructive criticism, the paper is of value, though, in the absence of counter-balancing constructive thought, it achieves less than its full potentialities. Prof. Stebbing fortunately does not make the common error of supposing that a single statement, by however distinguished a physicist, represents the unanimous view of 'physics'. "The point to be maintained here," she says, "is that these cloudy speculations cannot properly be regarded as 'philosophical implications' of the new 'physics'." This goes far to justify what might otherwise be construed as a philosopher's attack on the philosophical tendencies of modern physics.

Biology, a new Journal

WITH the object of helping teachers of biology in different types of schools at home and abroad, the British Social Hygiene Council has launched a new journal, *Biology*. It is hoped that the magazine will "serve as a medium for the interchange of ideas and information on practical and pioneer ventures in biology teaching". The scope of *Biology* is suggested by the articles in the first number. They include one advocating microscope work, dissection and physiology of growth and development in elementary biology teaching; another describing the methods in use in African dependencies. More general articles deal with plant communities and the school; the value of the micro-projector; biological activities out of school; and biology and general science in the First School Examination. The hesitation and delay in the introduction of biological teaching in schools throughout Great Britain is due largely to the indefiniteness of the subject's boundaries, and the lack of well-organised graded courses of fairly definite content. If *Biology* can lead to the development of such courses by pooling information, it will be performing great service to the science of life.

Research on Causes of Blindness

MR. WILLIAM H. ROSS, chairman of the Distillers' Company, Ltd., who is himself totally blind, has recently given £40,000 to establish in Edinburgh an organisation "with the object of investigating the origin and causes of blindness, and utilising the results of such investigation towards its prevention and cure". The income from the money will be applied partly to research work on blindness, and partly to practical measures for its prevention and for the preservation of sight. The chairman of the trustees is Dr. Arthur H. H. Sinclair, president of the Royal College of Surgeons of Edinburgh.

New Australian Research Laboratories

Two new research laboratories are to be built for the Commonwealth Council for Scientific and Industrial Research, using money voted for relief of unemployment. One, at a cost of £6,000, will replace an existing small building at the Council's viticultural research station near Mildura on the River Murray,

where investigations into problems of the dried grape fruits industry have been in progress for many years. The other will house the Forest Products Division, which hitherto has carried on in temporary quarters in Melbourne. The new laboratory, to cost £25,000, will be in the midst of the city's timber yards, and this should mean decided increase in the practical effectiveness of the Division's work.

Geographical Association

THE Spring Conference of the Geographical Association will be held at University College, Nottingham, on April 26–29. The meeting will include, in addition to several lectures and discussions, a long excursion to Southwell and Ollerton and visits to the tobacco factory of Messrs. J. Player and Sons, the hosiery factory of Messrs. J. B. Lewis and Sons, and Messrs. Boots new chemical factory. Members will be accommodated as far as possible in the Hugh Stewart Hall of Residence. Applications for accommodation and attendance at excursions should be made, before April 6, to Mr. N. V. Scarfe, University College, University Park, Nottingham.

Astronomical Exhibition in Paris

AT the next General Assembly of the International Astronomical Union, to be held at Paris on July 10–17, the French National Committee of Astronomy is arranging an exhibition of astronomical documents and apparatus, to exhibit the principles and the details of application of the methods of observation employed. The examination of actual instruments shows better than any description how they are applied, while original negatives or positives on glass will enable the quality of the results obtained to be judged. The exhibition will enable astronomers to examine the documents serving as the foundation of the astronomical discoveries of the present century. It is particularly hoped that auxiliary apparatus and accessory contrivances of all kinds will be exhibited by observatories and instrument makers: such instruments are micrometers, chronographs, photometers, spectrographs, driving motors, observing sheds and seats, abacuses, numerical tables and calculating machines. Inquiries can be addressed to M. le Comte de la Baume Pluvinel or to Prof. C. Fabry at the Paris Observatory.

Sixth International Congress for Scientific Management

THE Sixth International Congress for Scientific Management, the first congress of its kind to be held in Great Britain, will take place on July 15–20 and will be opened by its patron, the Prince of Wales. It will discuss commercial, agricultural and domestic problems and how far the adoption of the most scientific principles of management has facilitated their solution. Some three hundred chairmen, managing directors and professional and scientific men have so far enrolled, and the standard of the papers received from all parts of the world is most encouraging. The organisation of the Congress is in the hands of a Council convened by the Federation of British Industries. Subjects to be discussed include: manufacturing, distribution, development, agricultural, educational and training, and domestic. There is every indication that a really important gathering will take place. H.M. Government is to invite members to a reception, and the Lord Mayor and Corporation will receive them in the Guildhall. A series of visits to factories and institutions will take place in the week following the Congress. Invitations to the Congress containing membership forms and full details may be obtained from the Secretary, 21 Tothill Street, London, S.W.1.

Catalogue of Microscopes and Accessories

WE have received from Messrs. W. Watson and Sons, Ltd., the new edition of their catalogue of microscopes and accessories (Parts 1 and 2). The pages devoted to principles of construction on the optical bench system, now applied to all Messrs. Watson's microscopes, are of particular interest, and other constructional details in these pages are also noteworthy as evidence of the care devoted to the attainment of rigidity and accuracy. Attention may also be directed to the description of the dark ground condenser which can be made with working distances up to 4 mm. and to the low-power binocular dissecting microscope, strong in build and with two pairs of objectives mounted on a double nosepiece so arranged that the pair not in use is turned into a protected position. A considerable range of lamps for various microscopic purposes includes the Greenough lamp, which rests on the table beneath the microscope stage in place of the mirror and gives an evenly illuminated field, provision being made for centring the filament.

Announcements

SIR JOHN AMBROSE FLEMING has been awarded the Kelvin Medal for 1935 of the Institution of Civil Engineers in recognition of his services to electrical science and particularly of his invention of the thermionic valve. The Kelvin Gold Medal is awarded triennially as a mark of distinction in engineering work or investigation of the kinds with which Lord Kelvin was especially identified.

AT the meeting of the Australian National Research Council at Melbourne in January, the first award of the Lyle Medal was made, the recipient being Prof. J. R. Wilton, Elder professor of mathematics in the University of Adelaide, for his work in mathematics. This medal is to be awarded, at intervals of two years, to workers in Australia for such researches in mathematics or physics as may appear to the Council most deserving of such honour, the period covered by those researches being the five years preceding each award.

THE services of Prof. R. H. Dastur, professor of botany at the Royal Institute of Science, Bombay, have been secured on loan from the Bombay Government by the Government of the Punjab for the investigation of the cotton crop. His address for some years, therefore, will be the Cotton Research Laboratory, Lyallpur, Punjab.

THE Congress of the German Röntgen Society will be held in Berlin on April 28–30 under the presidency of Prof. W. Baensch, from whom further information can be obtained at his address, Liebigstrasse 20a, Leipzig.

A DISCUSSION on the "Origin and Relationships of the British Flora", to be opened by Prof. A. C. Seward, has been arranged by the Royal Society for the morning and afternoon of March 28. Other speakers will include Mrs. E. M. Reid, Prof. P. G. H. Boswell, Miss M. E. J. Chandler, Dr. H. Godwin, Dr. A. J. Wilmot, Prof. E. J. Salisbury, Dr. G. Einar du Rietz, Mr. H. Davey, Prof. O. T. Jones, Dr. R. L. Praeger, Dr. K. Sandford, Dr. G. C. Simpson, Mr. J. B. Simpson, Dr. W. B. Wright.

AT the annual general meeting of the Microchemical Club held on March 16 at the London School of Hygiene and Tropical Medicine, the following officers were elected for 1935–36: *Hon. Treasurer and Librarian*, Dr. L. H. N. Cooper, Marine Biological Laboratory, Plymouth; *Hon. Secretary*, Dr. S. J. Folley, National Institute for Research in Dairying, Shinfield, Reading. Vacancies on the committee were filled by the election of Miss I. H. Hadfield and Dr. J. R. P. O'Brien.

THE International Association for the Prevention of Blindness will hold a meeting at the Royal Society of Medicine, 1 Wimpole Street, W.1, on April 5, during the Congress of the Ophthalmological Society of the United Kingdom. The agenda are as follows: (1) address by Prof. de Lapersonne, president of the Association; (2) proposed international classification of the causes of blindness, by Prof. van Duyse, of Ghent; (3) hereditary diseases of the eyes ending in blindness and their social consequences, by Prof. Franceschetti, of Geneva.

A SYMPOSIUM on the "Welding of Iron and Steel" will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on May 2–3, under the auspices of the Iron and Steel Institute, in co-operation with the principal engineering and metallurgical societies of Great Britain. The symposium will be divided into four groups, namely: (1) present-day practice and problems of welding in the engineering industries; (2) welding practice and technique, including welding apparatus; (3) the metallurgy of welding; (4) specification, inspection, testing and safety aspects of welding. Further information can be obtained from the Secretary, Iron and Steel Institute, 28 Victoria Street, London, S.W.1.

AN animal welfare society has just been formed in the Otani University, Kyoto, Japan, to be affiliated to the University of London Animal Welfare Society. Prof. Beatrice Susuki, professor of agricultural and forest chemistry, is leader and secretary. Communications addressed to the new society will be received and forwarded by the University of London Animal Welfare Society, 68 Torrington Square, London, W.C.1.

THE Institute of Public Health of the University of Budapest, the sixtieth anniversary of which is to be celebrated this year, is the first institute of the kind to have been founded. In 1882, public health became a compulsory subject in the Budapest faculty of medicine and in 1893 in the faculty of pharmacy. The first director of the institute, Josef Fodor, who was also the founder of the Hungarian Society of Public Health, was a savant of world-wide reputation, and an excellent organiser, thanks to whose efforts the medical supervision of schools became generalised throughout western and southern Europe.

WE have received from the Association of British Chemical Manufacturers, 166 Piccadilly, London, W.1, a copy of "British Chemicals, 1935" (Pp. 459, bound in cloth). This is printed in English, French, German, Italian, Portuguese and Spanish, and gives the names of British manufacturers of classified products, a list of proprietary and trade names of materials, with their manufacturers, and indexes in the various languages. The volume is published gratis, but is obtainable only on direct application to the Association by genuine purchasers of chemicals.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A temporary engineering assistant for the Directorate of Works in the War Office—The Under Secretary of State (C 5), The War Office, London, S.W.1 (March 28). A chemist for rubber research (Malaya and Ceylon)—The Secretary, London Advisory Committee for Rubber Research (Malaya and Ceylon), Imperial Institute, London, S.W.7 (March 28). A principal of the East Ham Technical College—The Secretary for Education, Education Office, Town Hall, East Ham, E.6 (March 30). Two junior assistant bacteriologists in the City Bacteriologist's Department, Liverpool—Town Clerk, Municipal Offices, Dale Street, Liverpool, 2 (April 2). An assistant agricultural officer to the Kent County Council—The Chief Agricultural Officer, Brunswick House, Buckland Hill, Maidstone (April 4). A principal of the Northern Counties' Training College of Cookery and Domestic Science, Newcastle-upon-Tyne—The Secretary, 4 Royal Arcade, Newcastle-upon-Tyne (April 8). An assistant keeper (second class) on the Higher Technical Staff of the Library of the Science Museum—The Director, Science Museum, South Kensington, S.W.7 (April 13). A research worker in cancer—The Research Director, North of England Cancer Campaign, 14 Ellison Place, Newcastle-upon-Tyne (April 14). A demonstrator in organic chemistry at Bedford College for Women, Regent's Park, N.W.1.—The Secretary (April 27). A chemist for the Main Drainage Department of the Ministry of Public Works, Egypt—The Chief Inspecting Engineer, Egyptian Government, 41 Tothill Street, London, S.W.1. A principal of University College, Nottingham—Alderman E. Huntsman, 1 Bridlesmith Gate, Nottingham.

ERRATUM. In the list of members of council of the National Institute of Sciences of India, printed in NATURE of March 16 (p. 442), for "Dr. Baini Prasad" read "Dr. Baini Prashad".

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot 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.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 475.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Radioactivity of some Rarer Elements produced by Neutron Bombardment

EXPERIMENTS on the Fermi effect with some rarer elements have given the results summarised below. The neutrons were obtained from sources of radon, in quantities up to 100 millicuries, sealed in small glass tubes with powdered beryllium, and the radioactivity produced was measured with a Geiger-Müller counter which had been carefully calibrated with weighed amounts of uranium oxide. To utilise the enhanced activity produced by surrounding source and specimen with hydrogen compounds[1] most of the irradiations were carried out in a cavity in the middle of a large block of paraffin wax. The main results obtained are collected in the following table.

Element	Half-life	Relative intensity
Silver	2·33 min.*	1
Iodine	25 min.*	0·7
Europium	9·2 hr. ± 0·1	19
Terbium	3·9 hr. ± 0·1	0·5
Erbium	2·9 hr. ± 0·1	3
Ytterbium (? Lutecium)	2·5 hr.	0·6
Germanium	c.2 hr.	0·1

* Quoted from reference 2.

The relative intensities give a rough comparison of the activities produced per gram-atom when irradiated in the wax block in a fixed position for a time long compared with the half-life. Measurements on silver (2·33 min. activity) and iodine were also made to serve as standards.

Europium, terbium and gadolinium were kindly supplied as very pure oxides by Dr. J. K. Marsh. Europium shows a remarkably high activity compared with that of silver. Since the 20-sec. period of silver gives an intensity about four times that of the longer period, europium gives about four times the total activity of both periods of silver. The 'water effect' for europium was roughly determined and the activity was found to be increased forty times by irradiating the specimen in the wax block. The β-ray spectrum is now under investigation in the Physics Department of this College; the maximum energy is approximately $2{\cdot}0 \times 10^6$ e.v. In addition, γ-rays have been detected which are little absorbed by 4 mm. of lead.

A specimen of pure white gadolinium oxide (Gd_2O_3) which had been freed from europium and terbium[3] gave no detectable activity with the sources used. The activity with a half-life of 8 hours reported by Fermi and his co-workers[2] may possibly be due to the presence of a small amount of europium, which is not easily separated except by the method of electrolytic reduction. The terbia used in these experiments had been carefully purified for atomic weight determinations[3].

Specimens of erbia and ytterbia originally supplied by Merck were kindly lent by Prof. J. F. Spencer. In addition to the strong activity with a half-life of 2·9 hours, erbia gave a much weaker activity with a period of *c.* 30 hours. As, however, the specimen used may contain other rare earths, this period cannot definitely be ascribed to erbium. The ytterbia contained lutecium, so that the activity observed may be due to this element. It is hoped shortly to settle this point by examining specimens of these elements which have been separated by electrolytic reduction.

A specimen of pure scandia from Messrs. Adam Hilger, Ltd., which had been tested spectroscopically and was at least 99 per cent pure, gave no detectable activity when irradiated for 15 hours with 100 millicuries. Another specimen kindly lent by Prof. G. T. Morgan also gave no activity. The activity with a period of 16 hours reported by Hevesy[4] must presumably have been obtained with much stronger sources of neutrons.

I am much indebted to Prof. P. M. S. Blackett for his encouragement and advice whilst this work was in progress.

S. SUGDEN.

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March 9.

[1] Fermi et al., *Ric. Scient.*, V, 2, 7–8; 1934.
[2] Fermi, D'Agostino, Amaldi, Pontecorvo and Segrè, *ibid.*, Jan. 1935.
[3] Marsh, *J. Chem. Soc.*, 1972; 1934.
[4] Hevesy, NATURE, **135**, 96, Jan. 19, 1935.

Curare

IN 1931 Hartridge and West[1] noted a rigidity-removing ('lissive') action of curare in experimental parathyroid tetany in dogs. The application of the drug to diseases involving muscular rigidity in man was undertaken by West in a wide series of cases[2]. As it was observed quite early in the investigations that the 'lissive' action was apparently only present in certain samples of curare and might be due to some constituent other than the 'curarines' to which the classical action of curare is due, a broad chemical survey of the much neglected field of the curares was undertaken by the writer in close co-operation on the pharmacological side with Dr. Ranyard West.

Through the valuable co-operation of the Curator of Forests, British Guiana, we have been able to examine a number of *Strychnos* species, kindly identified botanically by the Kew authorities, for pharmacologically active alkaloids. The species examined, their numbers in the Forest Department Records[3], and their approximate relative total alkaloidal contents are shown in the following table.

Species.	Rec. No.	Alkaloid Content.
Strychnos Erichsonii	2284	++++
,, *toxifera*	2278; 2285	+++
,, *Melinoniana*	2260; 2279; 2286; 2303	++
,, *diaboli*	2295	++
,, *diaboli ?*	2270	+
,, *Mitscherlichii*	2261	0
Guettarda acreana	2317	++++

Of these *Strychnos* species one only, *St. toxifera*, contains an amorphous quaternary alkaloid, to the extent of 0·2 per cent, indistinguishable chemically and pharmacologically from the paralysing principle curarine isolated from calabash or gourd curare from

various native sources. Curarine from either source is readily isolated after suitable preliminary treatment, by precipitation with mercuric chloride, further purification being effected through the sparingly soluble amorphous iodide. This is the first occasion on which curarine has been isolated from *St. toxifera* bark of certain identity, and it confirms Robert Schomburgk's discovery of *St. toxifera* as the source of the main active ingredient of the curare of the Macusi Indians. *Guettarda acreana* is a reputed ingredient of native curare, but although rich in alkaloids, it does not contain a paralysing principle.

Through the kindness of the Department of Ceramics of the British Museum and of Mr. T. E. Wallis, curator of the Museum Department of the Pharmaceutical Society, we have been able to examine native preparations of tubocurare, put up in bamboo tubes and quite distinct from calabash curare as was emphasised by Boehm. The ether-soluble crystalline alkaloid *l*-curine isolated by Boehm from tubocurare has already been shown by Späth, Leithe and Ladeck to be the optical enantiomorph of *d*-bebeerine (α-chondodendrine), an alkaloid found in *Radix Pareirae bravae* (Chondodendron spp.) by Scholtz. The accompanying quaternary alkaloid tubocurarine obtained in an amorphous state by Boehm[4] has now been crystallised for the first time and has a paralysing activity on the frog only slightly less than that of curarine from *St. toxifera*. Tubocurarine is dextro-rotatory and has the empirical formula $C_{19}H_{22}O_3NCl$, which if doubled would make the salt isomeric with bebeerine methochloride. The double structure is supported by the results of *o*-methylation. Although *d*-tubocurarine chloride and *d*-bebeerine methochloride are closely similar in general properties, they are not identical; and *d*-bebeerine methochloride has a paralysing activity on the frog considerably less than that of *d*-tubocurarine chloride.

The nature of the isomerism between *d*-tubocurarine methochloride and *d*-bebeerine methochloride is under investigation; their *o*-methyl derivatives are different, but it is suggested that both will be represented eventually as being built up from two norcoclaurine units[5].

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March 4.

[1] *Brain*, **54**, 312; 1931.
[2] *Proc. Roy. Soc. Med.*, **25**, 39; 1932. *Lancet*, p. 88; 1935
[3] *Kew Bulletin*, **8**, 390; 1933.
[4] *Abhandl. Kgl. sächs. Ges. Wissensch.*, **22**, 201; 1895.
[5] H. King. *Ann. Rep. Chem. Soc.*, **30**, 242; 1933.

Flame Temperatures

WE have expressed the view[1] that flame temperatures determined by the sodium line reversal method are in general far greater than the true flame temperatures (mean molecular translational energy), but considerable criticism has been received which suggests a firmly held opinion that the sodium method measures true flame temperatures—at least approximately. The following facts are put forward in support of our view.

The sodium method and the platinum resistance method (a 0·0005 in. platinum-rhodium wire) yield very nearly (and almost exceptionally) the same temperatures during the combustion of carbon monoxide – air mixtures in the neighbourhood of the 'correct' mixture. But as the mixture strength is varied, the two methods yield temperatures which increasingly differ from one another until a 52 per cent mixture is reached, when the difference amounts to as much as 500° C. The sodium temperatures as measured by Ellis and Morgan[2] (using a Smithell's separator supplied with perfectly mixed mixtures) remain roughly constant over this wide range of mixture strengths at rather more than 1,900° C. (and qualitatively similar results were obtained in the sodium measurements of Loomis and Perrot and Griffiths and Awbery). The platinum wire temperatures, on the other hand, drop through this range of mixture strengths by more than 400° C., and this is much in accord with what would be expected from calculation.

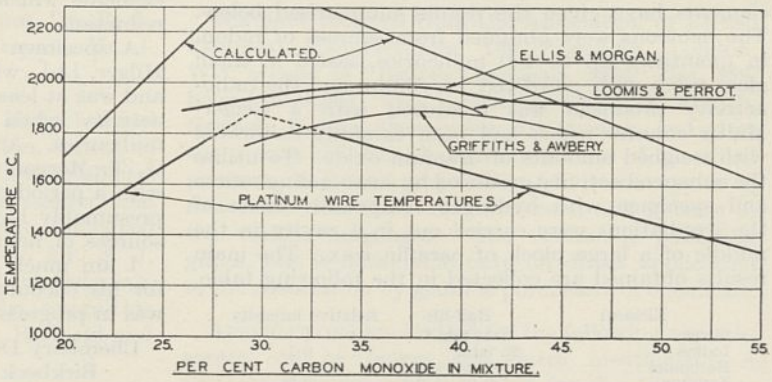

FIG. 1. Flame temperatures in carbon monoxide – air mixtures. The calculated temperatures are shown uncorrected for dissociation. As the actual temperatures in the flame gases are less than 2,000° C., dissociation in them is small and a fairer perspective is obtained by comparing them with calculated temperatures uncorrected for dissociation.

These results may be confirmed by an inspection of curves shown in Fig. 1. It will also be seen that for very over-rich carbon monoxide – air mixtures the sodium temperatures of Ellis and Morgan are much in excess even of the ideal temperatures calculated upon the basis of complete combustion and no radiation loss (some 200° C. in excess in the case of the 52 per cent mixture). An examination of the large numbers of sodium measurements made by Jones, Lewis and Seaman[3] in various hydrocarbon – air flames shows that they too are frequently much greater than the calculated temperatures—particularly in the case of very over-rich mixtures and sometimes in the case of weak mixtures.

In general, then, sodium flame temperatures should not be taken at their face value as indications of true flame temperatures. The error in doing so may amount to hundreds of degrees centigrade. Of course the sodium temperatures must have some significance, and a clue to this may possibly be found in the fact that most of the sodium measurements on record in scientific literature, when examined over a wide range, suggest a tendency towards independence both of the nature of the combustible gas and of the mixture strength; in any event they do not

vary nearly so much as the calculated temperatures.

Our platinum temperatures for all gases so far examined vary with the mixture strengths very much at the same rate as the calculated temperatures, but they are many hundreds of degrees below them[4]. It has been suggested that this is because they require a very large correction for radiation loss. We have given many reasons for the view that our measurements (which we have always given uncorrected for radiation loss) do not require a correction of more than about 40° C. even at the highest temperatures, and indeed if they did they would be much above the sodium temperatures in the neighbourhood of the 'correct' carbon monoxide – air mixtures (see Fig. 1).

Our measurements were made during the pressure period in gaseous explosions, and we took continuous records for a considerable time after the flame front had passed over the platinum wire, but there were no signs of increasing temperature. Indeed the temperature remained remarkably steady.

It was mainly for these reasons that we felt justified in postulating that flame gases hold a long-lived latent energy, which in flames burning at atmospheric pressure seems never to be less than about 15 per cent of the heat of combustion, and in the case of carbon monoxide flames is of the order of 20 per cent.

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Feb. 23.

[1] David and Jordan, *Phil. Mag.*, **18**, 228; 1934. David, *Engineering*, Nov. 2, 1934.
[2] *Trans. Faraday Soc.*, **28**, 826; 1932.
[3] *J. Amer. Chem. Soc.*, **53**, 1, 869; 1931.
[4] David and Jordan, *Phil. Mag.*, **17**, 172; 1934; and **18**, 228; 1934; and many series of unpublished results.

Stokes's Formula in Geodesy

IN NATURE of February 20, 1932, a letter appeared from Mr. B. L. Gulatee under the above heading. This was responded to by Mr. Walter D. Lambert in the issue for June 4, 1932.

Mr. Gulatee showed me his letter before he sent it off, we discussed it together, and on the whole I agreed with it; but during the past year I have given much attention to the application of Stokes's method to the determination of the earth's figure, and a paper on the subject has just been communicated to the Royal Society.

I am now convinced that, while Mr. Gulatee's letter is generally correct in the statements made, it gives a wrong impression of the case. Mr. Gulatee said, "I believe it will never be possible to use it [Stokes's method] for getting absolute elevations". My recent studies have convinced me that it will be possible to do so.

Mr. Gulatee gave some figures showing a particular case as example in which an error of 0·01 gal in 'g' would lead to an error of 40 ft. in geoidal elevation, and he added that "A systematic error of 0·01 in zones from 40°–100° and of − 0·01 in zones from 130°–170° would vitiate the results hopelessly", which is very true. Systematic errors are very much to be guarded against and it is essential that all possible precautions be taken to avoid them. However, a systematic error of 0·01 over the whole globe would lead to zero error of geoidal elevation; and it is artificial to suppose that systematic error should prevail over one half (nearly) of the globe and then reverse its sign for the other half, as suggested in the quoted passage. When a considerable region of the earth, such as 100,000 square miles, is to be represented by a single gravity determination, it is no doubt true that the observed anomaly will deviate from the mean value for the area; but *not* systematically. The deviation, which may be called the 'representative error', is mainly of the nature of an accidental error, due to irregularities in the earth's crustal density; and so the combined effect of such errors in each of some 2,000 elementary areas of quadrature should be very different from what was suggested by Mr. Gulatee.

In my paper, alluded to above, I have gone carefully into this matter. I find that, with 1,700 stations evenly spaced over the earth's surface, combined with 100 stations suitably distributed locally, the probable error of geoidal elevation at a point will be ± 34 ft.; while the probable error of tilt, found from a derived formula, will be ± 0·35 in.

It is to be noted that 34 ft. is only $1{\cdot}6 \times 10^{-6}$ of the earth's mean radius, and such precision is of the same order as, though smaller than, the lowest estimates of probable error of the earth's mean radius. For fixing the elevation of the origin of a large survey, which is a practical requirement, the accuracy is ample in relation to the standard of accuracy of the survey; and there is every justification for making the necessary gravity determinations to enable the calculations of geoidal rise and tilt to be carried out.

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Three-fold Magneto-ionic Splitting of the Radio Echoes reflected from the Ionosphere

THE phenomenon of reflection of radio waves from the ionosphere and the observed echo patterns has received satisfactory explanation from the magneto-ionic theory, first put forward by Appleton[1].

It is well known that a dispersion formula can be easily obtained from the generalisation of Lorentz's treatment of the problem of the propagation of the electromagnetic wave in a magnetic field. For vertical propagation, when damping is negligible, it has been shown that

$$\mu^2 = 1 + \frac{2}{2\alpha - \frac{\gamma_T^2}{1+\alpha} \pm \sqrt{\frac{\gamma_T^4}{(1+\alpha)^2} + 4\gamma_L^2}} \quad \ldots (1)$$

where

$$\alpha = -\frac{n^2 m}{N e^2} - a\,, \quad \gamma_T = \frac{n h_z}{eNc} \text{ and } \gamma_L = \frac{n h_x}{eNc}.$$

Reflection occurs when μ is equal to zero. From formula (1) we can plot a dispersion curve for various values of N, the number of electrons in a unit volume. It can then be shown that we get μ equal to zero for three different values of N (N_1, N_2, N_3) obtained from the conditions given below.

$$\left.\begin{aligned} 1+\alpha &= -(\gamma_T^2+\gamma_L^2)^{\frac{1}{2}} \quad \ldots (a) \\ 1+\alpha &= 0 \quad \ldots\ldots\ldots (b) \\ 1+\alpha &= +(\gamma_T^2+\gamma_L^2) \quad \ldots (c) \end{aligned}\right\} \ldots\ldots (2)$$

From these conditions it appears that there will be

three different heights corresponding to the above three values of N from which we can get reflections. But usually only a doublet is observed corresponding to conditions (a) and (b) of formula (2). Corresponding to (a) we get an extraordinary ray (shorter delay component) and corresponding to (b) we get an ordinary ray (the longer delay component). Reflections corresponding to (c) or N_3 (which is the highest concentration of electrons for which μ is again zero) are not usually observed, since the amplitude of the disturbance when it reaches the greatest height is very small, or even if it is reflected with sufficient amplitude from these heights the amplitude falls during its passage through the lower layer. (See Mary Taylor[2] who considers this possibility.)

As already reported in NATURE[3], a systematic investigation of the heights of the ionosphere is being carried out in this laboratory, and on several occasions different observers[4, 5] have independently noticed the appearance of a very close triplet set of the first reflected echo; two of these can be easily identified with those corresponding to N_1 (2,a) and N_2 (2,b), but the third can only be identified with N_3 (condition 2,c). The most favourable time for the occurrence of the triplet seems to be after sunset, when the first echo from the F-layer just begins to resolve into the ordinary and extraordinary ray. The triplets occur rather irregularly and have not been found to exist for more than a minute. On most favourable occasions when the measurement could be taken from visual observations, the separation of the components corresponded to an equivalent height of about 15 km.

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Feb. 7.

[1] E. V. Appleton, U.R.S.I. papers (Washington, 1927). Appleton and Builder, *Proc. Phys. Soc. Lond.*, **45**, 208; 1933.
[2] *Proc. Phys. Soc. Lond.*, **45**, 261; 1933.
[3] G. R. Toshniwal and B. D. Pant, NATURE, **133**, 947; 1934.
[4] G. R. Toshniwal and B. D. Pant, see appendix of a paper read before the first meeting of the National Institute of Sciences on Jan. 8, 1935 (in the press).
[5] R. R. Bajpai, Thesis for M.Sc. Examination. T. D. Bausal, Thesis for M.Sc. Examination.

Absorption of Cosmic Rays

THE Klein-Nishina formula, which is based on the scattering and absorption of X- and γ-radiation by extra-nuclear electrons, has been widely used in the calculation of the absorption coefficients of high-frequency quanta. But recent experimental work and theoretical deductions have shown that this formula is not applicable to the absorption of γ-radiation of energy greater than $1{\cdot}0 \times 10^6$ e.v., since for higher energies there is additional absorption due, in the main, to interactions between the radiation and atomic nuclei, these interactions giving rise to electron pairs. This nuclear absorption, which becomes of greater importance as the energy of the quanta increases, and is probably the predominant type of absorption which would occur with any ultra γ-radiation arising from actions such as the condensation or annihilation of protons and electrons in space, is not accounted for by the Klein-Nishina formula. The latter cannot, therefore, be directly applied to the cosmic ray problem as has been previously assumed, and the wave-lengths of supposed photon components calculated by means of this formula must be inaccurate, since the formula does not take into account the nuclear absorption.

Even assuming that the primary rays are photons, the agreement which has been obtained between the absorption coefficients calculated by assuming some hypothesis as to the process giving rise to the quanta, and the experimentally observed coefficients, is fortuitous, since nuclear absorption is neglected by the Klein-Nishina formula. Thus, before any postulation as to the origin of the rays which utilises agreement between calculated and observed absorption coefficients of ultra γ-radiation can be accepted, a theory of absorption which takes account of nuclear interactions must be developed.

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Random Distribution of Parasite Progeny

RECENT work by Salt[1] led him to question the validity of the hypothesis of the random distribution of progeny by parasites. In this connexion, experiments at Farnham House Laboratory with *Schedius kuvanæ*, a chalcid egg-parasite of the gipsy moth (*Porthetria dispar*), will be of interest. Although no figures are given here, those obtained in the experiments were such as to leave no doubt as to their significance.

Subject to controlled environmental conditions, and given a sample of host eggs all equally exposed to attack, the female almost invariably parasitises each available host with a single egg. If no healthy (unparasitised) hosts are present, the rate of laying (per diem) is approximately halved, that is, she tends to retain her eggs rather than deposit them in parasitised hosts. There is considerable individual variation in this ability to refrain from ovipositing in parasitised hosts—a feature which was also indicated in the table of Salt's work on *Trichogramma evanescens*.

The discriminating faculty is not due to memory, and seems to be of a qualitative rather than a quantitative nature. When a series of *Porthetria* eggs, containing respectively 0, 1, 2, 3 and 4 eggs deposited by a given female, are exposed to another female for a given time, at least 80 per cent of the progeny are placed in the hosts that contained no eggs when first offered to the female, these often being superparasitised with three or four eggs. This peculiarity of laying the great majority of additional eggs in hosts which a given female had herself parasitised in the original instance, in preference to hosts parasitised by other females, has been noticed in numerous cases where superparasitism was enforced by the experimenter.

The selective faculty is of a surprisingly high order, enabling the insect to choose the best of available host material. Thus, given a choice between—

(1) dead and alive gipsy moth eggs, she selects chiefly live eggs;

(2) dead healthy eggs and dead eggs, each containing a single dead parasite, she selects the healthy host;

(3) dead healthy eggs and dead eggs, each containing a single live parasite, again the healthy eggs;

(4) dead eggs each containing a single dead parasite and dead eggs containing a live parasite, she usually deposits in the former.

It should be stated that the female *Schedius* deposits her egg in the host with a portion of the pedicel protruding through the gipsy-moth egg-shell, this probably performing a respiratory function. To eliminate this as a means of distinction between parasitised and unparasitised eggs, all pedicels were removed with a sharp scalpel before the experiments. These preliminary experiments suggest that the oviposition response in *Schedius* cannot be due to any simple stimulus. It is hoped to investigate the conditions under which this selective faculty is impaired or destroyed.

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[1] Salt, G., *Proc. Roy. Soc.*, B, **114**, 455; 1934.

Diet of Seals

THE recent illegal slaughter of grey seals in the supposed interests of the Cornish fishermen directs attention to the diet of seals. On what do they usually feed? On fish, as the fishermen and their friends assert, or on some of the other creatures which abound in the waters of the ocean?

Obviously the diet of seals, like that of whales, can be ascertained only by opening their stomachs and examining their contents. In the case of the arctic and antarctic seals this has been done to a considerable extent.

Nansen[1], R. Brown[2], Kumlein[3], Malmgren[4] and Chapman Spencer[5] all testify to the extent to which the arctic seals feed on creatures other than fish—squid, crustaceans and shellfish—and, in the case of the antarctic seals, the evidence of E. A. Wilson[6] and Matthews[7] is equally strong.

As to the diet of the grey seal, there seems to be very little scientific evidence beyond that which is contained in Mr. Steven's report[8]. Unfortunately, Mr. Steven was only able to examine the stomach contents of three seals; there were fish remains in two, and a cuttle-fish beak in a third. The examination by him of a greater number of stomachs might have led to the discovery of more remains other than those of fish, that is, those of crustaceans and shellfish, and might have still further weakened the case against the grey seal.

Until the matter is more fully investigated, the destruction of grey seals on the plea that they destroy large quantities of food-fish does not seem to be justified.

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Exmouth.
Feb. 19.

[1] Nansen, "Hunting and Adventure in the Arctic", p. 267.
[2] Brown, R., "On the Seals of Greenland", *Proc. Zool. Soc., Lond.*, p. 411; 1868.
[3] Kumlein, L., "Report of the Howgate Polar Expedition".
[4] Malmgren, *Arch. Naturg.*, p. 75; 1864.
[5] Chapman Spencer, "Watkins's last Expedition", pp. 116, 134, 223 and 280.
[6] Wilson, E. A., "National Antarctic Expedition", **11**, 13, 28, 36, 44 and 45.
[7] Matthews' "Discovery" Report on the Natural History of the Elephant Seal.
[8] Steven, G. A., "A Short Investigation into the Habits, Abundance, and Species of Seals of the North Cornwall Coast", *J. Mar. Biol. Assoc.*, **19**, No. 2, 489–502; May 1934.

Red 'Water-Bloom' in British Columbia Waters

IN NATURE of September 22, 1934, there is a communication from Mr. T. John Hart describing the occurrence of a red 'water-bloom' caused by *Mesodinium* in South African seas. It may be of interest to record an occurrence of blood-red water at Nanaimo, British Columbia, during the week of April 28, 1933. The water in a channel immediately north of the harbour was coloured crimson red in great patches. Examination of a sample of the water revealed a pure culture of a ciliate, identified by Mr. G. H. Wailes as *Mesodinium rubrum*, Lohmann.

About this time oysters in Ladysmith Harbour, fifteen miles south of Nanaimo, were reported to contain red 'worms'. Investigation disclosed the fact that the crystalline styles were coated with a red colouring matter, evidently as a result of feeding upon *Mesodinium*. Examination of the styles of local clams showed a similar condition.

The appearance of this 'bloom' of *Mesodinium* followed a period of a couple of weeks of bright, sunny, calm weather. No discoloration was observed in 1934.

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Jan. 31.

Magnetic Measurement of Ionic Deformations in Crystals

DURING the past few years, it has been shown that the diamagnetic susceptibilities of ions in crystals are approximately additive, and their values are in fairly close agreement with values calculated theoretically from the wave-mechanical structures of free ions[1]. Attempts to interpret the experimental results in more detail have been handicapped by a lack of essential data, for although results are now available for many substances, some have been obtained for solutions and others for crystals, and the two are not directly comparable. With the view of obtaining more precise information for a particular group of crystals, we have studied the susceptibilities of the alkaline halides, using a method of measurement previously described[2].

We have been specially interested to see how closely the additivity principle holds in this group of crystals, and we find that in general it holds to within 1 per cent. The results for the rubidium halides are typical.

Salt	Diamagnetic Susceptibilities $\chi \times 10^6$		
	(1) Obs.	(2) Calc.	$\Delta\chi$, (1)–(2)
RbF	31·9	31·4	− 0·5
RbCl	46·4	46·2	− 0·2
RbBr	56·4	56·5	0·1
RbI	72·2	72·6	0·4

The only important exceptions to the additivity rule are the chlorides, bromides and iodides of lithium and cæsium, for which the calculated values exceed the observed values by 1·6, 1·5 and 1·3 in the case of the lithium salts, and by 2·7, 2·4 and 3·1 in the case of the cæsium salts. For the other halides upon which measurements have been made in the course of this work, the differences are of the order of 0·2–0·3.

Exceptional results might have been expected for the cæsium halides, since these crystals have a different structure from the other halides, all of

which have the rock-salt type of structure. A different explanation is suggested in interpreting the results for the lithium halides. These crystals are composed of the small Li^+ ion and the relatively large Cl^-, Br^- and I^- ions; the negative ions here approach more closely than in the other halides, and the greater electrostatic repulsions produce larger interatomic distances than would be expected from considerations of the 'sizes' which these ions have in the other halides[3]. The conclusion we draw is that the interatomic forces which thrust apart the negative ions in the lithium halides and result in a change of structure in the case of the cæsium halides produce deformations of the ions which *lower* their susceptibilities. We find that this conclusion holds good also for the ammonium halides, the chloride and bromide of which normally have the CsCl type of structure and show low values for their susceptibilities, while the iodide has the NaCl type of structure and gives a normal susceptibility.

A detailed account of this work will appear elsewhere.

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Jan. 25.

[1] See E. C. Stoner, "Magnetism and Matter", chap. ix (Methuen, 1934).
[2] F. E. Hoare, *Proc. Roy. Soc.*, A, **147**, 88; 1934.
[3] See L. Pauling, *Z. Krist.*, **67**, 377; 1928. W. Zachariasen, *Z. Krist.*, **80**, 137; 1931.

Variation of the Carbon-Halogen Link Distances in Different Types of Organic Structure

THE improved electron diffraction method[1] of determining molecular structure in the vapour phase has brought to light the fact that the distance between a carbon and halogen atom depends on the character of the binding attaching the carbon atom to other atoms in the system. Hitherto, the magnitude of this distance has been regarded as constant. We have shown that the carbon-halogen distance is smaller in aromatic compounds than are the accepted values for the aliphatic series[2]. This suggested that an investigation of certain aliphatic, ethylenic and acetylenic compounds by electron diffraction might throw more light on this question.

	Aliphatic >C–Hal.		Ethylenic =C(Hal.)(Hal.)		Aromatic =C–Hal.	Acetylenic ≡C–Hal.
Link	New	Old	New	Old	New	
C–Cl	1·76[3]	1·82[4,5]	1·74	1·82[7,6]	1·69	—
C–Br	1·93	2·05[4,6]	1·91	2·05[5]	1·88	1·84
C–I	2·12	2·28[6]	2·10	—	2·05	2·03
	CCl_4		*Trans.* $C_2H_2Cl_2$		C_6Cl_6	Dibrom-
	CBr_4		,, $C_2H_2Br_2$		C_6Br_6	acetylene
	CHI_3		,, $C_2H_2I_2$		Sym. $C_6H_3Br_3$	Diiodo-
			C_2Cl_4		,, $C_6H_3I_3$	acetylene
			C_2Br_4			
			C_2I_4		*p*- $C_6H_4Br_2$	
					p- $C_6H_4I_2$	

The 'new' results are tabulated above, showing that the carbon-halogen link distances in angstroms decrease from left to right and are not constant, as the 'old' results would seem to indicate. The order of accuracy is $\pm$ 0·01 A. Below each column we give a list of the substances used for this work, the results of which will be published shortly in greater detail.

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London, W.C.1.
Feb. 5.

[1] de Laszlo, *Proc. Roy. Soc.*, A, **146**, 662; 1934.
[2] de Laszlo, *ibid.*, **143**, 690; 1934.
[3] Cosslett and de Laszlo, NATURE, **134**, 63; 1934.
[4] Wierl, *Ann. Phys.*, **8**, 521; 1931.
[5] Dornte, *J. Chem. Phys.*, **7**, 567; 1933.
[6] Dornte, *ibid.*, **1**, 630; 1933.
[7] Wierl, *Ann. Phys.*, **13**, 553; 1932.

Dipole Moment of Acetonitrile

ALTHOUGH several determinations of the dipole moment of acetonitrile have been made, considerable uncertainty attached to the results since the values of different observers varied widely. The figures already published for this compound are as follows:

		μ	Temp.
Williams, *Z. physikal. Chem.*, **138**, 75;	1928	3·4 D	25° C.
Werner, *ibid.*, B, **4**, 371;	1929	3·11	20°
Eide and Hassel, *Tids. Kjemi.*, **10**, 93;	1930	3·51	—
Hunter and Partington, *J.C.S.*, 2812;	1932	3·16	20°
Snoek, *Physikal. Z.*, **35**, 196;	1934	3·45	25°

In all cases the solvent was benzene.

We recently remeasured the moment of acetonitrile in connexion with some other work, shortly to be published, and have found a value $\mu = 3{\cdot}44 \pm 0{\cdot}02$ D at 20°. This figure is in excellent agreement with that obtained by Snoek.

The two lowest values quoted above were both found using acetonitrile which had been repeatedly fractionated with phosphorus pentoxide. This treatment would not remove traces of acetic acid formed by slight hydrolysis of the cyanide, and possibly the low values are in part due to this cause. It may be noted that the moment of acetic acid in solution is about 0·8 D (Wolf; *Physikal. Z.*, **31**, 227; 1930) although smaller values have been recorded.

In the present experiments, Kahlbaum's acetonitrile was purified by standing over caustic potash to remove any traces of acid, was then left in contact with calcium chloride for a week to remove any ammonia, and was finally dried with phosphorus pentoxide. It was twice fractionated over phosphorus pentoxide, and had a constant boiling point 81·6°C./760 mm.; d_4^{20} 0·7823; n_D^{20} 1·3438. Kahlbaum's benzene was used as solvent.

The dielectric constants have been measured on an improved form of the apparatus previously used by us, which we shall describe elsewhere.

The polarisations of acetonitrile are: $P_\infty = 262 \pm 1{\cdot}5$ c.c.; $P_E = 11{\cdot}1$ c.c.; $\mu = 3{\cdot}44 \pm 0{\cdot}02$ D.

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Feb. 11.

Solid Carbon Dioxide

THE commercial and workshop value of solid carbon dioxide is fully described in a recent article in NATURE[1]; there are, however, further interesting uses of this material to which it may be worth while to direct attention.

(1) Diamonds and pearls may at once be distinguished from their counterfeits, inasmuch as the real substances emit a rattle or squeak when touched with solid carbon dioxide. Similarly, a quartz lens may at once be distinguished from a glass one.

(2) Metal bars and tuning forks of high pitch may be powerfully excited by touching them with the substance, and the overtones of low-pitched forks and bars may similarly be picked out—a fact of practical importance in the tuning of metal bars of musical instruments.

(3) Brittle materials, of suitably high thermal conductivity, may also be set into vibration.

These facts, and the manner of their discovery, were demonstrated before Section A at the York meeting of the British Association. As no trustworthy account exists on the origin of these experimental researches, I should like to put on record the actual facts. The well-known fact that solid carbon dioxide will make a bicycle bell rattle was brought to my notice on July 11, 1932, by an itinerant vendor of ice-creams, and investigations were at once entered into, the results of which, together with an explanation of the phenomenon, have recently been published[2,3]. Briefly, the loss of heat from the hotter to the colder body supplies the energy, and the efficacy of carbon dioxide is due to the fact that it sublimes, thereby producing considerable gas pressure.

I have recently noticed that solid carbon dioxide in the form of 'Drikold' can set soft metals into vibration in a manner impossible with a hammer.

The accidental nature of the discovery and the mechanism of the phenomenon may well be compared and contrasted with that of Trevelyan's rocking bar.

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Feb. 26.

[1] NATURE, **135**, 293, Feb. 23, 1935.
[2] *Proc. Phys. Soc.*, **45**, 101; 1933.
[3] *Proc. Phys. Soc.*, **46**, 116; 1934.

Points from Foregoing Letters

PROF. S. SUGDEN has investigated the radioactivity induced by neutron bombardment (Fermi effect) in the rarer elements europium, erbium, terbium, ytterbium, etc.). He tabulates the relative intensity and half-life periods of the radioactive elements produced, comparing them with the intensity produced in silver and iodine in the same circumstances.

Curare and tubocurare—plant extracts employed by South American Indians as arrow poisons because of their paralysing properties—have been used medically to alleviate muscular rigidity in man. Dr. Harold King has investigated several species of *Strychnos* and other plants from which curare is said to be obtained. Of these, *S. toxifera* alone contains the active principle curarine, having paralysing properties. Chemical examination of bamboo-tube curare (tubocurare) yielded crystalline tubocurarine, which has properties similar to those of curarine, together with an allied substance *d*-bebeerine, which is much less active.

The temperature of flames as measured by the increased resistance of a platinum wire does not agree with that determined by the 'sodium line reversal' method. (The spectral lines of sodium present in the flame seen against a background of a continuous spectrum of a tungsten filament, of known temperature, appear dark when the flame is cooler and bright when it is hotter than the filament.) Prof. W. T. David maintains that the 'sodium temperatures' are too high, as they do not agree with the calculated temperatures for flames of carbon monoxide while the 'platinum temperatures' do. The sodium temperatures show an unexpected constancy over a wide range of variations in the mixture strength and in the nature of the combustible material.

Stokes's formula shows how, from a knowledge of the variations in gravity at different known points of the earth's surface, one may calculate the shape of the earth's figure (geoid). Mr. B. L. Gulatee suggested that minute systematic errors in the determination of g might completely vitiate the results. Dr. J. de Graaff Hunter now calculates that if gravity determination were made at a large number of stations suitably distributed over the earth, Stokes's formula would give the 'absolute elevation' with a fair degree of accuracy.

According to theory, there should be three different heights in a given ionic layer (of the upper atmosphere) from which radio waves can be reflected; these correspond to certain values in electronic density. Only doublet echo patterns are, however, usually found. Mr. G. R. Toshniwal states that triplet radio echoes have been observed at Allahabad from the F layer—especially after sunset; the separation of the components indicates an equivalent height difference of about 15 km.

Mr. H. J. Walke points out that the Klein-Nishina formula by means of which the wave-lengths of γ-rays are calculated when their absorption coefficient is known neglects nuclear absorption. It should not therefore be applied in the case of γ-rays of more than one million electron volts energy, such as those supposed to exist in cosmic rays, since such hard γ-rays can interact with atomic nuclei.

Mr. D. C. Lloyd reports that experiments with the parasite wasp (*Schedius Kuvanae*) which deposits its eggs within those of the gypsy moth, show that the female *Schedius* possesses a selective faculty enabling it to pick the best available material as host.

Mr. G. W. Brindley and Dr. F. E. Hoare have investigated the diamagnetic susceptibilities of the alkaline halides in order to test how nearly additive are the ionic susceptibilities in this group of crystals. They find that the additive rule holds to within about one per cent in all cases except CsCl, CsBr and CsI (which have different structures from the other halides), and LiCl, LiBr and LiI (where the negative ions are in unusually close proximity).

Research Items

Blood Groups and Physiognomy. Prof. R. Ruggles Gates has recently received from Dr. L. D. Livingston the photographs of six out of eleven Eskimo of Pond Inlet (lat. nearly 73° N.) tested by him for blood-groups, who were regarded as "practically full-blooded Eskimo". The photographs are published in the March issue of *Man*. On inspection by several anthropologists and laymen, two out of the six were selected as pure-blooded, while of the remainder one was singled out by one observer who had experience of Canadian Indians as having Indian blood. The remaining three were regarded by all observers as having European blood. This classification agrees with the blood groups. The two individuals selected as pure Eskimo belong to the *O* group, the remainder to the *A* group. In the instance of the individual showing Indian admixture, this must be explained as due to a remote white strain, which does not show in the features. Otherwise the evidence of physiognomy agrees entirely with the evidence of the blood groups, as usually accepted for American aborigines. The striking fact which emerges is that while the pure-blooded are *O*, those of mixed ancestry are all *A*. It is pointed out that a European who has the *A* group is more likely to be heterozygous than homozygous for *A*. Any white man who is heterozygous for *A* would have an equal chance of transmitting to his offspring in a cross with an Eskimo the genes for European features combined with either blood-group *A* or *O*. One must conclude, therefore, that while crosses between a white father who was heterozygous for *A* and an Eskimo woman would in many cases be expected to produce a child of *O* blood-group combined with some European features, yet on the other hand the presence of *A* in the offspring can be taken as confirming the evidence from physiognomy that a cross has taken place.

Mortality amongst Game Birds. The Hungarian partridge (*Perdix p. perdix*) has been introduced into the Great Lakes region of the United States, and there it is better adapted to intensively farmed areas than the native game birds or the pheasant, with neither of which does it seem to compete. Large numbers, amounting to more than 260,000 individuals, have been set free in the United States and Canada, mostly during the present century. In the course of a careful description of the standing and relationships of the Hungarian partridge in the Great Lakes region, Ralph E. Yeatter discusses the mortality at different stages. In the breeding seasons of 1930, 1931 and 1932, out of a total number of 143 nests observed, 32 per cent were successful, 68 per cent unsuccessful. The causes of failure were mainly farming operations, which accounted for 46 per cent of the destruction, predators (26 per cent), desertion (16 per cent), while smaller losses were due to farm animals and hatching failures (Bull. 5, Univ. Michigan, School of Forestry and Conservation, Dec. 1934). In later life, careful counts of birds in definite localities were made during the year, and these again showed a very marked decrease in numbers, both during the winter period, when in one case there was an 11 per cent loss in the course of a month, and during late summer in young birds in their first few weeks. Losses of adults appear to be gradual through autumn, winter and spring.

Aeroplane Dusting and Bees. According to Science Service (Washington, D.C.), bees are often destroyed by poisonous dusts spread by aeroplanes as a means for combating insect pests. The matter came up for discussion before the American Association of Economic Entomologists at a meeting held in Pittsburgh on December 27. One speaker maintained that such aeroplane dusting is responsible for the reduction of about one million colonies of the honey-bee in the United States during the past three decades. The mischief, it is stated, is mainly caused by the drift of poisonous dust into the flowers where they are working. Pollen-gathering bees themselves are unaffected owing to the fact that the pollen is stored on their legs and bodies, but the poisonous food is transferred to the hive, where it is fatal to the larvæ, thus inhibiting the increase of the colony at its source.

Historical Investigation of Heterœcism. A study of the heterœcious fungus *Puccinia graminis* is now part of even an elementary course of biology, and it is difficult to conceive that there was a time when the link between its two hosts, barberry and wheat, had not been established. Mr. J. Ramsbottom has published an interesting article (*Trans. Brit. Mycol. Soc.*, **19**, Part 2, 128–138, January, 1935), which reveals the extensive observations made by L. G. Windt, on the connexion between the two hosts. Windt was a "counsellour in the chamber of accounts of the Count De Lippe Schaumberg", and published his findings in a book "Der Berberitzenstrauch, ein Feind des Wintergetreides" ("The Barberry-bush an Enemy to Winter Corn"), 1806. The incidence of disease on wheat and rye when barberry bushes grew in the neighbourhood was established in different places and on numerous occasions. Then wholesale eradication of the bushes was recommended, and sponsored by the Count. This measure was entirely successful, and the book closed with a summary of the available knowledge about the causal fungus. A passage, obviously written just before publication, acknowledges Sir Joseph Banks's demonstration that the æcidium fungus on barberry and the *Puccinia* on wheat were really stages of the same fungus.

Cretaceous Mollusca of Japan. The Cretaceous Lamellibranchs and Gasteropods of the Miyako district of Honshû, Japan, have recently been described by T. Nagao (*J. Fac. Sci., Hokkaido Imp. Univ.*, **4**, (2), 177–277; 1934). The Cretaceous deposits occur in six small areas along the eastern border of the Kitakama mountainland in north-eastern Japan, where they rest unconformably on Palæozoic or igneous rocks and consist mainly of sandstones with some layers of shale and conglomerate. They include a rich molluscan fauna, comprising 41 species of lamellibranchs and 28 species of gasteropods, of which the striking feature is the large proportion of forms either identical with or closely allied to those found in Europe. These indicate that the deposits are of Gault age and perhaps in part Aptian, but until the Ammonites have been studied more carefully, exact zonal divisions cannot be made. In addition to the Mollusca, calcareous Algæ, Foraminifera, corals and echinoids are also found. The faunal

assemblage in some of the deposits includes numerous examples of a Rudistid lamellibranch (*Præcaprotina*), abundant reef-building corals and *Orbitolina*, recalling the Urgonian facies of Europe.

New Type of Filament Hygrometer. In the course of a paper read at the Royal Society of Arts on January 23, entitled "Humidity, Health, and some New Inventions", Mr. C. L. Burdick described a new form of filament hygrometer (*J. Roy. Soc. Arts*, Feb. 22, 1935). As is well known, old pine cones continue to open and close with changes of humidity. This is due to the fact that the outer layer of the conifer scale or bract consists of highly hygroscopic fibres, which lengthen when moisture is absorbed and shorten with desiccation, and with suitable cone fibres treated so as to oxidise remaining traces of resin, a high degree of reaction to moisture can be obtained. Using these treated cone fibres, Mr. Burdick has constructed several types of hygrometer. With hair, linen or cotton thread, paper or vellum, and gold beater's skin, all of which have been utilised for the construction of filament hygrometers, the zero point undergoes considerable alteration in course of time, but cone fibres have been found to remain almost constant during a period of two years, and the cone fibre in its reaction to moisture has three times the linear contraction and expansion of hair, and is practically non-elastic.

Nature of Lightning Discharges. In a recent paper on this subject (*J. Franklin Inst.*, December 1934), Dr. Harald Norinder describes the application of the cathode ray oscillograph to the recording of the electric field changes caused by lightning flashes. For this purpose the author has used the oscillograph and technique which he developed a few years ago for the study of lightning and other surges on electric power transmission lines. A horizontal antenna, suitably damped, was connected to earth through a high resistance, across which the deflecting plates of the oscillograph were connected. The time scale used with the oscillograph gave a sweep time which could be varied from 10 to 10^4 microseconds. The paper referred to above gives an account of the results obtained from some 290 oscillograms of lightning discharges, many of which are illustrated. It is shown that a lightning flash consists of a series of partial discharges, the duration of which may range up to 200 micro-seconds. When these partial discharges are examined on the high-speed records, they are seen to be of a quasi-oscillatory nature having a period of the order of 60 micro-seconds, with superimposed variations of a duration of 1 or 2 micro-seconds. An analysis has also been made of the polarity of the discharges, and the resulting net field changes. At a distance of 2–7 km. from the lightning flash, the variation of electric field intensity was found to be of the order of several hundred volts per metre.

Induced Radioactivity. Mr. Wenli Yeh, writing from the Institut de Biologie Physico-Chimique, 1 rue Pierre Curie, Paris, sends us details of a classification of isotopes which shows that there is a continuous sequence of radioactive isotopes from $_3Li^5$ to $_8O^{15}$, whereas from $_9F^{18}$ to $_{17}Cl^{37}$ the unstable and stable isotopes alternate, this sudden variation in the sequence affording some evidence of a change in the nuclear structure beyond oxygen. The classification cannot be extended beyond chlorine owing to the lack of experimental data. A shell model of the nucleus proposed by Mr. Yeh (*Comptes rendus*, **199**, 1209, 1404; 1934) suggests that $_{19}K^{40}$ is formed from $_{19}K^{39}$ by neutron capture, the unstable $_{19}K^{40}$ disintegrating with the emission of positrons, or electrons, into $_{18}Ar^{40}$, or $_{20}Ca^{40}$. Recent work by Klemperer (*Proc. Roy. Soc.*, A, **148**, 638; 1935) indicates that probably the relatively rare isotope K^{40} is responsible for the β-ray activity of potassium. A communication upon the same subject has been received from Mr. S. Nishida, who writes from Konan-Koto-Gakko, Motoyamamura, near Kobe, Japan. Applying the Landé neutron shell nuclear structure to the light elements, Mr. Nishida finds that the radioactive isotopes which emit negative electrons possess neutrons in excess of those required to complete an inner shell, whereas positive electrons are emitted from those isotopes which have incompleted shells. Accordingly there are two types of electron emission, namely, (*a*) a reaction in which an α-particle is formed with γ-ray emission, for example, $_{11}Na^{24} \rightarrow {}_{12}Mg^{24}$, (*b*) the formation of a proton and a deutron, for example, $_{12}Mg^{27} \rightarrow {}_{13}Al^{27}$. In addition, two types of positive electron are possible; in each reaction a proton loses a positron and so an additional neutron is produced, for example, $_7N^{13} \rightarrow {}_6C^{13}$, $_{15}P^{30} \rightarrow {}_{14}Si^{30}$. The proton within the nucleus, if associated with zero or one neutron, is unstable, being converted into a neutron with the emission of a positive electron. This suggests that a proton may be formed by the combination of a neutron and a positron.

Combustion of Carbon Monoxide. The catalytic action of moisture in the reaction $2CO + O_2 = 2CO_2$ has been clearly realised since the researches of H. B. Dixon, and different explanations of it have been given. W. F. Jackson (*J. Amer. Chem. Soc.*, **57**, 82; 1935) has made experiments with the object of gaining knowledge of the steps postulated in the chain mechanism involving hydroxyl radicals and hydrogen atoms according to the scheme:

(1) $OH+CO=CO_2+H$; (2) $H+O_2+CO=CO_2+OH$.

An electrical discharge through moist hydrogen or water vapour provides a reliable source of hydrogen atoms, and there is some evidence that hydroxyl can be drawn from the water discharge. It was found that carbon monoxide was oxidised by the products of an electrical discharge through water vapour. Numerous substances are present during such a discharge, and the discussion of the probable effects of these shows that several of them could not well be assumed to act as catalysts in the oxidation of carbon monoxide. Atomic hydrogen is shown to cause oxidation but it is considered probable that the reaction does not occur directly according to equation (2) but in two steps, with the intermediate formation of HCO or HO_2. It was found that the products of the action of the discharge on water vapour at pressures below 1 mm. cause the oxidation of carbon monoxide even when they have been drawn several decimetres from the discharge. One of the products of such a discharge is shown to be hydrogen peroxide. It is considered possible that OH radicals may be withdrawn in sufficient concentration to account for the fraction of the carbon dioxide yield which cannot be attributed to hydrogen atoms.

Archæological Excavations in Iraq*

IN the season 1932–33, which is covered by the third preliminary report of the director, Dr. Henri Frankfort, the Oriental Institute of Chicago was responsible for three major investigations in Iraq—at Tell Asmar, Khafaje and Khorsabad, and to the last of these were subjoined two minor investigations at Tepe Shenshi and Jerwan, to which the attention of the field staff was turned when, towards the close of the season, the weather precluded further activity in southern Iraq.

The results of the season 1932–33 fully confirmed the impression which had been formed in the previous season that the site at Tell Asmar, the ancient Eshnunna, is likely to prove one of the most important in the south. Not indeed that it is probable that it will eclipse Ur in the richness of the finds or in the imposing character of the buildings; but, on the other hand, the evidence which it has already afforded indicates that it will be of first-rate significance in the elucidation of a number of problems of Mesopotamian prehistory.

Of these problems one of the most vigorously debated has been the dating of the Royal Tombs at Ur. According to the interpretation of the evidence from Tell Asmar by Dr. Henri Frankfort, this must now be placed much lower than has been proposed by Dr. L. Woolley, though it does not demand the extreme reduction favoured by some authorities. At the time of writing this third report, Dr. Frankfort was not yet in a position to formulate a final judgment; but he was able to show that the evidence pointed to a contemporaneity of the tombs at Ur with the fifth stratum of his series at Tell Asmar, that is, the stratum preceding the Sargonid period. A possible date would, therefore, be *c.* 2700 B.C. as against the *c.* 3500 B.C. which commended itself to Dr. Woolley.

The conditions of excavation at Tell Asmar were peculiarly favourable to determining chronological questions; they were such as to afford a basis of greater certainty than could be obtained from the excavation of a cemetery. The northern hills of Tell Asmar had not been inhabited in the Larsa period, or later, while in the extreme north a large building and a group of private houses south of it had been partially uncovered. It was, therefore, possible to extend the excavations over a wide area and to avoid generalisation on a single example. At the same time, stratification could be determined with certainty. This latter factor is of special importance, as it was found, in working out the plan of the city, that stratification was not a mere matter of determining absolute levels. Constant rebuilding of structures fallen into disrepair over a long period of time had been responsible for differences in level, sometimes of a metre or more, between buildings of the same cultural epoch. A further cause of a possible confusion was the survival of archaic features into periods to which they did not belong. This was found to be due to the adaptation of the ruins of older structures as supports for the new.

In two respects in particular, the season's excavations at Tell Asmar are of outstanding importance for the cultural history of early Mesopotamia—the view they afford of the conditions of life of the private citizen; and, secondly, in the new knowledge they have yielded of early phases of religious cult and belief.

The conditions of life among the ordinary citizens are revealed in the remains of the large number of private dwellings which have been uncovered. From these the excavators have been able to determine or infer the lines of a fairly complete plan of the city, and at the same time to reconstruct the typical dwelling of the Sumero-Akkadian culture. So far as the private dwelling is concerned, it is noted that there appears to be no marked break in occupation with the incoming of the Sargonid era, and it continued uninterrupted down to the period of the Third Dynasty of Ur; but in the area of the large building, which Dr. Frankfort considers sufficiently extensive and complex to justify the denomination 'palace', there is a period of apparent abandonment represented by about a metre of rubbish which intervenes at the close of the Sargonid period.

The reconstruction of the Akkadian dwelling-places emphasises several interesting features in the arrangement and relation of the various chambers. They differ from buildings at Ur in the absence of the open courtyard. Two notable additions are made to knowledge of the architectural accomplishments of this early period in the form of a window, lighting a store-room by means of a terra-cotta grille, and the use of the arch in communicating doorways. In both instances this is the earliest known example in Mesopotamia. In the 'palace' building by far the most remarkable structural feature is the sanitary system, in which, however, Dr. Frankfort notes, in the greater number of instances, the rooms are not congruous with this use.

The excavation of the 'Temple of Abu', the temple of the god of fertility, has provided some remarkable material bearing upon the early form of religious belief in Mesopotamia, of which, however, the full significance is to be completely appreciated only when it is brought into relation with the cult material obtained from the private dwelling houses. The unity of 'public' and 'private' cult is striking. The salient fact which emerges is that this Sumero-Akkadian religion centres around one deity; although, it is true, at this time the existence both of a great mother goddess and of a sun-god was recognised. The god of fertility, however, is the central figure of the pantheon. He personifies the generative forces of Nature and is closely associated with the crops and flocks and herds. It follows that the various names of deities, Ninurta, Ningirsu, Abu Dumuzi (Tammuz) and the like are in reality but epithets referring to different aspects of this early deity, and tradition may have decided which aspect was to prevail in any given locality. Hence also it is clear that this fertility god was a Sumerian and not a Semitic deity. Not only was he the generative force in Nature, manifest in the fertility of the soil and the flocks, but also he lived in the netherworld, often assumed the shape of a serpent, was exposed to dangerous encounters, and vanquished monsters. From this last manifestation Heracles, it has been shown, stands in direct line of descent. The

* Iraq Excavations of the Oriental Institute, 1932–33: Third Preliminary Report of the Iraq Expedition. By Henri Frankfort. (The Oriental Institute of the University of Chicago: Oriental Institute Communications, No. 17.) Pp. ix+92. (Chicago: University of Chicago Press; London: Cambridge University Press, 1934.) 7*s.* net.

consummation of his marriage with a goddess was an essential part of the annual ritual. This ceremony was well known from other sources, but Tell Asmar has afforded on a seal the only known representation of the divine nuptials in early Mesopotamia.

Among a hoard of copper objects enclosed in a pot was a bronze open-work dagger-handle in which was wedged a fragment of the original blade. This has been examined by Dr. C. H. Desch, who pronounces it to be iron of telluric origin. As it belongs to the 28th century B.C., it is by many hundreds of years the earliest example known. The same applies to a fragment of clear glass which has been examined by Mr. Horace C. Beck, who points out how surprising it is to find in Mesopotamia clear glass dating from 2700 B.C., since in Egypt, although opaque glass was known in the second millennium B.C., clear glass was not introduced before Roman times.

It has been possible to touch only on the more striking points in Dr. Frankfort's report, while the excavations at Khafaje and Khorsabad must be passed over, notwithstanding their interest and importance. The excavations of the Oriental Institute closed for the season in 1933 at a point which promised much in the following season. This expectation was not disappointed and the further reports of the director are awaited with interest.

Three-Colour, One-Exposure Camera

THE customary method of making a set of colour-separation negatives for colour photography is by successive exposures on separate plates through the appropriate colour filters. Usually three negatives are required. This method fails for snapshot exposures of moving objects. For many years inventors have attempted to devise three-colour cameras operating with a single exposure during which all three images are simultaneously recorded. Several of the optical devices which have been used to achieve this end were briefly described by Dr. D. A. Spencer in 1933 (*Photographic J.*, **74**, 103; 1934) and a further method was described in 1934 (*ibid.*, **74**, 244; 1934) by the late Mr. W. T. P. Cunningham.

One of the less difficult methods depends on the use of two inclined, semi-reflecting, plane mirrors. Light from the camera lens strikes the first mirror and a portion of it is deflected to form an image on one of the photographic plates placed behind its suitable colour filter; the remainder of the light goes on and meets the second mirror, which deflects a portion on to another plate, and the remainder goes on to the back of the camera where the third filter and plate are situated. One objection to this method is that reflection takes place at both surfaces of each mirror and, if the mirrors are thick, double images may be formed. This has led to the use of thin pellicle mirrors which are said to have been suggested by Geisler so long ago as 1910 (see Spencer, *loc. cit*) and have recently been made as commercial articles by Mr. H. O. Klein. It is said that other ways of avoiding double images with this general arrangement of semi-reflecting mirrors are also available.

The method has therefore led to considerable practical success and at present there are available two cameras which make use of it. These were both shown at the recent British Industries Fair. One is the Taylor-Hobson three-colour camera (Vivex system) and the other is the Klein tri-colour camera invented by Adrian B. Klein and manufactured by Messrs. Bellingham and Stanley, Ltd. These cameras are said to work successfully to give exposures ranging from 1/25 sec. to 1/10 sec. in winter sunshine. Inquiries about these cameras should be addressed, in relation to the first to Messrs. Colour Photographs (British and Foreign), Ltd., Victoria Road, Willesden, N.W.10, and in relation to the second to Messrs. Farquhar and Moloney, 15–16 Newman Street, London, W.1, or to Messrs. Bellingham and Stanley, Ltd., 71 Hornsey Rise, London, N.19.

A Japanese Scientific Expedition to Manchoukuo*

THE Japanese have lost no time in examining the resources of the new 'independent' kingdom of Manchoukuo, and in October and November of 1934 were published in Tokyo the early sections of a report upon the first Japanese scientific expedition to the country, which carried out exploration work with the aid of motor transport and some aeroplane reconnaissance during the period June to October 1933. Under the leadership of the geologist, Prof. Shigeyasu Tokunaga, of Waseda University, thirteen scientific workers representing geography, botany, zoology and anthropology were dispatched from Japan, largely through the influence of Viscount Toki, Vice-Parliamentary Secretary of the War Office. Never before has a scientific expedition been dispatched abroad from Japan on so big a scale. The reports now published are in Japanese with a very full transcript in English, which manages to express some of the enthusiasm with which the expedition has undertaken its task, regarded as important both on patriotic and scientific grounds.

Before leaving Tokyo on July 22 the members of the expedition assembled in Tokyo in front of the 'Nijiu Bashi' (bridges at the entrance of the Palace) and worshipped at the entrance of the Palace; by July 30 they were in Hsin-king, the capital of Manchoukuo, and there they met again on October 12 "amidst the tear-prompting, enthusiastic welcome of the Government officials as well as plain people". On October 11 in the presence of Viscount Toki "the expedition drank to the happy completion of the scientific investigations at the risk of lives". During the intervening seventy days, some 5,000 kilometres had been covered in automobiles over trackless country; "the bottoms of the rivers are rather shallow [elsewhere described as "abdomen-deep"], yet the quagmire-bed so deep. The treacherous rivers!" So far as possible they drove

* Report of the First Scientific Expedition to Manchoukuo under the Leadership of Shigeyasu Tokunaga, June–October 1933. Section 1: Natural Science Research of the First Scientific Expedition to Manchoukuo. By Shigeyasu Tokunaga. Pp. iii+76+69 plates. Section 4, Part 1: Plantæ Novæ Jeholenses, I. By Takenoshin Nakai and Masao Kitagawa. Pp. iv+71+20 plates. Section 5, Part 1: The Fresh Water Fishes of Jehol. By Tamezo Mori. Pp. ii+61+21 plates. (Tokyo: Waseda University, 1934.)

along the dry beds of rivers, but frequent storms, which in Jehol turned scorching summer to bitter cold, often delayed or prevented a projected tour. "A proverb goes 'a precipice in front, a wolf behind'; when our march was impeded, we could not safely stay where we were because of there being a danger of bandits' assault". The expedition's work was done under escort of thirty soldiers and occasionally under additional protection from garrisons.

Dirty and scarce drinking water, and "horribly poisonous insects", with the concomitant troubles of dysentery, trachoma, etc., were probably greater difficulties than the bandits, who only fired upon a camp on one occasion. An endemic epidemic goitre was found to be widespread in south-western Jehol.

The preliminary scientific results are summarised by the head of each section in the first general report (October 1934). A brief stratigraphical summary reports abundant fossil *Lycoptera* and many fossil insect larvæ (*Ephemeropsis*) in lower Cretaceous rocks. In loess strata of Middle Pleistocene age, remains of *Ovis* and *Elephas* included bone pieces apparently engraved by ancient man. Jehol was a nomad zone originally occupied by Mongolians; during the Shin dynasty, these Mongolians had declined in prosperity and the Hans (Chinese in the Han dynasty) emigrated there. In the northern district of Manchoukuo the Mongolians still predominate, and throughout the country three systems of farming can be traced, the North Chinese, Manchurian and Mongolian. The animals found still recall the forests, which have been ruthlessly despoiled since the Hans. The November report (Section 4, Part 1) figures and describes eight species of new woody plants (by Dr. T. Nakai) and twenty-nine new herbaceous plants (by Dr. T. Nakai and M. Kitagawa).

Section 5, part 1, consists of an account of the freshwater fishes of the province of Jehol. This province—a highland area occupying the south-western part of Manchoukuo and contiguous with the north-eastern border of the Chinese province of Hopei (Chili)—is irrigated by the upper reaches of several rivers in the waters of which and those of associated lakes and ponds 783 fishes were collected. These comprised 33 species and one sub-species representative of the two families Cyprinidæ and Ophicephalidæ. The detailed taxonomic descriptions are accompanied by twenty-one beautifully produced plates in which all the species are carefully figured, some of them in colour.

Lubricating Value of Mineral Oils

IN 1929, under the auspices of the Department of Scientific and Industrial Research, a paper (Lubrication Research, Technical Paper No. 1) by the late Sir William Hardy and M. E. Nottage on the analysis of commercial lubricating oils by physical methods was prepared. It was considered, however, inadvisable to draw conclusions from the results of experiments reported therein, since only two oils, and those of unknown origin, had been employed. A further paper by Miss Nottage recently published under similar conditions (Lubrication Research, Technical Paper No. 2. London: H.M. Stationery Office. 9*d*. net) entitled "A Study of the Boundary Lubricating Value of Mineral Oils of Different Origin" is intended in certain respects to supplement the original one.

When the film of lubricating oil separating two smooth bearing surfaces is so thin that no part of it is beyond the range of cohesive forces of attraction transmittable from these surfaces, boundary conditions are said to prevail. Interposition between the two surfaces of a film of oil may, to some extent, neutralise these conditions or, in other words, boundary lubrication may be employed. In these circumstances two important factors must be taken into consideration: the effect of the surface on the oil, hence the nature of the bearing surface, since chemical activity occurring at an interface differs materially from that occurring in bulk; and chemical properties of the lubricant, the function of which of neutralising the cohesive forces of attraction is effected by the formation of adsorptive layers on the bearing surfaces.

Inasmuch as mineral lubricating oils consist of inactive, non-polar constituents and surface-active polar constituents, from which the greater part of the adsorptive layer is formed, the properties of the film may differ considerably from properties of the oil in bulk. Important factors determining friction-reducing properties of the adsorptive layer are the chemical nature of the constituents and their degree of dispersion. This, in turn, may be varied by changes of temperature, the presence of other substances which play no part in reducing friction, or the solution of oil in certain volatile solvents.

Having regard to the important part played by wax in mineral oils, concurrent investigations were made to obtain some indication of its rôle in a lubricant under boundary conditions. It is shown that, in spite of the general view that wax is detrimental to a lubricant, it does, in certain cases, enhance the lubricating value of the oil at the boundary layer.

University and Educational Intelligence

CAMBRIDGE.—At St. John's College a research studentship and research exhibitions are offered for competition in July 1935. One Strathcona research studentship of the annual value of £150 is offered for competition among research students who are graduates of any university other than Cambridge. Two Strathcona exhibitions of the annual value of £40 are also offered for competition under the same conditions as the studentship.

Grants from the Worts Fund have been made as follows:—£75 to D. B. Keith, A. B. Whatman, and J. W. Wright towards the expenses of an expedition to survey the north coast of North-East Land (Spitsbergen); £120 to P. T. Cotton, D. W. Ewer and L. E. R. Picken towards the expenses of an expedition to investigate the freshwater ecology of the south-west Balkans; £50 to T. T. Paterson towards the expenses of an expedition to the North-West Frontier of India for the purpose of studying quaternary deposits; £26 10*s*. to J. R. B. Stewart for archæological investigations in Asia Minor; £25 to Dr. T. C. Phemister towards the expenses of a geological and petrological survey of the Coast Range batholith of British Columbia; £25 to T. G. Tutin for a visit to the Mediterranean coast of Spain to study the destruction of the eel-grass, *Zostera marina*; £25 to K. H. Chapman for an expedition to Morocco to study the Moroccan locust, *Dociostaurus morocannus*.

J. H. Lockhead, of Christ's College, has been nominated to use the University's table at the Zoological Station at Naples.

LONDON.—Mr. R. O. Kapp has been appointed as from March 1 to the Pender chair of electrical engineering tenable at University College.

THE Board of Education is prepared, as in recent years, to consider applications for full-time studentships from teachers in England and Wales with at least five years teaching experience who desire financial assistance to follow courses of advanced study at universities or other institutions at home or abroad. Particulars of the awards and application forms are obtainable from the Board of Education, Whitehall, S.W.1.

APPLICATIONS, which must be received not later than April 15, are invited for the following scholarships awarded by the Council of the Institution of Electrical Engineers. Further particulars can be obtained from the Secretary of the Institution, Savoy Place, London, W.C.2. Duddell Scholarship, valued at £150 a year and tenable for three years, open to British subjects under nineteen years of age on July 1, 1935, who wish to take up a whole-time day course in electrical engineering; Ferranti Scholarship, valued at £250 a year and tenable for two years, open to British subjects under twenty-six years of age on July 1, who desire to carry out whole-time research or post-graduate work in electrical engineering. Swan Memorial Scholarship, valued at £120, and for one year, open to British subjects under twenty-seven years of age on July 1, who desire to carry out whole-time research or post-graduate work in electrical engineering. Silvanus Thompson Scholarship, valued at £100 a year and tuition fees, tenable for two years, for works employees, open to British subjects under twenty-two years of age on July 1; the successful candidate will be required to take up a whole-time day course in electrical engineering at an approved university or technical college.

FROM Heriot-Watt College, Edinburgh, we have received a brochure signalising the completion and opening, in January, of the first section of an important extension of the College buildings, planned, in conjunction with the Town Council, in 1928. The second section, to be completed, it is hoped, in 1936, has already been begun, and the governors propose to make now an appeal for the sum of £100,000 to finance the construction and equipment of the final section. The appeal will be associated with the celebration of the fiftieth anniversary of the assumption by the College of its present name and functions. Prior to 1886, the institution was concerned mainly with evening classes for young persons employed during the day in earning their living, and without any other means of advancing beyond the standards of education of the elementary schools. The pamphlet gives, in addition to full particulars of the extension scheme, a very interesting account of the stages through which the 'School of Arts', founded in 1821 by Leonard Horner (afterwards first principal of University College, London), gradually reached its present status—that of an affiliated college of the University of Edinburgh, preparing students for careers in mechanical, electrical, mining and oil engineering, applied chemistry, brewing, pharmacy, building and printing and conducting evening classes in commerce. Special prominence is given to the amplitude, due in large measure to the exertions of the late Edward Clark, of the equipment of the printing school for the teaching of all phases of book production.

Science News a Century Ago

Chemistry of the Sea

The chemical composition of sea and mineral waters was being actively investigated by Dr. Daubeny in the years 1835–37. In his manuscript "Note-book of Experiments" he records, "March 25th. Having brought from Naples a bottle containing the residuum of 2 gallons of the sea-water taken off the Island of Ischia evaporated till there remained only 6 ounces, I tested it for Bromine . . . I obtained 5·1 grains of silver precipitate—chiefly bromide." From previous analyses it appeared that there is an almost exact correspondence between the quantity of bromine present in the sea-water off Southampton and off Naples.

Temperature of Fishes

Dr. John Davy (1790–1868), the brother of Sir Humphry Davy, became an army surgeon and rose to the rank of inspector-general of army hospitals. He was eminent as a chemist, geologist and physiologist, and in 1834 was elected a fellow of the Royal Society. On March 26, 1835, he read a paper to the Royal Society "On the Temperature of some Fishes of the Genus Thunnus". He said that many years before he had observed that the bonito had a temperature of 99° F. when the surrounding medium was 80·5° F. and that it, therefore, constituted an exception to the general rule that fishes are universally cold-blooded. Having found that the gills of the common tunny of the Mediterranean were supplied with nerves of unusual magnitude, that the heart of this fish was very powerful and that its muscles were of a dark red colour, he was led to conjecture that it might, like the bonito, be also warm-blooded, and this opinion was corroborated by the testimony of several intelligent fishermen. In the course of his paper he endeavoured to extend the analogy to other species of the same family which, according to the reports of the fishermen of whom he made inquiries, have a high temperature and in the internal structure of which he noticed the same peculiarities as in the tunny, namely, very large branchial nerves, furnished with ganglia of considerable size.

Faraday on the Manufacture of Pens

On March 27, 1835, Faraday lectured at the Royal Institution on the manufacture of pens. A report of the lecture was given in the *Records of General Science* of May 1835. Quills, Faraday said, appear to have been employed at least as early as the seventh century. England was supplied with the article from Russia and Poland, where immense flocks of geese were kept for the sake of their quills. Twenty million quills were imported into England from those countries in 1834. A wing of a goose produced about five good quills, and by proper management, a goose might afford twenty quills during the year. The preparation of quills was a nice process of which, up to seventy years previously, the Dutch had had a monopoly. A pen cutter would cut about 1,200 quills a day. A house in Shoe Lane cut annually about six million. Steel pens for writing were first made by Mr. Wise in 1803, and were fashioned like goose pens. A patent was taken out in 1812 for pens with flat cheeks, and in this way all metallic pens were made for some time, as the rhodium pen of Dr. Wollaston and the iridium pens of others. About twelve years

previously, Mr. Perry began to make pens, and about six years after that they were manufactured in Birmingham. Faraday described the processes employed in the making of steel pens and said that, from information given him, the total quantity of steel used in Great Britain for pen-making was 120 tons. When first introduced, steel pens were 8*s*. a gross, but recently they had been manufactured at 4*d*. a gross. It appeared that the only interest that had suffered by the employment of steel pens was that of the pen-knife makers.

Samuel Clegg and the Gas Industry

In the *Mechanics' Magazine* of March 28, 1835, is a contribution from "L. L." on "Materials for a Memoir of Mr. Samuel Clegg, and Authentic History of the Art of Gas Lighting". Samuel Clegg, the elder, was born in 1781 and died in 1861, and "L. L." described himself as one of his earliest and oldest friends. Clegg learnt the art of gas-making from Murdoch at the works of Boulton and Watt. In 1805 he set up a small gas plant at his mother's house in Manchester, and in the following year installed gas lighting in some of the Lancashire factories. He was the first chief engineer of the Gas Light and Coke Company and he was the first to invent a gas meter. In the course of his article "L. L." said: "In 1814 Mr. Clegg superintended the fitting up of the pagoda in St. James's Park. This splendid display of the power of gas illumination was exhibited to the Royal family on the evening previous to the night when it was burned down by the fireworks. The pagoda was an octagonal figure, 80 feet high from the bridge. At each angle there was a pipe running the whole height, with a small hole drilled every two inches, through which gas issued, and opposite each of the lowest holes in the perpendicular pipes was placed an oil lamp, concealed by a piece of sheet iron, so that when the gas was turned on, the first flame was ignited by the oil lamp, and each gas flame lighted the one immediately above it all the way to the top. This gave the whole the appearance, when first lighted, of so many rockets ascending into the air. There certainly never was anything so beautiful before, and it is likely that there never may be again."

Societies and Academies

LONDON

Royal Society, March 14. M. L. E. OLIPHANT, A. E. KEMPTON and LORD RUTHERFORD: The accurate determination of the energy released in certain nuclear transformations. If changes of mass are taken into account, the law of conservation of energy holds closely for the transformations of the isotopes of lithium when bombarded by ions of ordinary and of heavy hydrogen. The masses of Li^6 and Li^7 are found to be $6{\cdot}0143 \pm 0{\cdot}0002$ and $7{\cdot}0148 \pm 0{\cdot}0002$ respectively, in good agreement with the mass spectroscopic values $6{\cdot}0145 \pm 0{\cdot}0003$ and $7{\cdot}0146 \pm 0{\cdot}0006$ found by Bainbridge. By application of the laws of conservation of momentum and energy, the mass of the hydrogen isotope of mass 3 is found to be $3{\cdot}0152 \pm 0{\cdot}0002$. Attention is directed to the factors involved in determining the mean ranges of expelled particles and to the difficulties of interpretation when more than two particles are emitted in a single transformation. While there is good agreement in the case of lithium, which involves the masses of particles measured in terms of helium, a number of nuclear reactions in beryllium and other elements show large discrepancies on the accepted mass scale. These reactions, as well as those in lithium, can be brought into line by assuming a small error in the helium oxygen ratio. H. J. TAYLOR: The tracks of α-particles and protons in photographic emulsions. α-particles and protons give tracks in photographic emulsions, which are visible, after development, as rows of grains in straight lines. These tracks have been studied, using special emulsions more suitable for such work than those commercially obtainable. Exposure of a plate to a neutron source gives rise to well-defined tracks, which are due to the protons ejected by the neutrons in their passage through the gelatine of the emulsion. The method is, however, unsuitable for quantitative study of neutron energies.

PARIS

Academy of Sciences, February 4 (*C.R.*, **200**, 429–500). The president announced the deaths of Charles Flahault, non-resident member, and of Theobald Smith, *Correspondant* for the Section of Rural Economy. B. HAVELKA: The curves in Euclidian space of n dimensions the curvatures of which are connected by linear relations with constant coefficients. JEAN LOUIS DESTOUCHES: Conditions to be imposed on a physical space and the generalisation of Poincaré's definition of the number of dimensions. HENRI ROURE: The calculation of a periodic solution in the perturbation of Pluto by Neptune. F. TESSON: A liquid microcathetometer. The distance between two vertical points is measured by running water from a microburette into a circular trough containing water covered with a layer of oil. Contact with the point can be determined to 0·001 mm. and, by arranging a suitable area for the section of the trough, this corresponds to the addition of 0·02 c.c. of water. AMÉDÉE GUILLET: The measurement of the moment of a couple by the use of the chronometric motor. Application to the study of viscosity. MARCEL CHRÉTIEN: A new apparatus for the restitution of aerial photographs. LÉONARD SOSNOWSKI: The radioactivity excited by neutrons in platinum. The neutrons in the experiment described were obtained from irradiated beryllium. Platinum, after 15 hours exposure, gave a radiation which from its rate of decay and absorption on passing through aluminium, would appear to be due to β-particles. PIERRE AUGER and A. ROSENBERG: The secondary effects of the cosmic rays. FRANCIS PERRIN and WALTER M. ELSASSER: The theory of the selective capture of slow neutrons by certain nuclei. PIERRE MONTAGNE: The calculation and graphical representation of the elementary displacements in the reactions of homogeneous chemical equilibrium. Variation of the concentrations. Reactions at constant volume. RAYMOND LAUTIÉ: The molecular weight of a pure liquid at its normal boiling point. PAUL LAFFITTE and PIERRE GRANDADAM: The oxides of platinum. The authors have previously described the preparation of a mixture of the two oxides PtO and PtO_2 by the direct action of oxygen at high pressure and at a high temperature on platinum. The dioxide was isolated from this mixture and in the present communication the isolation of PtO is described. Hydrogen reduced PtO instantaneously at the ordinary temperature. The mixed oxides act as a very active catalyst in the hydrogenation of certain organic

compounds. FÉLIX TROMBE : The isolation of gadolinium. The gadolinium is separated by electrolysis of its chloride in the presence of cadmium : the cadmium is afterwards removed from the gadolinium by distillation in a high vacuum. MARCEL CHÂTELET : A transition compound in the formation of complex compounds of trivalent cobalt. PIERRE FRÉON : The preparation of α-aldehyde alcohols. The Grignard reaction takes place normally with α-isonitrosoketones, and the aldehyde alcohol $C_4H_9.C(CH_3)(OH)CHO$ has been prepared by this method. GERARD DESSEIGNE : The condensation of isopropyl alcohol with toluene and some substitution derivatives. GEORGES DARZENS and ANDRÉ LÉVY : The synthesis of a methylmethoxytetrahydronaphthalenic acid, the corresponding naphthalenic acid and of 1.7.methylnaphthol. GEORGES MIGEON : The proportion of water and the dehydration of sepiolites. V. BABET : The first fossil molluscs collected in French Equatorial Africa, in the formations of the interior basin of the Congo. JOSEPH BLAYAC, RODOLPHE BÖHM and GASTON DELÉPINE : The age of the Lydian horizon of the base of the Carboniferous of the Montagne-Noire. ALBERT ROBAUX : The presence of the Upper Cretaceous at the base of the Flysch series of the south of the province of Cadiz. E. FOURNIER : The experiment with fluorescin at the Paradis gulley (Doubs). The fluorescin test showed that the water from this gulley appeared at four outlets, taking from three to eight days to travel. JEAN CUVILLIER : The distribution and stratigraphic value of *Nummulites uroniensis* in Egypt and in the Mediterranean basin. FRON and MONCHOT : The influence of certain derivatives of quinoline on vegetation. The neutral sulphate of ortho-oxyquinoline (cryptonol), which is known to possess a powerful anticryptogamic action, when added in suitable proportions to soil, hinders the development of injurious fungi and does not reduce the fertility of the soil. ARON POLACK : The disadvantage of didymium in optical glasses. YVES LE GRAND : The measurement of acuteness of vision by means of interference bands. A. DORIER : The passage to latent life of the larvæ of the Gordiaceæ. HENRI HEIM DE BALSAC : The line of demarcation between the Berber and Saharan fauna in North Africa. Its ecological determinism. JAMES BASSET, MICHEL MACHEBŒUF and JEAN JACQUES PEREZ : Studies on the biological effects of ultra-pressures. Modification of the antigenic specificity of serums under the influence of very high pressures. MICHEL FAGUET : The photometric study of microbial multiplication.

LENINGRAD

Academy of Sciences (*C.R.*, 4, No. 7). A. MAYER and E. LEONTOVICH : Some inequalities relating to Fourier's integral. I. VERCHENKO and A. KOLMOGOROV : Further investigations on the point of inflexion of functions of two variables. L. RADZISHEVSKIJ : A method for investigating certain classes of integral equations and of systems with an infinite number of unknown quantities. A. POPOV : Some types of series. J. SEDOV and A. FILIPPOV : Optical dissociation of indium bromide and indium iodide. L. GROSHEV : The spectral distribution of photo-electric current in salts dyed by colloidal copper. S. ARTSYBYSHEV, L. MILKOVSKAJA and M. SAVOSTJANOVA : The influence of illumination on the formation and destruction of colloids of sodium in rock salt. A. PETROV and T. BOGOSLOVSKAJA : Problem of the chemistry of voltol oil formation. G. TARASOV : Polymerisation of liquid hydrocarbons under the action of electric discharges. P. BUDNIKOV and L. GULINOVA : Methods for the determination of active silica in pozzolanic substances. M. BRIK : A find of Lower Triassic flora in Central Asia. N. FILIPJEV : Lepidopterological notes. (16) A case of nomenclature.

SYDNEY

Royal Society of New South Wales, December 5. ADRIEN ALBERT : *Myoporum Deserti* : a preliminary investigation. *Myoporum Deserti*, otherwise known as dog-wood poison bush, Ellangowan poison bush, turkey-bush, etc., has been long suspected of being toxic to cattle. The fruits and the leaves contain a poisonous substance, probably of a glucosidic nature, which could not be isolated during the present work, but leaves and extracts of the leaves tested at Glenfield Veterinary Research Station have confirmed the toxicity of both leaves and fruits to calves and sheep. One pound of air-dried leaves was fatal to the latter. A small amount of volatile oil containing an unidentified ketone was obtained from the leaves. J. C. EARL and G. H. MCGREGOR : A chemical examination of blackfellows' bread, the sclerotium of the fungus *Polyporus mylittæ*, Cke. and Mass. The material was examined by acetylation and by degradation of the acetate with methyl alcoholic hydrochloric acid. The acetate closely resembled cellulose triacetate except that the specific optical rotation was slightly high. The principal degradation products were the methyl glucosides, but there was evidence of the presence of some other methyl glycoside. By direct acid hydrolysis of the original material, a solution containing glucose and some ketose sugar was obtained. The quantities of nitrogenous and ether-soluble substances present were low. J. W. HOGARTH : A note on the decomposition of cobalt amalgam. A new cobalt amalgam, prepared by electrolysis of cobalt sulphate with a mercury cathode, at a high current density, when exposed to the air is rapidly oxidised to what appears to be a suboxide of cobalt. This latter substance is a fine, intensely black powder, yielding some hydrogen on treatment with dilute acid, and neutral water on reduction with hydrogen. T. H. HARRISON : Brown rot of fruits and associated diseases of deciduous fruit trees. (2) The apothecia of the causal organisms. In continuation of his studies of the taxonomy of the brown rot fungi, the author presents a comprehensive account of the apothecial stage of the three common species of brown rot fungi, namely, *Sclerotinia fructigena*, Ader. and Ruh., *S. laxa*, Ader. and Ruh., and *S. fructicola* (Wint.), Rehm. A further record of each of the first two species is presented. Comparative studies of all three are reported and discussed. V. M. TRIKOJUS and D. E. White : Chemistry of the constituents of the wood-oil of the 'callitris' pines. (2) Guaiol. Guaiol, from *C. intratropica*, $C_{15}H_{26}O$(i), on oxidation with potassium permanganate yields the dihydroxyether, $C_{15}H_{26}O_3$(ii), obtained by previous workers, and a substance, $C_{13}H_{24}O_3$, the function of the oxygen atoms being undetermined. (i) on oxidation with percamphoric acid gives $C_{15}H_{26}O_2$ in quantitative yield, a further indication of the presence of a double band or labile third ring in (i). The action of bromine (1 mol.) on (i), followed by hydrolysis, gives good yields of an inseparable mixture of $C_{15}H_{24}$ and $C_{15}H_{24}O$, which reduces catalytically to a mixture of the corresponding dihydroderivatives. Oxidation of guaiene, dihydroguaiene, or (ii) has not

led to positive results. ELINOR S. HUNT: A summary of changes noted in the allantoic membrane of the chick in 500 experiments. The allantoic membrane of the embryo chick was prepared in the manner described by Moppett (*Proc. Roy. Soc.* (B), **105**, 402; 1929) and exposed for periods varying from 2 hours to 6 days to the radiation from a 3 mgm. radium needle. A comparison with controls exposed over a blank needle case clearly demonstrated a radiation effect for the longer exposures. It was thought that mere exposure had a sensitising effect since many of the controls showed abnormalities. An extended investigation with control specimens gave no evidence of infective changes but the incidence of abnormal specimens was greatly reduced by 'sheltering' the exposed area by placing face down on cotton-wool.

(*To be continued.*)

VIENNA

Academy of Sciences, January 10. ERWIN KOSAK: The variability of corresponding differences of meteorological elements and its application to climatological problems. GERTRUD PERL: True solar radiation at different geographical latitudes. The results of measurements of the intensity of the sun's radiation at eighty stations distributed over the earth's surface are summarised, and from them the mean diurnal course of the intensity is derived for the months of March, June, September and December. KARL MAYRHOFER: Real partial fraction series. RUDOLF INZINGER: A geometry of the line elements of the first and second order of space. THEODOR PINTNER: The tissues of cestodes.

January 17. LEOPOLD SCHMID and HUGO KÖRPERTH: Amber (3). The insoluble succinin remaining after treatment of amber with alcohol constitutes the principal component of this resin. On dehydration it yields pimanthrene (1 : 7-dimethylphenanthrene) and agathaline (1 : 2 : 5-trimethylnaphthalene). MAX TOPERCZER: Knowledge of the earth's magnetic field derived from the results of the magnetic survey of Austria in 1930: (1) The potential-free part. RUDOLF ALLERS: Certain differences between monocular and binocular vision and mental influence on the organ of sight. MAX BEIER: The mode of life of *Ochthebius quadricollis* subspec. *steinbühleri*, Rtt. (Col. Hydroph.). ERWIN SCHADENDORFF and AUGUST VERDINO: Condensations of cholesteryl chloroformate with alcohols and phenols.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, March 24

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—G. Tandy: "Plant Life of the Sea".*

Monday, March 25

BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—G. V. Seccombe Hett: "Caribou".*

VICTORIA INSTITUTE, at 4.30.—D. Dewar: "A Critical Examination of the Supposed Fossil Links between Man and the Lower Animals".

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—G. M. Dyott: "Indians of Ecuador" (Geographical Film).

ROYAL SOCIETY OF ARTS, at 8.—J. Grantham: "Research in the Cultivation of Raw Rubber" (succeeding lectures on April 1 and 15).

Tuesday, March 26

ROYAL AERONAUTICAL SOCIETY, at 6.30.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP), at 7.—Annual General Meeting.

Dr. D. A. Spencer: "The Accuracy Attainable by Straightforward Colour Reproduction. (2) Filters for Subtractive Colour Photography".

Wednesday, March 27

BRITISH PSYCHOLOGICAL SOCIETY (MEDICAL SECTION), at 8.30.—(at the Medical Society of London, 11 Chandos Street, Cavendish Square, W.1).—Dr. J. D. Unwin: "Sex Regulation and Culture".

Thursday, March 28

ROYAL SOCIETY, at 11–1 and 2.15–4.—Discussion on: "The Origin and Relationships of the British Flora", to be opened by Prof. A. C. Seward.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Major M. Hotine: "Surveying from Air Photographs".

Friday, March 29

ROYAL INSTITUTION, at 9.—Lord Rutherford: "The Neutron and Radioactive Transformations".

INSTITUTE OF PHYSICS, March 28–30.—Conference on Industrial Physics, entitled "Vacuum Devices in Research and Industry", to be held at the University of Manchester.

Prof. W. L. Bragg: President.*

THE FARADAY SOCIETY, March 29–30.—General discussion on "The Structure of Metallic Coatings, Films and Surfaces". Introductory paper by Dr. C. H. Desch.

Official Publications Received

GREAT BRITAIN AND IRELAND

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies. Vol. 6, No. 1, March. Pp. v+309. (London: H.M. Stationery Office.) 5*s.* net.

The Physical Society. Reports on Progress in Physics. Pp. iv+371+2 plates. (London: Physical Society.) 12*s.* 6*d.* net to non-Fellows.

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