NATURE

SATURDAY, MAY 24, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

NO. 2847, VOL. 113]

Science and Labour.

THE British Science Guild was happily inspired in seeking the co-operation of the National Joint Council of the Trades Union Congress and the Labour Party in the organisation of the conference on Science and Labour in the Modern State to be held at the British Empire Exhibition at the end of this month. The labours of the joint committee, presided over by Sir Richard Gregory, have now borne fruit in the published programme of the conference. Science in its widest sense has a history as old as the known world. As an active agent for the betterment of human life, for the promotion of man's joys and the alleviation of his sorrows, its history is comparatively recent. The researches of Robert Boyle, who died in 1691 and was described on his tombstone as the father of chemistry, found no immediate application in the workaday world. Sir Isaac Newton, the outstanding figure in English science, discovered the secret of the movements of the heavenly bodies ; but it cannot be said that his life-work had much effect on the great mundane movement in his own day and generation.

Sir Humphry Davy's safety lamp for miners was an early example of the application of science to the daily needs of the working man. We may surmise that this invention was hailed with joy and gratitude by the miners : but on the side of mechanical invention generally, the march of progress caused some alarm and misgiving to the working classes. They thought that their livelihood was imperilled ; and occasionally their anxiety sought a drastic remedy in smashing the new machines. That an invention obviously reducing the demand for manual labour should lead indirectly to increased employment was an idea too complex to be grasped by the uneducated populace of the early years of the industrial revolution. One of the greatest indirect services rendered by the progress of science and invention is the insistent demand it makes for higher educational standards in the community generally. The chauffeur must be better educated than the driver of the old horse omnibus. Civilisation must advance line upon line, precept upon precept, step by step and in an ordered phalanx.

The unequal contest between mechanical invention and obsolescent industrial methods soon reached its inevitable conclusion. But after a few decades, the scene of conflict was shifted from the workman's cottage to the country parsonage. The Darwinian theory raised angry protests against science from a section of the community more articulate and not less vehement, if less destructive in a physical sense. Mid-Victorian controversies between science and religion are now a fading memory ; and the reader of the history of these times is surprised and rather amused that men of

brilliant intellect such as Huxley and Gladstone should have expended so much energy on such barren themes as the miracle of the Gadarene swine. Coming to more recent times, the War provided a large-scale object lesson of the destructive power of applied science. In some minds the repercussions of the War have encouraged an atavistic mistrust of science and all its works. More generally, however, the War has quickened the sense of private and public responsibility for the development of science and its application to the needs of the community. If, as Conrad says, "we are bound to the chariot of progress," may we not hope, nevertheless, in some measure to direct its course? Or if, to change the metaphor, science is a Frankenstein monster, may we not try to set the monster to benevolent tasks? That thought, we have no doubt, was in the minds of the promoters of the conference, which will serve a most useful purpose if it helps to reconcile all classes of the community to the claims and progress of science and its applications, and to increase public appreciation of the value of science in all departments of modern life.

These somewhat discursive remarks may serve as a preamble to an examination of the programme of the conference, which has the merit of being coherent and comprehensive. Priority in the list of subjects is given to the Place of Science in Government, the discussion of which is to be opened by Mr. Sidney Webb, president of the Board of Trade. The art of government is popularly supposed to be based on a few simple principles such as counting heads. "Let us talk of the state of the nation," Squire Western said, "or something that everybody understands." Mr. Sidney Webb, as a life-long student of the subject, will not be expected to endorse this view. We cannot doubt that he will admit the increasing complexity of government and administration in the modern state, and the pressing need both for formal study of the subject by men and women of scientific training and experience and for their active co-operation in the work. For the discussion of Scientific Research in Relation to Industry, the conference committee has been fortunate in securing an excellent combination of speakers in Sir Oliver Lodge, whose brilliant researches in abstract physics have contributed to practical results of the highest value, and in Mr. Hugo Hurst, who has established a great research department in connexion with the General Electric Company which he directs. The promotion of scientific research, pure and applied, bristles with difficult problems in the selection of the workers and of the problems they are to attack, and in securing for them the best conditions of work, spiritual as well as material. The well-intentioned efforts of the Government in promoting scientific research will, no doubt, be passed under review. The Co-operation of Science and Labour in Production, the subject of the third meeting, also raises difficult questions. Is it possible, under present-day industrial conditions, to secure for the worker opportunities for the development of his personality and pleasure in his work and a contented outlook on life, undaunted by possible changes which scientific discovery and invention may render necessary? Can the worker expect to be safeguarded against economic, and even fiscal, changes which may render his acquired skill a useless asset?

Science and the Human Factor is the subject to be discussed at the fourth meeting, when the preservation of physical health and the principles and applications of that comparatively new science—applied psychology—will be under consideration. There is a suspicion in some sections of the working classes that the efforts of the experts in these subjects are directed primarily towards increasing the profits of the capitalist. We may hope that men of the calibre of Sir Arthur Newsholme and Dr. C. S. Myers will be able to dispel this suspicion. The worker surely stands to benefit by improved conditions of sanitation, lighting, heating and ventilation, and by the reduction of fatigue and discomfort which is rendered possible by a scientific study of the organisation of manual labour. He should gain also by the methods of vocational selection and guidance which ascertain the tasks best adapted to his temperament and mentality.

At the final session, the subject is Science and Educational Organisation. Possibly no department of public life is more encumbered by tradition and obscurantism than our educational system. A new scientific approach is urgently needed. Education must be recognised as a process of continuous intellectual development in which statutory age limits are almost irrelevant. We must look beyond the ambit of the class-room and the school for stimulating educational influences. If we may conclude by striking an Imperial note, appropriate for a conference to be held in the British Empire Exhibition, it will be to quote Sir James Barrie's suggested motto for the British Empire, "That every child born into the British Empire should get an equal chance." The ideal expressed in this motto will not be realised by sitting in the shade. It is one of the ironies of public life that whereas, thanks to the struggles and sacrifices of our forefathers, positions of influence in government are now freely open to talent, the same cannot be said of many other professions and industries. The present Government should be peculiarly sympathetic to an educational policy which will deal with this question by scientific methods, without fear or favour, and with fairness and impartiality to all classes of the community. T. LL. H.

Colour and Chemical Constitution.

Couleur et constitution chimique: Cours professé à la Faculté des Sciences de Besançon. Par J. Martinet. Rédigé avec la collaboration de Mlle. P. Alexandre. (Collection de Physique et Chimie.) Pp. 328. (Paris: Gaston Doin, 1924.) 25 francs.

AMONG the fields opened up to research by the work of Frankland and Kekulé upon valency, not the least interesting is that which is devoted to tracing a relationship between the chemical constitution of substances and the colour which they exhibit; and since the theory of structure has made greatest progress in the organic region of chemistry, it is not surprising to find that our knowledge of the origin of colour has advanced among the carbon derivatives much further than among inorganic compounds.

In the early days, visual colour as determined by the human eye was assumed to be a sufficiently wide field; and attention was concentrated upon this region, to the exclusion of both the ultra-violet and the infra-red regions of the complete spectrum. Nowadays, however, this arbitrary limitation has broken down; and it must be admitted that any substance showing an absorption band in any portion of the spectrum is possessed of the quality which, when it presents itself in the visible region, is termed "colour"; so that it is scarcely possible to restrict attention to visually coloured substances without running the risk of missing important correlations in the invisible regions of the spectrum.

The development of the subject falls into a series of well-marked stages. In 1867, Graebe and Liebermann observed that when certain coloured compounds were reduced, the colour vanished; and from this they inferred that coloured compounds probably contained unsaturated groupings of atoms. Ten years later, Witt showed that in the structure of coloured substances there is embedded a group of atoms which he termed a "chromophore"; and that the colour is due to the presence of this group and not to the remainder of the molecule. For example, the azo-group –N : N– is one of the chromophore class. These chromophoric groups, however, are unable to exist alone; and in order to give them stability, they must be linked to other radicles. The stable material so formed was termed a "chromogen," by which is meant a coloured compound such as azobenzene, C_6H_5–N : N–C_6H_5. Now azobenzene, though coloured, is not a dye, since it will not fix itself upon any fabric; but if there be introduced into the azobenzene structure a fresh radicle, such as the hydroxyl or amino-group, then the coloured material may become capable of dyeing cloth. But, simultaneously, the colour of the compound is deepened by the introduction of the amino or hydroxyl radicle; so that evidently such radicles, though intrinsically without colour-producing properties, have the power of influencing molecules into which they are introduced and changing their tint. Radicles of this kind are termed "auxochromes."

While the study of the visible region of the spectrum was thus progressing, two fresh fields were being opened up by Hartley and Abney, one working in the ultra-violet, the other in the infra-red; and although Armstrong's quinonoid theory helped to fix attention upon visual colour, the prevailing stream of research turned towards the ultra-violet region.

At the beginning of the present century, another stride was taken by Stieglitz in the application of structural ideas to the behaviour of indicators, the alteration in colour in this case being traced back to an intramolecular change in the indicator molecule which either destroys or produces a chromophoric group in the structure of the indicator.

Shortly after this, a fresh orientation in interest took place owing to the introduction of dynamic ideas into the subject. It was assumed that since selective absorption implies the stoppage of certain light-waves, there must be in the molecules of coloured substances some vibrating mechanism having a period identical with that of the light-waves which are absorbed; and in order to represent this machinery, it was suggested that something akin to tautomeric change was taking place within the molecule. Thus for the old idea of a "static" chromophore, the newer conception substituted a "dynamic" chromophore based ultimately upon electronic ideas.

Fresh possibilities were opened up, about a decade ago, by the invention of the spectrophotometer, by means of which Henri was able to measure the extinction coefficients of substances in the ultra-violet region. This new mode of attack at last introduced a definitely quantitative factor into the study of absorption spectra, and thus brought within the limits of possibility the calculation of curves of absorption from certain ascertained constants.

Though absorption spectra have thus been brought within the limits of calculation, and although remarkable results have been attained in this field by Henri and Baly, it may be doubted whether this advance is ever likely to be so useful in practice as other cognate discoveries have proved themselves. Refractive index and magnetic rotation have been of great service to organic chemists owing to the simplicity of the calculations involved in dealing with these properties; but this simplicity is due to the fact that only one wave-length of light is dealt with. If it were necessary to calculate a complete graph of the refractivity of a

substance over the whole spectrum, it is doubtful if much use would be made of the method; and the problem of calculating the absorption graph of a compound is almost as complex as this. Thus, though from a purely theoretical point of view, the advance to calculation is of great interest, it seems doubtful if the calculation of absorptive power will ever become as common in laboratories as calculated refractivities now are.

In the work under notice, Prof. Martinet and Mlle. Alexandre have confined their attention almost exclusively to the subject of "visible colour." Their aim has been to show that from a simple examination of chemical structure it is possible to foretell whether a compound will be coloured or not and to predict within rough limits what its actual tint will be. The origin of colour they have relegated to the physicists. Within the limits which they have laid down for themselves, their review is so extensive and thorough that it seems a pity that they did not extend the scope of their book to include the whole field. The volume is a mine of information on the subject of chromophores, auxochromes and their effects. The phenomena of halochromism, chromoisomerism, thermotropism, and tautomerism have been included in their survey; and in their sections upon molecular organic compounds, organo-metallic compounds and free radicles, they have collected a fund of examples which are extremely interesting. It is a book which cannot fail to suggest many interesting problems to any reader. The gravest defect in it is the lack of an index of compounds; and as this would greatly increase its value as a work of reference, it is to be hoped that in future editions such an index will be included. A. W. S.

Science and the Future.

(1) *Daedalus, or Science and the Future.* A Paper read to the Heretics, Cambridge, on February 4, 1923. By J. B. S. Haldane. Pp. vii+93. (London: Kegan Paul and Co., Ltd., 1924.) 2*s.* 6*d.* net.

(2) *Icarus, or the Future of Science.* By Bertrand Russell. Pp. 64. (London: Kegan Paul and Co., Ltd., 1924). 2*s.* 6*d.* net.

(1) MR. HALDANE has been known for some time to his acquaintances as a man of encyclopædic knowledge and portentous versatility, as well as of high scientific attainment; but this little book is his first public venture outside the covers of scientific journals. It is an amplification of a paper read before the Heretics Club in Cambridge; even allowing for the expansion, the paper must have provided a "crowded hour of glorious life"!

Mr. Haldane sets out to explain that the future of science, in his opinion, will lie more and more with biology, just as its past has lain predominantly in the fields of physics and chemistry. He then goes on to point out that so far, almost every invention of practical utility has been physico-chemical—that is, has given man increased power without in any way affecting or coming to close quarters with his nature as an organism. Of important biological inventions there have been a bare half-dozen, and four of these are older than history. "Bactericide" and the artificial control of conception are the only two modern ones the claims of which he is ready to admit. But clearly, he continues (and clearly too he is right), we are on the verge of scores of new inventions of a biological nature. The control of the sex-ratio is a matter of a few decades; the applications of endocrinology are beginning already; and we shall doubtless soon be adding considerably to the list of substances which, like alcohol or tea or tobacco, have such pleasant or stimulating properties that they will come into general use.

The author's further prophecies are cast in amusing form. He supposes a Cambridge undergraduate in A.D. 2024 reading an essay to his tutor on the progress of applied biology in the past century. We are introduced to artificially evolved nitrogen-fixing organisms, to the artificial alteration of character through applied endocrinology, and finally to "ectogenesis"—the artificial development of human embryos outside the body, from ova taken from ovaries cultivated *in vitro* and artificially fertilised.

Far-fetched, this last prophecy? Not so very, if what has already been done with tissue-culture be remembered. As Mr. Haldane says, think of the rapidity at which human evolution will then be able to progress, once the whole of each generation can be reared from a few dozen parents of selected type.

There are some biological possibilities which Mr. Haldane seems to have forgotten—what, for example, of the regulation of sleep? There is surely room for improvement there. What, too, of the difficulties which civilisation seems always to bring in its train? How will biology prevail upon men to be moderate and to live healthy lives? Half our present diseases are diseases of excess or of carelessness.

However, one cannot prophesy everything. We hope that Mr. Haldane's booklet will not lack readers—they will find in it not only entertainment but also food for much thought.

(2) Mr. Bertrand Russell's sequel to "Daedalus" is not so good. Its title tells nearly all of what is within. His thesis, briefly, is that, since man collectively is a more unpleasant being than man individually, and since, further, the application of science has been chiefly instrumental in giving man more power in his

collective capacity while on the whole reducing his individual independence, therefore science is dangerous, and that unless we take steps to counteract these tendencies we may perish by science instead of living by it.

In one sense this is all but commonplace—everything is what we make it, and all implements are only good or bad as we use them well or ill. But Mr. Russell doubtless intends his book to be more than commonplace; and if so, he should have made more of it, and not left so much out of the picture. He has left medicine almost wholly out of the picture, both curative and preventive—and that is a big omission. But, bigger omission than that, he has left the scientific spirit out of the picture. The scientific spirit, we take it, is that which finds out what is true, and attempts to act on what it has found out—rational imagination and imaginative reason. However much governments or individuals may attempt merely to utilise the practical results of science, they cannot have those results without men of science, and they cannot have men of science without the scientific spirit. As the men of science grow more numerous, the scientific spirit will spread, and as it spreads, it will make more and more difficult a foolish use of the practical applications of science. Hitherto, though science has transformed social and industrial conditions, there has been no corresponding change in the relationship of labour to management, or in the provision of administrators adapted by scientific knowledge to deal with problems of the new era.

Mr. Russell dislikes present-day Western civilisation: but he is impatient. If ever there was a time of rapid transition, it is now. Does he forget that our modern science as an organised body of knowledge is scarcely three centuries old? Or does he forget what a short time is three centuries, even in the life of a rapidly evolving species like man? Frankly, it is a rather disappointing little book, from one of whom we expect so much.

Mathematical Philosophy.

Mathematical Philosophy, a Study of Fate and Freedom: Lectures for Educated Laymen. By Prof. Cassius J. Keyser. Pp. xv+466. (New York: E. P. Dutton and Co., 1923.) 4.70 dollars.

MOST of us make use of mathematical ideas and processes to some extent, and many of us have wondered from time to time what these ideas and processes really were. What is the meaning of function, transformation, invariance, limit, infinity? What are the relations of algebra and geometry? Has geometry anything to do with space? What is the meaning of a geometry of n dimensions? What are irrational numbers? These and many more questions naturally occur on reflection. The mathematicians themselves are seldom able to give much help to the outsider. None of the questions of this type are easy to answer, and some of them the mathematicians themselves could not answer until recently. Indeed, inquiry into the fundamental principles of mathematics is of very modern growth; the older school of mathematicians were content to find that the methods they use worked all right without finding out the reason why.

Prof. Keyser sets out to answer such questions, and explains to those who are not mathematicians what mathematical reasoning is and what it is about. He has succeeded admirably. He is lucid and interesting. His illustrations are always to the point, and his digressions (which are many) are always entertaining and provocative of thought. If any reader complains that the author whets the appetite rather than satisfies it, he has his reply ready: "I trust we are not so stupid as to be able to answer all the questions we are able to ask."

A more serious criticism that might be made is that among the questions Prof. Keyser discusses, he gives rather scant attention to the very fundamental problems of the nature and relations of the various types of numbers, and his treatment of infinity consists mainly of digressions, though they are interesting ones. Of course, he might reply to this that any one who wishes information on these matters can get it from Russell's "Introduction to Mathematical Philosophy," to which he refers.

In the last three lectures the author leaves his more strictly mathematical topics. In one, perhaps the best in the book, he discusses the psychology of mathematics. He points out how, from the time of Pythagoras almost to the present day, the bad psychology of mathematicians has frequently hindered mathematical discovery. It has taken a long time to persuade them that things can be reasoned about even when they cannot be imagined. The last two lectures, interesting and highly controversial, deal with the nature of mankind, civilisation, and progress. These topics are not quite so remote from mathematical philosophy as might be thought at first sight.

The work is emphatically a book to be read by all who wish to learn what the science of mathematics is about. Even if the study, as Prof. Keyser says, "is not so entertaining as a movie or so easy as the life of maggots in a cheese," he has made it sufficiently easy and entertaining for any reasonable person, without sacrificing lucidity and accuracy.

A. D. R.

Our Bookshelf.

Jacquards and Harnesses: Card-cutting, Lacing and Repeating Mechanism. By Thomas Woodhouse. Pp. xxii+429. (London: Macmillan and Co., Ltd., 1923.) 25*s.* net.

THE book under notice is an admirable illustration of the great advance textile technology has made chiefly through the influence of the great technical schools established in the textile districts of Great Britain. Students and the mill men have been allowed only a mere smattering of the detailed work associated with any given process so far as text-books are concerned, and even the long and patient acquisition of knowledge in the mill has been confined to the limited branch of the work on which they were and are engaged. A specialised book such as this is now throws open to all information hitherto confined to a few. Both mental development and manipulative ability must result from a study of its contents.

The author has had a long experience in teaching, and his books have established his reputation as a writer. This new work bears evidence of careful thought and of clear descriptive ability in dealing with a subject that presents so many manipulative intricacies and complicated mechanical movements. An unusually large number of excellent drawings, diagrams, and half-tone blocks illustrate the text and add considerably to the value of the book.

The arrangement of the matter follows a rational course. Quite wisely, the Jacquard and its operative mechanism is ignored; its existence is taken for granted. After an introductory chapter which lays down the relative positions of the Jacquard, comber board, etc., the author devotes the next two chapters to the methods of tie-up of the harness, both straight and mixed, this being very thoroughly treated numerically and by illustrated examples. The remaining chapters deal with the controlling elements of the harness, namely, the cards, and here we see the specialist at work guiding one through the various methods of cutting the cards, from the simplest form to the most modern and complicated mechanical card-cutting and repeating apparatus. Descriptions and illustrations are given that cover the whole range of the industry, and not the least valuable feature lies in the excellent advice and comments on the advantages of the various methods for their respective uses.

The student will find in the book a stimulus to a more complete knowledge of weaving, whilst those in responsible positions in the mill will welcome it as a valuable aid in their attempts to attain a high degree of efficiency.

An Introduction to the Mathematical Theory of the Conduction of Heat in Solids. By Prof. H. S. Carslaw. Second edition, completely revised. Pp. xii+268. (London: Macmillan and Co., Ltd., 1921.) 30*s.* net.

IN 1906, Prof. Carslaw published a work on "Fourier Series and Integrals and the Mathematical Theory of the Conduction of Heat." An appreciative notice of this book appeared in NATURE of March 14, 1907, over the initials "G. H. H." Prof. Carslaw's book has since then reached a second edition, in the form of a very much rewritten work in two volumes. The first volume of the second edition contains the pure mathematical theory, and has been already reviewed in NATURE of April 8, 1922, by Prof. G. H. Hardy. The second volume of the second edition is the subject of this present notice.

The book is an enlarged form of that portion of the original work which dealt with the boundary problems arising in the application of Fourier series and integrals to problems in the conduction of heat. The usual problems are passed in review in a thoroughly systematic manner, and discussed with mathematical completeness and rigour. After establishing the fundamental differential equation of the problem of heat conduction, the author proceeds to examine the one-dimensional problems, such as Fourier's ring, linear flow in an infinite and a semi-infinite rod, and the flow of heat in a solid bounded by two parallel planes. Two-dimensional problems are treated next, as well as the case of the rectangular parallelepiped. Problems depending on polar co-ordinates, such as that of the circular cylinder, the sphere, and the cone, are followed by more general types of discussions on the method of sources and sinks in cases of variable temperature and the use of Green's function.

The new feature of the present second edition is represented by the chapters on the method of contour integrals and of integral equations.

Although the book is essentially mathematical in outlook, and quite uncompromising in the complexity of the mathematical discussions, there is, nevertheless, a thread of physical interest which adds considerably to its usefulness and readableness. References are to be found to practical experimental evidence, and to such applications as the theory of conduction of heat through the earth. It is an important book, that has established itself as an authoritative exposition of an important branch of mathematical physics, and no applied mathematician can afford to ignore it. S. B.

The Physical Basis of Life. By Edmund B. Wilson. Pp. iv+51. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 7*s.* net.

PROF. E. B. WILSON, in this, the first William Thompson Sedgwick Memorial Lecture, has given biologists an extremely interesting glimpse of the line which his thoughts, stimulated by the recent advances in cytology, genetics, and developmental physiology, are pursuing. Prof. Wilson is not only the doyen of cytologists and an all-round zoologist of the first rank, but also one of the select few among scientific workers capable of writing clearly and with style. His cytological reflections on chromosomes as the physical basis of heredity, and on the Golgi bodies and mitochondria, illuminate the subject, while his all-too-brief discussion of certain facts of experimental embryology runs along a somewhat unfamiliar track.

Most cytologists will find Prof. Wilson's suggestions concerning the ultimate, ultra-microscopic structures of protoplasm the most original matter in the book. He imagines, in brief, that there is probably a continuously graded series between the visible "granule" and other inclusions of the cell, and the smallest molecules which merit the style of *living*; and further, that many of the ultra-microscopic particles are probably self-reproducing units. This return to the biophor type of corpuscular theory on the part of so experienced a

cytologist is of great interest. His conclusion, from numerous converging lines of evidence, that "the primary basis of the egg organisation lies in the ground-substance or hyaloplasm," coincides with that of most workers in the field of experimental embryology. (Why does no one invent a single word to do duty in English for *Entwicklungsmechanik*?) On the other hand, his confession of complete ignorance as regards the nature or essence of this primary organisation of the egg is curious, coming as it does from a fellow-countryman of Child's, whose theory of axial gradients seems to many competent workers to throw a real light on the question. In point of fact, there is actually no reference, either in the text or the literature list, to Child's name or work. Is there a feud between Chicago and New York?

There is, however, so much of fact and of idea within these fifty pages that it would be ungracious to carp at omissions. This little book will make every biologist hope with all his heart that its author's long-promised revision of his classic work on the cell will not be long delayed.

Varnishes and their Components. By Dr. R. S. Morrell. (Oxford Technical Publications.) Pp. xii+361. (London: Henry Frowde and Hodder and Stoughton, 1923.) 25*s.* net.

WITH few exceptions, books on varnish have been of the type of the craftsman's handbook. Empiricism ruled because the industry was more or less secretly pursued and many of the recipes had been adopted from practical experience, often without any insight into the fundamental changes involved. To understand the nature of varnishes, a knowledge of the properties of colloids, especially in non-aqueous media, is required. With the modern development of this branch of physical chemistry the art and craft of the varnish-maker is certain to be influenced.

Dr. Morrell is not only intimately connected with the industry, but, as the records of the literature show, he has also for more than twenty years been an active investigator of the subject. He has broken away completely from the traditional outlook and has not been satisfied with a mere sorting of the literature. He has produced a stimulating and suggestive thesis of outstanding merit which must be of great value to the technologist and research worker.

The first section, which follows a short historical introduction, deals in a thorough manner with the components of varnish and their preparation and properties. The second section embraces the different types of varnish, their manufacture and application. Special attention might be directed to two extremely useful chapters on properties and defects of varnish and on insulating varnishes. In this section is also included a chapter on analytical methods. The book, which is excellently printed and illustrated, is provided with a long list of references, a bibliography, and a subject and name index. JOS. REILLY.

Galvanomagnetic and Thermomagnetic Effects: the Hall and Allied Phenomena. By Prof. L. L. Campbell. (Monographs on Physics.) Pp. xii+311. (London: Longmans, Green and Co., 1923.) 16*s.* net.

THE phenomenon of the Hall effect and the allied galvanomagnetic and thermomagnetic effects have for many years been studied closely by physicists, who have hitherto failed to give any satisfactory explanation of the fact that the several effects have different signs in different metals. It seems probable that no satisfactory explanation of these phenomena can be given until the internal structure of the atom and the interaction of atom and electron are better understood. It would be necessary also to have a common electron theory for heat, electricity, and magnetism. To the serious research student this book will prove of great value.

There are 618 entries given in the bibliography at the end of the volume, and their number is extending daily. Some of these papers describe novel experimental effects and others discuss elaborate theories. A clear compilation of these results has been made.

In his latest theory (Proc. Nat. Acad. Science, 9, p. 41, 1923), Hall postulates the presence of two transverse streams of electrons in a metal plate placed in a magnetic field. One of the streams consisting of free electrons gives rise to a negative Hall effect; the other consisting of associated electrons gives rise to a positive Hall effect. One or other of these effects will generally predominate, according to the kind of metal, its physical condition and temperature, and the strength of the magnetic field.

The Foundations of Indian Agriculture (formerly "The Bases of Agricultural Practice and Economics in the United Provinces, India"). By Dr. H. Martin Leake. Second edition. Pp. viii + 277. (Cambridge: W. Heffer and Sons, Ltd., 1923.) 7*s.* 6*d.* net.

DR. MARTIN LEAKE'S book is written primarily for the needs of the Indian student. It covers a wide field, as it deals with historical development, agricultural science, and agricultural economics. The latter section will prove of most interest to the English reader, who has already available extensive literature dealing in detail with both agricultural history and science. Dr. Leake discusses lucidly a fundamental problem in Indian rural life—the system of inheritance which in both Hindu and Mohammedan law recognises equality of right between the children. The inevitable result is a progressive division and subdivision of holdings to an uneconomic size, and since the good and the bad land must be fairly divided, the problem is further complicated. Nor do the difficulties end here. The cultivation operations essential for the full growth of crops cannot be carried out owing to the lack of sufficient sturdy cattle. Religious difficulties are serious but not insurmountable, and the solution appears to be that in use in Egypt, where cattle are stall-fed largely on fodder grown in rotation with maize, cotton, wheat, and other crops. The final sections dealing with the development of co-operation, and the replacement of the village money-lenders' activities, are of considerable interest. B. A. K.

Osmics, the Science of Smell. No. 2. By John H. Kenneth. Pp. 43-79. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1924.) 2*s.*

THIS book contains a further list of 500 references to original papers dealing immediately or remotely on the sense of smell. It should prove useful to those engaged in original work on the subject.

Letters to the Editor.

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On Editing Newton.

THE recent presidential address of Dr. J. L. E. Dreyer at the Royal Astronomical Society, remarking on the lack of a standard edition of the writings of Sir Isaac Newton, has given rise to some misconception in the daily Press. It would, of course, not be correct to infer any want of interest in that great heritage, or in the mode in which it has come down to us. Dr. Dreyer has naturally a special claim to attention in matters of scientific bibliography. His work on Tycho Brahe and on Sir W. Herschel, including the valuable introductions, will be a permanent possession. The writings of Newton involve, however, difficulties that were absent in these cases, as also in the immense outputs of Huygens and Euler and Laplace, to which he refers. There all is straightforward: the material had been published in standard form, and the main task was to collect and arrange it. With Newton scarcely anything was systematically published except the "Principia," that stupendous result of eighteen months' labour, and the "Opticks." The rest circulated largely in fragments, printed often long afterwards, and in part the subject of intricate international controversy, now perhaps mainly of antiquarian interest, if not largely obsolete. Moreover, the effect of Newton's writings reverberated all through the eighteenth century, and their adequate presentation should involve discussion of their indirect influence on the mode of progress of physical science in Britain and elsewhere.

An edition merely bibliographical is scarcely needed. There is no part of them that is not readily accessible, sometimes in numerous editions published in various countries, except two sections. One of these is Newton's correspondence, which has been accumulating in public collections but has not hitherto been systematically dealt with; the other is his work at the Mint, especially in relation to the restoration of the coinage, which, as one learns on high authority, includes documents fundamental for the history of economic science.

I have been anticipated in offering reasons for caution by Prof. Sampson. In the last Monthly Notices of the R.A.S. he has given a very attractive account of a project developed at Cambridge twenty years ago, in which colleagues in the University, some of them now deceased, were closely concerned along with me. We succeeded in gaining Prof. Sampson's active and stimulating support. The valuable memorandum, planning an edition of Newton's works, which he prepared for us as the basis of a working scheme, has now been printed by him. The intention was to begin with a collection of the letters, in which his special knowledge would have made him the main agent: the rest was not urgent, for the reasons indicated above. But as time passed it became clear, to me at any rate, that a committee of editors could not be very effective, especially when it consisted of men primarily intent each on his own scientific pursuits. Thus no effort has since been made to push the project.

It is perhaps not superfluous to record this entire confirmation, by independent opinion, of Prof. Sampson's own matured judgment on the difficulty and even tedium of the task. But one may be permitted to express the view that a systematic collection of the letters remains most desirable, and the hope that some day that part of the scheme may be realised. It might possibly best be done by weaving them into a biography; though the "Life" by Brewster, now nearly seventy years old, is wonderfully adequate when the limitations of the writer on the mathematical side are remembered. The notes to the edition of the correspondence with Cotes, prepared by Edleston in 1850 for Trinity College, are an additional mine of concise information drawn from the original documents; and there are shorter historical accounts by Mr. Rouse Ball and others, including a re-issue of Prof. De Morgan's critical essays by Mr. Jourdain.

The Report of the Cambridge University Syndicate which dealt exhaustively with the Portsmouth Manuscripts, now deposited at Cambridge, has scarcely received the recognition that it merits, though it is gratifying to observe that Dr. Dreyer has studied it closely. The rather hurried final publication (in 1888) perhaps reduced it too much to a catalogue. It, however, provided an adequate though very condensed summary (pp. xxx, 58) of the results of a scrutiny spread over many years by Adams, Stokes, Liveing, with Luard for University history and theology, dealing with a mass of manuscripts which, as one learns on direct authority, came to them after many vicissitudes in most disordered and often seemingly hopeless condition.

JOSEPH LARMOR.

Cambridge, May 7.

The Band Spectrum of Boron Nitride.

DR. R. S. MULLIKEN has described in three letters his recent work on the application of the quantum theory of band spectra to the study of isotopy. In the first of these letters (*Science*, vol. 58, p. 164, August 31, 1923) he establishes the isotope effect in the case of boron by the analysis of my data for a band spectrum which I had shown to be due to a nitride of boron (Roy. Soc. Proc., A, vol. 91, p. 120, 1915). At the time he accepted this attribution. Since then, however, Dr. Mulliken has undertaken a new experimental investigation and obtained data, a theoretical consideration of which has induced him to ascribe the spectrum to BO rather than to BN, although, as he states in the second letter (NATURE, vol. 113, p. 423, March 22, 1924), "the possibility of BN is not yet altogether excluded." Apart from this passage, the letter and its title (in which the band spectrum is called that of boron monoxide) leave the impression that in Dr. Mulliken's view the possibility of BN is definitely excluded, an impression which finds later justification in the third letter (NATURE, vol. 113, p. 489, April 5, 1924), where it is stated that "In the case of the BO bands, it was in fact the magnitude of the observed isotope effect which first definitely indicated that they were not due to BN as formerly supposed."

Dr. Mulliken in his second letter (footnote 7) supports his attribution of the bands to the oxide by his observation that, as developed by the action of active nitrogen on BCl_3, they are far more intense when a small amount of oxygen is present than when the nitrogen is freed as completely as possible from oxygen by means of phosphorus; whereas the reverse is the case with the spectrum produced when $SiCl_4$ is used instead of BCl_3—a spectrum which I attributed to a nitride of silicon

(Roy. Soc. Proc., A, vol. 89, p. 187, 1913), and Dr. Mulliken regards as due to SiN. I am of the opinion that no weight can be attached to this argument, which recalls the discussion which arose when Lord Rayleigh first showed that the nitrogen afterglow is associated with the presence of a chemically active modification of nitrogen, as to whether the afterglow could be produced in pure nitrogen, or whether, as certain observers asserted, a trace of oxygen must be present.

The subject was reviewed by Lord Rayleigh, who finally showed (Roy. Soc. Proc., A, vol. 91, p. 303, 1915) that neither view is correct, for while only a little active nitrogen is obtainable from perfectly pure nitrogen, yet on the other hand it is not necessary that oxygen should be present for a high yield of active nitrogen to be produced. Lord Rayleigh found that "gases carrying oxygen, sulphur, chlorine, carbon, and hydrogen are capable of promoting formation of active nitrogen," and in fact "almost any small admixture of a foreign gas will enormously increase the yield of active nitrogen. The amount of admixture required to produce the best effect is usually of the order of 1/1000 part, but, to quote one case particularly examined, a very distinct effect is produced by adding a 1/30,000 part of methane." These observations make it reasonable to suppose that the spectrum of any nitride, produced in the manner described, that is, by the action of active nitrogen on a suitable substance, would also be intensified by the admission of a trace of oxygen. From this point of view it would appear more surprising that the silicon nitride spectrum is enfeebled than that the boron nitride spectrum is greatly intensified. Experimental fact, then, cannot be said to support the oxide origin.

Two further tests suggest themselves. First, can any other gas be found which, admixed in very small quantity with the nitrogen, has the same effect as oxygen on the boron nitride spectrum? If so, it would be fair to conclude that the effect of the oxygen is to increase the yield of active nitrogen used in the reaction which develops the spectrum of boron nitride. Secondly, if, as Dr. Mulliken asserts, the spectrum is due to BO, it should be possible, and indeed easy, to produce it in the absence of nitrogen.

In 1914, and again recently, I made observations of the spectrum of the tube discharge through the vapour of BCl_3, but have not detected the bands in question, which would appear, therefore, to be dependent on the presence of nitrogen. Again, in the course of some recent observations (to be published shortly) of the uncondensed discharge through $SiCl_4$ vapour, I have shown that in the absence of air or oxygen a band spectrum is produced which is to be attributed to a chloride of silicon, while if air or oxygen be admixed with the $SiCl_4$ vapour, a band spectrum of silicon oxide is developed and the chloride spectrum is eventually quenched. In similar circumstances with CCl_4 carbon monoxide bands appear, and with $TiCl_4$ the Antarian bands of titanium oxide are produced, as shown by Prof. Fowler (Roy. Soc. Proc., A, vol. 79, p. 509, 1907). By analogy, if the bands in question are due to boron oxide they would be expected in the uncondensed discharge through a mixture of BCl_3 vapour and oxygen. I hope to make this test at an early date.

One further question arises. I found in 1914 that the boron nitride bands were feebly developed in the arc in air (*loc. cit.*, 1915, Plate 2, strip 1; and G. Kühne, *Zeit. f. wiss. Phot.*, vol. 4, p. 173, 1906), together with the well-known bands in the visible region which have *hitherto* been attributed to an oxide of boron (see Kayser, "Handbuch der Spectroscopie," vol. v. p. 138, and Plate I., Figs. 1 and 2). If, as Dr. Mulliken claims, BO is the real origin of the former bands, to what are the latter now to be attributed?

I have no wish to question the validity of Dr. Mulliken's theoretical considerations, but I am of the opinion that there is yet no experimental ground for ascribing the bands in question to an oxide rather than to a nitride of boron.

W. JEVONS.
Physics Department,
Artillery College, Woolwich.

Control of the Pink Boll-worm on Cotton.

IN view of the appearance of the pink boll-worm on cotton in Queensland, and Reuter's report, on April 16, of the measures taken to combat the attack, a consideration of a possible method of control may be of interest.

In connexion with an investigation of the summer fallow in Egypt, a series of distance thermometers was installed for recording the soil temperatures at various depths. The records obtained have been plotted in the form of soil isotherms, and show that at Giza in July a temperature of 50° C. is attained daily at a depth of 10 cm., the temperature at the surface of the soil rising as high as 68·5° C. This fact is of great importance in connexion with the pink boll-worm problem.

Heating the seed, ginning before a specified date, and burning the old cotton sticks and bolls are the methods used to eliminate possible sources of carry-over of the pink boll-worm from one crop to another. There still remains, however, one source of carry-over —the infected bolls which have fallen and become buried in the soil. This latter source of infection is probably the main one to be contended with in view of the precautions taken to prevent the carry-over from other sources.

In Egypt, the crops following cotton are either winter cereals or a leguminous crop. The preparation of the land for these crops necessitates ploughing, and results in the burial of the fallen infected bolls to a possible depth of 10 cm. Following the winter crops the land is fallow until the sowing of maize—now sown in July but formerly in August. If the land could remain fallow throughout July, the soil to a depth of 10 cm. would become heated daily during this month to a temperature of 50° C. The thermal death-point of the pink boll-worm resting larva is 50-55° C. (Willcocks, "The Insect Pests of Egypt," vol. i., Pt. I., p. 162). It will be seen, therefore, that the soil temperatures in fallow land during July are sufficiently high to kill the pink boll-worm larvæ in the fallen bolls from the previous crop.

There is one difficulty in the way of the application of this method for the control of the pink boll-worm in Egypt. Before the water supply of Egypt was augmented by the Aswan Dam, the land was compulsorily fallow until August, it being impossible to irrigate the land until the arrival of the Nile flood. The fallow land under these conditions was annually heated to the high temperatures recorded. Maize was then sown about August 15. Since the Aswan Dam has been built, the water supply conditions during the month of July have changed considerably. Instead of waiting for the arrival of the flood for irrigating the fallow, the supply of water in the Aswan Dam is now used to supplement the early stages of the flood, so that the irrigation of the fallow is now possible early in July. The following is a quotation from the irrigation report for the year 1909: "The tendency is to hold the reservoir supply later and later every year, so that the mass of the water is employed to augment the early stages of the flood rather than to increase the volume of the

river at its lowest. Amongst the various concessions rendered possible by the plentiful water supply, none was more appreciated than the early removal of the prohibition to irrigate the land for maize, which was effected on dates varying from 15th June to the 1st July."

The early sowing of maize results in a heavier yield. As maize is the main food of the fellah, any alteration of the present method of using the stored water so as to reintroduce a fallow in July would be unpopular.

The same difficulty may not present itself in Queensland. A comparison of the geographical positions of Egypt and Queensland, and the meteorological observations in the two countries, shows that the fallow land temperatures in Queensland during November will probably be similar to those in Egypt during July. The following comparison is made, the figures being taken from the Réseau Mondial for 1913:

EGYPT.

Situated between 22° N. and 32° N.

July.

Station.	Av. Max.*	Abs. Max.
Cairo	307·6	316

QUEENSLAND.

Situated between 10° S. and 29° S.

November.

Station.	Av. Max.	Abs. Max.
Georgetown	311·4	314·1
Mitchell	306·4	313·6
Rockhampton	308·2	313·6
Brisbane	303·8	314·2

* All temperatures in degrees absolute.

The maximum screen temperatures in July in Egypt are similar to those in November in Queensland at the stations quoted. Owing to the similarity in the geographical positions of the two countries, the number of hours sunshine in Queensland will be similar to that of Egypt. It seems, therefore, that soil temperatures in November in Queensland will be similar to those in July in Egypt. It appears probable that a temperature of 50° C. will be attained at a depth of 10 cm. in the soil in Queensland in November, and hence, that any resting larvæ of the pink boll-worm can be killed to this depth in fallow land. The intensity of this effect can be increased by the ploughing and cultivation of the fallow land.

It is suggested that, after the removal of the winter crops in October, the land which carried cotton the previous year should be fallow and thoroughly cultivated in November. This would ensure that the whole of the resting larvæ in the soil would be subjected to temperatures above their thermal death-point, and hence, the main source of infection of the cotton crop with pink boll-worm would be removed.

C. M'KENZIE TAYLOR.
Cotton Research Board, Giza, Egypt.
Ministry of Agriculture,
April 19.

Junior Teaching Appointments at Universities.

THE University Court of Edinburgh has notified the members of the non-professorial staffs that certain economies will be effected by reducing the salaries and altering the conditions of tenure of junior teaching appointments.

During the past triennial period assistants (demonstrators) have been paid at an initial salary of 250*l.* p.a. with annual increments, if reappointed, of 10*l.*, rising to a maximum of 280*l.* p.a. Junior lecturers have been appointed at an initial salary of 300*l.* p.a. with annual increments of 20*l.*, rising to a maximum of 400*l.* p.a. Such appointments are made at the beginning of each academic year. For the forthcoming year, the University Court has decided that annual increments in both grades shall cease, and further, that in future, assistants shall be appointed at a salary of 200*l.* p.a. without increment. The economies thus effected will amount to about 700*l.* a year, which seems a very small sum compared with the resentment which the decision has aroused.

The decision of the Court, which we understand was received by the members of the Senatus with approval, comes at a most inopportune moment. On May 24 the University Grants Committee will be paying a visit to the University, presumably to discuss the financial position of the institution as well as the other matters germane to their functions, and they might well have been consulted previous to any such decision of the Court. The action of the Court will prejudice the issue and the possibility of the previous recommendations of the University Grants Committee regarding salaries of university staffs being put into effect.

The National Union of Scientific Workers protests emphatically against the reactionary policy of the Court. The Court's decision is one which affects all university teaching staffs and not merely those at Edinburgh. The importance to the nation of maintaining staffs at institutions of university rank who are capable of leading thought and giving a direction to industry cannot be over-estimated. The university should therefore offer conditions of service and salaries commensurate with the responsibilities of the staffs and sufficient to retain the services of the most efficient and distinguished juniors. It is evident that a local university authority, faced with financial embarrassment, is not a competent body to deal with the questions at issue. Such a body is too susceptible to considerations of precedent, of out-worn tradition regarding the treatment of university junior staffs, and apt to regard matters of national importance from a purely parochial point of view. What is wanted is a Royal Commission to investigate the financial condition and administration of British universities other than Oxford and Cambridge, but in the meantime, the recent decisions of the University Court of Edinburgh should be rescinded, and the Treasury be approached for such further assistance as the circumstances warrant. Steps to this end are being taken by this organisation.

G. H. HARDY, President.
A. G. CHURCH, General Secretary.
National Union of Scientific Workers,
25 Victoria Street,
Westminster, S.W.1, May 19.

Radial Velocities and the Curvature of Space-time.

IN a letter to NATURE of April 26, Dr. Silberstein makes a proposal for determining the distance of a remote star by observing the displacement of the spectral lines at six months interval; he claims that this method will separate the ordinary Doppler effect of the unknown motion of the star from the distance-effect predicted by de Sitter. It seems to me clear that this proposal contains a fallacy. The material to be experimented on is a certain regular train of light-waves proceeding through the small region round the sun accessible to us; the star itself is inaccessible. The frequency of these waves is to be

measured by two observers—for example, a January observer and a July observer. These observers differ only in their velocities V_1 and V_2 relative to the frame of reference; Dr. Silberstein neglects any effects of the short interval of time and of space between the two observations and of the distortion of the waves by the local gravitational field.

There exist well-known formulæ for transforming the frequency of a wave-train for an observer with velocity V_1 to the frequency for an observer with velocity V_2, namely, the Lorentz transformation. Dr. Silberstein's formulæ disagree with these, and introduce data referring not to the wave-train but to the particular circumstances of the star originating it, which must clearly be irrelevant to the transformation. If he were right it would be possible to have two trains of plane waves in the same region identical with one another in one system of reference but not identical in another system of reference. I do not know whether Dr. Silberstein's theory intentionally deviates from orthodox relativity; but I think he can scarcely have wished to throw over the fundamental principle that the change of frequency of light-waves due to a change of velocity of the observer depends on a local transformation independent of the origin of the light.

It is not possible to indicate the precise cause of the fallacy, since Dr. Silberstein gives only the results of his calculation; but the error apparently occurs in passing from his formula (2), which gives the Doppler effect referred to the sun

$$D^2 = \frac{r^2}{R^2} + \frac{v_0^2}{c^2}$$

to the Doppler effect referred to the earth, formula (3),

$$D_1^2 = \frac{r^2}{R^2} + \frac{(v_0 - V_1)^2}{c^2}.$$

It may be well to remind the reader that v_0 (if it is real) is the velocity of the star at some epoch in the very remote past or future, so that $(v_0 - V_1)$ has no *obvious* relevance to the problem. If the star-constant v_0 is imaginary, as will happen in many cases, Dr. Silberstein's formula makes the Doppler effect a complex quantity; this in itself seems sufficient ground for distrusting the formula.

A. S. EDDINGTON.

Observatory, Cambridge,
May 3, 1924.

Sense of Direction in Mathematics.

THE question of right- or left-handedness is always with us in mathematical physics. In this connexion the symbol V is used in one sense by Maxwell, in the other sense by some of his followers, and indeterminately elsewhere in work of growing importance.

I would therefore suggest a simple way out by using the three variants of the Greek character upsilon: for general use υ, for the right-handed (say) $\dot{\upsilon}$, and for the left-handed case the aspirated $\dot{\upsilon}$. The latter would serve excellently as a temporary sense-contradiction (for example, in "boiling down" expressions by applying a nil-sum), without recourse to that computer's inferno, the sign of minus.

The same convention would be welcome in respect of three pairs of directivities mutually at right angles. For example, if one draws a regular hexagon and assigns the letters $\dot{\alpha}\ \dot{\eta}\ \dot{\omega}$, $\alpha\ \eta\ \omega$ (ah ee oh, ha he ho) to the six sides, and joins three alternate points to the centre, so as to represent a cube, then the whole trouble with the inherent sense-ambiguity of the binormal is simply wiped out, both for beginner and for expert. In fact, with the aid of the well-known two-colour stereo effect (by the use of the green and red perspective and green and red glasses) it would be quite possible for any one to get a clear notion, at first sight, of what the three-space radian is, the code of operation (say, on $\dot{\eta}$, if $\upsilon\alpha\eta$ is ω) being

$$120(1 + \upsilon\alpha(1 + \tfrac{1}{2}\upsilon\dot{\eta}(1 + \tfrac{1}{3}\upsilon\omega(1 + \tfrac{1}{4}\upsilon\alpha(1 + \tfrac{1}{5}\upsilon\dot{\eta}(1 + \tfrac{1}{6}\upsilon\omega(\ldots).$$

In the case of the most ivied of the sciences, the economy would, of course, not immediately be realised, but it would be quite practicable in this way to banish the sign of subtraction not only from gravitational statements but also from their meritorious translation into the blue-book.

T. C. HUDSON.

337 Brownhill Road, S.E.6,
April 11.

Sunlight and Glass: an Inquiry for Hygiene.

FOLLOWING upon several communications from me to NATURE in recent years regarding sunlight and health, may I ask a question which can perhaps be answered instantly and completely by many of your readers, but which I am too unfamiliar with physics to answer for myself?

We have found high antiseptic powers and even more valuable powers of blood-enrichment and of stimulating vital resistance to disease, in ultra-violet light, to which glass is opaque. Thus, as I saw in the Home for Hebrew Infants in New York in 1922, infants who are living in glass cubicles on a balcony (to prevent infection) must be moved out into the open to receive the best value from sunlight. Inquiring the cost of quartz windows, I learnt that even Jewish philanthropy in New York would "scarcely run to that."

Celluloid, I am informed, has an absorption band in the ultra-violet.

What cheap substitute for glass is available, such that the ultra-violet rays may serve us through it, both for therapy and for hygiene? If there be none, can the physicists make one for us? I appeal to them, if you will let me. C. W. SALEEBY.

Royal Institution,
April 28.

The Language (if any) of Insects.

AN abstract of a paper by C. F. Elwell in Journ. Inst. Electrical Eng., vol. 62, p. 231, briefly describes Dr. de Forest's methods of producing talking-motion-pictures. Telephonic currents are received in a two-electrode valve emitting highly actinic light. This is focussed on a slit, and a record is made on the edge of an ordinary film travelling at the usual rate of 12 to 18 inches per second. To reproduce the sounds, light passing through the developed film is received on a photoelectric cell, and weak currents are obtained and are amplified and passed to a telephone. Sound vibrations as high as 3000 per second are said to have been obtained.

Lord Avebury and others have suggested that insects and other small creatures may communicate with each other by sounds of supersonic frequency. The forms of gas flame and hot wire microphones employed by Dr. de Forest would not be applicable, but the only other modification necessary to look for high frequency sounds is the speeding up of a specially sensitive film, and this, of course, has already been done. A. P. TROTTER.

Greystones,
Teffont, Salisbury.

Fused Silica.

By Sir RICHARD PAGET, Bart.

THOUGH silica (SiO_2), either free or combined, is the commonest constituent of the earth's crust, and is estimated to constitute sixty per cent. of the first ten miles depth, there are no sources of silica sufficiently pure for fusion known in Great Britain. The highest grades of transparent fused silica "glass" are made from rock crystal, or from deposits of minute crystals, commercially known as geyserite, which occur in Germany, Sweden, and elsewhere. True geyserite, however, is a semi-hydrated silica of the opal type, deposited by water containing dissolved SiO_2. The celebrated pink and blue terraces in New Zealand, which were destroyed by the volcanic eruption of Mount Tarawera in 1886, consisted of silica in the form of geyserite. Pure silica occurs also rarely in other crystalline forms known as tridymite and crystobalite. Opaque fused silica ware is made by the fusion of pure silica sand, of a silica content of about ninety-nine per cent.

Silica fused by lightning has been found in many countries, particularly in the form of long tubes, ¼ in. to ½ in. in diameter, produced by the passage of the electric discharge through a bed of silica sand. These are known as fulgurites or Le Chatelierite, and were first observed in 1711 by Hermann in Silesia, and attributed to lightning by Dr. Hentzen, in Westphalia, in 1805. Darwin, in the "Voyage of H.M.S. *Beagle*," refers to the Uruguayan fulgurites. A specimen 37 ft. in length has been found in Drigg, Cumberland.

The earliest experiments in silica fusion were made in 1838 by Gaudin, of Paris, who fused rock crystal by means of the oxy-hydrogen blowpipe. He found that fused quartz never became truly fluid; that it began to volatilise near its melting point; that on cooling it formed a transparent glassy mass, which was unaffected by sudden changes of temperature, and showed remarkable strength and elasticity; and that on prolonged heating the glassy mass returned to a crystalline condition and lost its mechanical strength. In 1878 Gautier exhibited small fused quartz tubes made in a blowpipe.

In 1888, Sir Charles Parsons made extended experiments in heating carbon and other substances to a very high temperature under pressures of from 5 to 30 tons per sq. inch, and in this connexion he fused small quantities of silica sand by means of an electrically heated carbon rod surrounded by the sand. In 1887, Vernon Boys devised his method of drawing fine quartz threads by attaching one end of an anchored quartz rod to the arrow of a miniature crossbow, heating the rod with a blowpipe, and discharging the arrow so that its flight drew out a thread. This process was, in a sense, the forerunner of the present methods by which fused silica rods and tubes are now drawn out, but on a larger scale, with this difference, that the initial fusion is made by means of an electric resistance heating, and that the drawing-out process is performed in a slower and less poetic fashion than by the flight of an arrow.

About 1889, Vernon Boys, at Leeds, made fused quartz tubes by fusing pieces of rock crystal in the blowpipe, drawing them out into rods and winding these rods into the form of a closed helix, of which the adjacent coils were then fused together in a blowpipe so as to form a continuous tube. In 1899, Threlfall, at Oldbury, fused quartz in quantity in a 100 kw. arc furnace.

The earliest fused quartz lens was exhibited by Schott and Genossen at the Paris Exhibition of 1900; and in the following year Shenstone demonstrated his method of building up fused silica tubes by fusing together a number of rods assembled faggot-wise around a platinum core. In 1903, Heræus greatly improved the technique by fusing rock crystal inside an iridium tube and afterwards working the product in the blowpipe. In Great Britain, Johnson and Matthey took up the work of Shenstone, and developed Kent's method of building up bubble-free fusions by feeding a rock crystal powder into the heated zone of an electric arc.

Numerous attempts have been made to avoid the formation of bubbles in the fusing of silica, for, as Gaudin originally showed, the material never becomes liquid, so that bubbles cannot float to the surface. Day and Shepherd in the United States showed that the liquid condition is not reached even when silica is superheated at a pressure of 35 atmospheres. In 1904 and 1905, Bredel, in Germany, proposed a method of fusing *in vacuo*, and, in particular, of fusing the mass from below, so as to avoid the inclusion of bubbles. In the United States, in 1906, Wingrens patented a process of silica fusion *in vacuo*, and in the same year Day and Shepherd produced transparent silica plates by fusion at 2000° C., followed by a further heating at 1800° C. under a gaseous pressure of 500 lb. In 1907, Ludwig Bolle in Germany patented a process of silica fusion in a tubular furnace, the fusion being extruded by mechanical or gaseous pressure.

Reverting now to the fusion of silica sand, Elihu Thomson, in America, R. S. Hutton, at Owens College, Manchester, and Ruhstradt, in Germany, developed a process similar to that of Sir Charles Parsons, but working at atmospheric pressures. Hutton also made small fused silica tubes by enclosing a layer of silica in a graphite trough, a graphite core being supported axially within the trough, and heating the fusion from above by means of a travelling electric arc. At Oldbury, Threlfall, using the same method as Hutton, Elihu Thomson, and Ruhstradt, made rough tubes up to 5 in. and 6 in. in diameter (in one case up to 12 to 15 ft. in length). In all these processes it was essential to keep the temperature as low as possible, so as to avoid the reaction which takes place at high temperatures between silica and carbon, producing carborundum and evolving carbon monoxide.

In 1903 experiments were started at Wallsend under the late Dr. J. F. Bottomley, with R. S. Hutton as consultant, with the object of developing a commercial method of silica fusion by means of electric resistance or arc heating. After many months of failure, the first success was obtained in 1904. A mass of silica fused round a central heating core became overheated, and the evolution of carbon monoxide gas caused the plastic

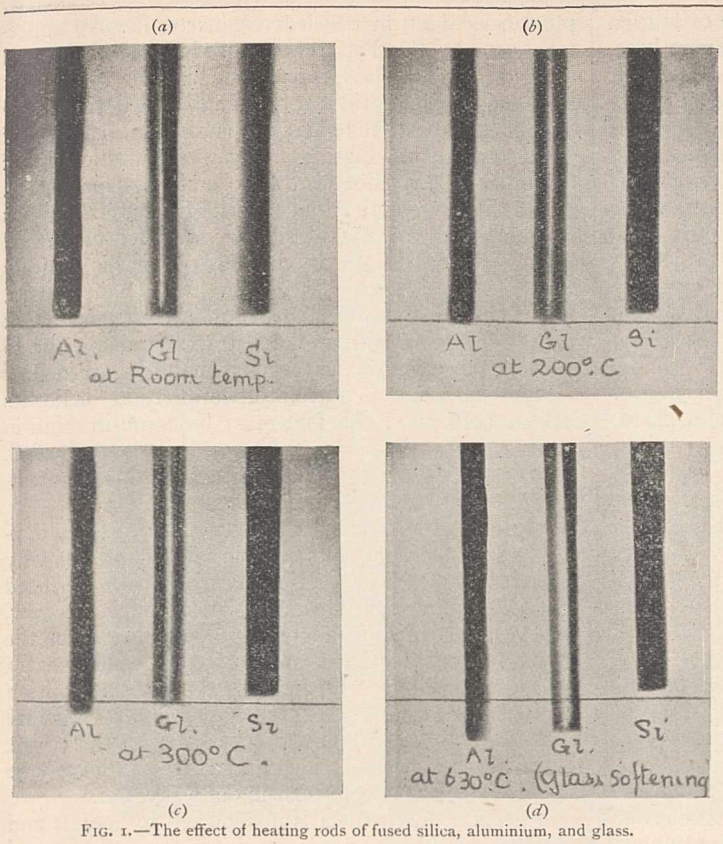

FIG. 1.—The effect of heating rods of fused silica, aluminium, and glass.

fusion to be blown up into the form of a large "ostrich egg." From this accidental result was developed the present methods whereby fused silica is melted by means of an electrically heated carbon or graphite rod. When the fusion has been brought to the right degree of plasticity the rod is withdrawn, and the fusion is drawn, or blown by internal gas pressure, either freely or into a mould, or is pressed or rolled without reheating.

The essential conditions are that the fusion shall not touch the rod, excepting at its relatively cool extremities. This is effected by so adjusting the temperature that there is an initial evolution of gas and silica vapour which inflates the fusion just sufficiently to keep it clear of the rod, while not allowing the fusion to become so plastic as to flow down on to the rod. This process was commercially developed by the Thermal Syndicate Ltd., which sold its products under the trade name "Vitreosil."[1] The change from crystalline quartz to the amorphous condition is stated to begin at 1400° C., melting at 1650° C., and the plastic condition at between 1750° C. and 1800° C.

Between 1907 and 1910, Dr. Volker, in Germany, developed an alternative to the Thermal Syndicate process, in which the fusion was blown up, after the withdrawal of the heating core, by introducing a slice of potato or other moisture-containing substance inside the fusion before closing it at either end by mechanical pressure.

In America the General Electric Co. has, in recent years, produced transparent rods and tubes by fusing rock crystal *in vacuo* in a tubular furnace, and drawing the fused mass between water-cooled dies. This Company has also produced opaque-moulded insulators for high-tension work by Elihu Thomson's method.

The most important property of fused silica is its low coefficient of expansion. In this respect fused silica stands in a class by itself, its expansion being less than one-sixth of that of the best Jena or Pyrex glasses, and less than one-twentieth of the high-expansion glasses. The relative expansion of rods of fused silica, glass and a metal, such as aluminium or copper, may be shown by suspending rods of similar length inside a tubular furnace, and throwing the shadow of the projecting ends of the rods on to the screen. Fig. 1 shows (with suitable magnification) the result of heating rods of fused silica, aluminium, and glass, each of about 30 cm. length when at room temperature, to temperatures of 200°, 300°, and 630° C.

The practical effect of the low coefficient of expansion of fused silica may be demonstrated by heating rods of fused silica, Jena, Pyrex, and other glasses, afterwards dipping them into cold water. Under this treatment a mass of cracks develops throughout the chilled portion of the glasses, but the fused silica is quite unaffected. Fig. 2 shows the result of quenching rods of Jena, Pyrex, and fused silica glass when heated to 540° C.

The relatively high softening point may be shown by clamping a number of similar silica and glass rods at one

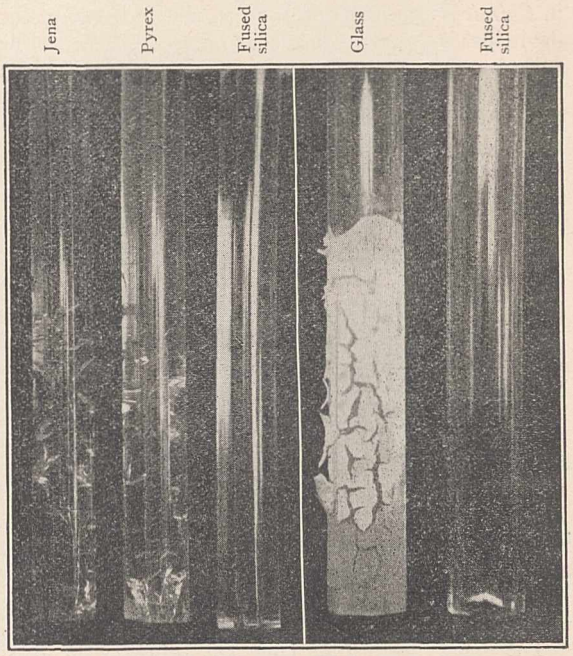

FIG. 2.—Rods of Jena, Pyrex, and fused silica glass quenched from 540° C.

FIG. 3.—Rods of German glass tubing (potash glass as used commonly in laboratories) and fused silica after 1½ min. immersion in strong hydrofluoric acid, washing and drying. The glass rod is rendered opaque by gelatinous silica liberated by the treatment.

[1] See Patents No. 10670/04, Bottomley, Hutton, and Paget; No. 18437/04, Bottomley and Paget; No. 9522/05, Bottomley and Paget; No. 14774/06, Bottomley and Paget.

end, projecting horizontally over a number of bunsen burners, the burners being fixed on to a common base, so that they can be all applied simultaneously to their respective rods. Under this treatment the most refractory glasses readily bend under their own weight, whereas the fused silica rod is quite unaffected.

The low coefficient of expansion of fused silica has found an interesting application in the case of the National Physical Laboratory standard metre bars, which consist of a fused silica tube having a projecting tongue or " tenon " in the form of strips of optically worked fused silica let in longitudinally across each end of the rod. The actual measurements are taken from fine engraved lines formed on the surface of the projecting tenons. The properties of low coefficient of expansion and high softening point find practical use in such apparatus as muffles, retorts, pyrometer tubes, roasting trays, and combustion tubes.

As Gaudin pointed out, vitreous silica tends, on prolonged heating, to return to the crystalline form. This change is accompanied by a reduction in volume of from 3 to 5 per cent., and the crystalline mass consists of small crystals of crystobalite, or of tridymite, or both, according to the temperature, times, and other conditions of heating. Devitrification scarcely commences at 1120° C., but is appreciable after four hours of continuous heating at 1140° C. Above this temperature continuous heating gradually converts vitreous silica into crystobalite.

Silica heated in the presence of a suitable catalyst, such as chloride of potassium or lithium, devitrifies at considerably lower temperatures; thus, continuous heating for eight days at 800° C. converts vitreous silica into tridymite.

The physical properties of fused silica have been fully dealt with by Prof. Georges Flusin, of Grenoble, in *Chimie et Industrie*, of June 1920. Pure fused silica devitrifies less rapidly than silica mixed with any known substances. The density of transparent fused silica is 2·21, while that of the opaque variety is 2·07; the difference is due to the inclusion of minute bubbles in the opaque mass. The hardness of fused silica is of the same order as that of hard glass. Its elasticity is rather higher than Jena glass, namely, 6·6 kg. per mm.^{2} as against 6·0 for Jena glass. The crushing strength is about 7 tons per sq. in., *i.e.* between that of granite and blue brick. The tensile strength of quartz fibre, provided the surface is unscratched, is 70 tons per sq. in. Its shear rigidity modulus is $3{\cdot}0 \times 10^{11}$ dynes per cm.^{2}, as compared with copper $4{\cdot}0 \times 10^{11}$, crown glass $2{\cdot}9 \times 10^{11}$, flint glass $2{\cdot}3 \times 10^{11}$.

Fused silica becomes more resistant to shear with increasing temperature up to 1000° C., its rigidity at 850° being about 7 per cent. higher than at room temperature. Heavy articles of fused silica which have been allowed to cool rapidly are increased in strength by reheating for four hours at 1188°, due to the removal of strains produced during cooling. The heat conductivity of fused silica is of the same order as that of glass.

The most interesting chemical property of fused silica is its resistance to acids. Fused silica is completely insoluble in all acids or mixtures of acids, except hydrofluoric (in which its solubility is less than one-tenth of that of common glasses) and hot concentrated phosphoric acid, in which it begins to dissolve appreciably at 300° C. Fig. 3 shows a rod of fused silica and a rod of German glass, after immersion for 1½ minutes in strong hydrofluoric acid, washing and drying; the opaque surface of the glass rod is due to liberation of gelatinous silica. Figs. 4 and 5 show a collection of exhibits of fused silica ware for chemical purposes, etc.

The International Atomic Weight Commission has recommended the use of silica vessels for analytical operations of high precision. Fused silica is entirely insoluble in water, which is not the case with the glasses. It is, therefore, of material use in refined chemical work where contamination by minute traces of alkali, due to the solvent action of the reagent, has to be avoided.

Fused silica begins to volatilise appreciably below its melting point, and this fact must be borne in mind in analytical work involving temperatures above 1350° C. It is completely resistant to steam, and has been successfully used for gauge glasses for steam boilers.

Solutions of neutral salts may be evaporated to dryness and the resulting salts fused in silica vessels, usually without any chemical reaction occurring with the fused silica. Alkaline solutions and basic salts, however, attack fused silica to an extent depending upon the nature of the substance, and upon the conditions of concentration and temperature. Prolonged ignition of a silica vessel contaminated with traces of mineral salts produces a crumbling of the surface of the vessel, due to accelerated devitrification, which can largely be obviated by care in the cleansing of the vessel.

In general, fused silica is unattacked by metals and metallic vapours in a non-oxidising atmosphere, and it has, in fact, been used for the distillation of many pure metals *in vacuo*. The noble metals, as well as mercury, tin, zinc, cadmium, lead, and copper, are without action in such an atmosphere. Powerful reducing agents, such as aluminium above 800° C., magnesium, cerium, and calcium, at a bright red heat, and sodium vapour, all attack silica by direct reduction. Oxides which form stable silicates are found to attack fused silica vessels upon ignition, but this does not preclude the use of silica crucibles, etc., for the ignition of granular precipitated oxides, provided these do not fuse, and thus do not wet the surface of the silica under the conditions of ignition.

Fused silica is permeable to gases at high temperatures. Helium begins to diffuse at 180° C., hydrogen at 300° C., nitrogen at 600° C. A well-evacuated bulb of one litre capacity and wall thickness 1·5 mm. may be heated in air at 400° C. for 100 hours before the internal pressure reaches 10^{-4} mm., the gas which diffuses into the bulb being mainly nitrogen.

Fused silica has outstanding advantages as an electrical insulator, its resistivity at 150° C. being 500 times that of porcelain. At higher temperatures the resistivity (in megohms per cm.^{3}) is, at 230° C. 2×10^7, at 250° C. $2{\cdot}5 \times 10^2$, at 700° C. 3×10^1, at 800° C. 2×10^1. Fused silica is also less hygroscopic than glass and porcelain, and therefore less liable to produce surface leakage. Its specific inductive capacity is 3·5-3·6, as compared with porcelain at 5·6. Its dielectric strength is equal to that of the best glass.

In optical properties fused silica is interesting for its high transparency to ultra-violet radiation, visible light, and heat. Fig. 6 shows an experiment in which a fused

silica rod 4 ft. long, and bent through 270°, has one end heated to incandescence by an oxy-hydrogen blowpipe. The light passes through the length of the rod, being guided by internal reflection, and emerges at the thickened opposite end as a colourless beam. An appreciable amount of heat is transmitted through 4 ft. of fused silica, and in working short lengths of rod with a blowpipe, the operator must take care not to burn his fingers with the radiant heat which emerges at the cold end of the rod.

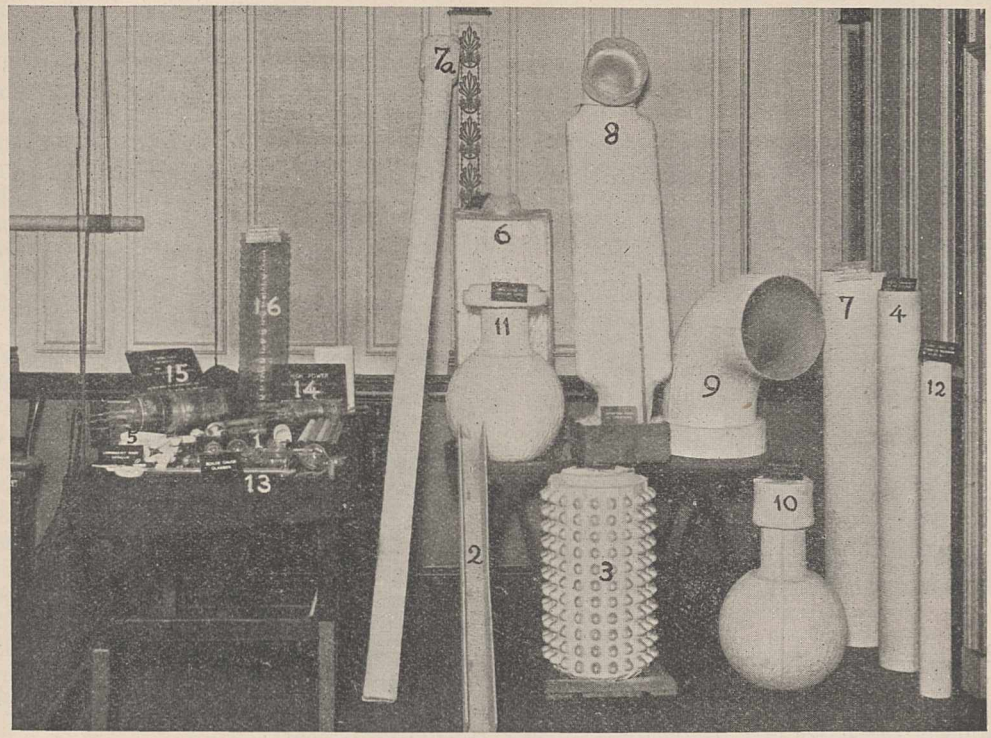

FIG. 4.—Photograph of exhibits (transparent and heavy chemical ware, etc.).

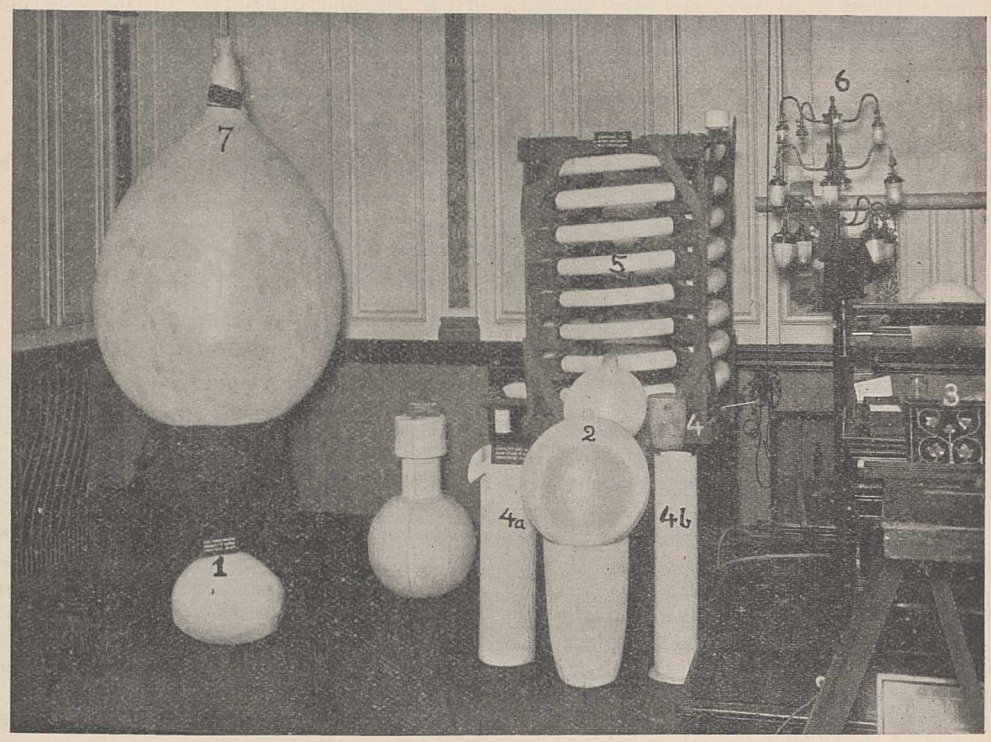

FIG. 5.—Photograph of exhibits ("Ostrich Egg," big flask, Brussels Exhibition fire exhibit, etc.).

Fused silica is quite transparent to ultra-violet rays down to $\lambda = 0{\cdot}226\mu$ to $0{\cdot}220\mu$, and to some extent down to $\lambda = 0{\cdot}189\mu$ ($\mu = 10^{-3}$ mm.). Thus, a screen of fused silica allows the passage of ultra-violet radiations, so as to discharge an electrically charged zinc plate, while the substitution of a glass screen prevents the discharge. Similarly, a solution of potassium iodide and starch

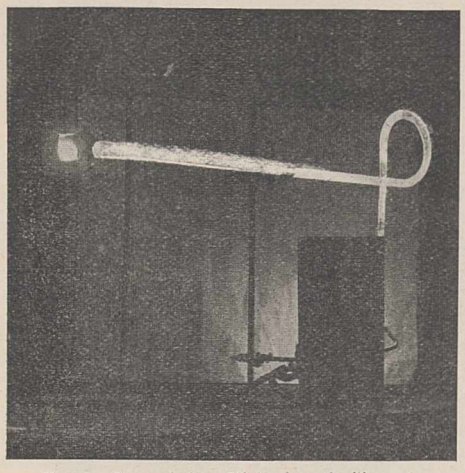

FIG. 6.—Transmission of light through silica rod.

contained in a fused quartz vessel is rapidly discoloured by the ultra-violet light from a mercury arc, while a similar solution in a glass vessel is unaffected, owing to the absorption of the active rays by the glass. This property of fused silica has found useful application in America in the sterilisation of water and other liquids by the action of ultra-violet light from mercury vapour lamps. The refractive index of fused silica ranges from 1·4561 for the lithium "r" line ($670{\cdot}8\mu\mu$) to 1·5743 for the aluminium line at $185{\cdot}2\mu\mu$.

Apart from chemical uses, the most important commercial field for fused silica at the present time is in the manufacture of globes for incandescent gas burners (Fig. 5, No. 6). These, though considerably more expensive than glass, are entirely unaffected by heat changes, and also allow of a higher flame temperature (due to the reduction of excess of air round the flame), so as to produce an increased lighting efficiency. In the case of globes and laboratory ware, the material is glazed on both sides by a subsequent heat treatment. Fig. 4 (No. 3) shows the moulding of a cluster of small laboratory crucibles before the operations of cutting off and reheating.

Transparent fused silica envelopes are especially suitable for large thermionic valves for wireless telegraphy. Fig. 4 (Nos. 14 and 15) shows the Admiralty type of 5 kw. and 10 kw. valves respectively, the larger valve being due to Morris Airey, and manufactured by the Mullard Radio Valve Co. Messrs. Kelvin, Bottomley and Baird have successfully developed optical fused quartz for various purposes, and have specialised on silica mercury vapour lamps, and silica enveloped gas-filled lamps. The earliest fusion made by the Thermal Syndicate in 1904 is shown at Fig. 5 (No. 1); their latest fusion, a flask of 170 gallons capacity, is shown at No. 7 of the same figure, and indicates the advance made during the first twenty years of the industry.

My thanks are due to Dr. Drane, Research Engineer to the Thermal Syndicate, for the experiments and many of the data described.

The Mineral Resources of the British Empire.

By THOMAS CROOK.

DURING recent years there has been much incentive to the study of natural resources of every description. The manifold and complex needs of industrial civilisation are such as to make it invidious to select any aspect of natural resources as being of more vital significance than the rest; but it requires only a little consideration to realise how very important to any country its reserves of mineral wealth must be. These reserves have been described very aptly as "wasting assets," in contrast with those yielded by the soil, which are reproductive. The quantities of minerals available are limited, and are so small as to justify the suspicion that in two or three generations from the present time it may be difficult, if at all possible, to obtain supplies of many important minerals at a rate sufficiently cheap to ensure industrial expansion, or even to maintain industries at their present level of prosperity. The importance of this prospective impoverishment of resources as regards base metals has been duly emphasised on various occasions recently by Sir Richard Redmayne, Sir Thomas Holland, and Prof. Thomas Turner.

Minerals, indeed, are fundamental requisites in the production of power and power machinery, on which the foundation of all industrial efficiency is based. Without an ample supply of coal, iron, and base metals, no country can travel far on the path of industrial progress, however efficient its human equipment may be. On the contrary, for any country adequately equipped with these primary needs of industrial development, there is scarcely any limit to trade expansion. In this connexion, and showing the value of outputs of fuels, iron ore, and base metals as indicators of commercial prosperity, it is noteworthy that the wealthiest and industrially the most prosperous country in the world at present (the United States) is the world's leading producer of coal, petroleum, iron ore, copper, aluminium, lead, and zinc. Moreover, the United States outputs of coal, petroleum, iron ore, and aluminium are consumed largely in its own productive industries; while without the base metal supplies of the United States, which are largely in excess of its own requirements, many another country would find its industries handicapped.

The world's industries, however, are still at the developing stage. The investigation and development of the resources of the United States are much more advanced than those of the British Empire. This is due in large measure not merely to the energy of the United States citizen, but also to the compactness of his country. The area of the United States is enormous, and the distribution of its resources is such as to present serious difficulties in the commercial co-operation of the western and eastern parts of the

country. Large as it is, however, it is all in one piece, and in this respect it has had much the same advantage as formerly made Great Britain commercially supreme.

The British Empire as a whole, on the contrary, is in scattered pieces, and citizens of the Empire are proud of the fact that these pieces are to be found in all the ends of the earth. It is scarcely to be wondered at if, in these circumstances, the investigation and development of the Empire's resources are in a comparatively backward state as a whole; but it is important that this fact should be realised, for it has an important bearing on future possibilities.

For the present, the British Empire Exhibition gives large scope to those who wish to learn something of the Empire's mineral resources, so far as we know them at present, from both the educational and business point of view, and offers a favourable opportunity of reviewing these resources. The various countries of the Empire have made excellent provision for the display of their mineral wealth, and nothing seems to have been forgotten. The exhibits are scattered, but wonderfully complete. An enthusiast in the study of resources may be excused for wishing to see a mineral grouping in preference to a geographical one, since the latter presents obstacles to a complete view.

In anticipation of this difficulty, however, the Imperial Mineral Resources Bureau has issued a useful publication entitled the "Minerals of the Empire." This publication gives a summary of information as to the Empire sources of the various useful minerals and metals. A section is devoted to each mineral or metal, and the sections are arranged alphabetically. In each section an account is given of the Empire deposits of the mineral. The descriptive account for each product of the Empire is followed by a list of the products shown at the British Empire Exhibition by various governments and firms, the position of each exhibit being indicated. Mention is made of the uses and commercial grades of mineral and metals. Each section concludes with a statistical summary of production, imports, and exports, showing the extent to which the different parts of the Empire are concerned in the production and consumption of mineral products.

The following table, compiled from data available at the Imperial Mineral Resources Bureau, shows approximately the British Empire's share of the world's output of the more important minerals during 1922:

	Per cent.		Per cent.
Coal	25	Silver ore	18
Petroleum	2	Diamonds	71
Iron ore	9	Graphite	11
Manganese ore	44	Magnesite	6
Nickel ore	68	Asbestos	96
Cobalt	95	Mica	55
Chrome ore	81	Corundum	92
Tungsten ore	19	China clay	60
Molybdenum ore	90	Felspar	28
Aluminium ore	2	Barium minerals	14
Copper ore	5	Strontium minerals	85
Lead ore	28	Fluorspar	20
Zinc ore	29	Gypsum	13
Tin ore	37	Fuller's earth	20
Bismuth ore	2	Phosphates	8
Antimony ore	6	Monazite	53
Arsenic	16	Salt	21
Gold ore	68	Talc	5

The extent to which the different parts of the Empire contribute to the outputs of these and other minerals of economic importance is shown clearly in summary form in "Minerals of the Empire," which those interested in Empire resources will find useful as a supplement to the information available at the Exhibition. It is not possible in the space here available to do more than mention briefly the various pavilions in which are to be seen some of the more important exhibits bearing on mineral resources. These are as follows:

GOVERNMENT PAVILION (UNITED KINGDOM).—In this pavilion the Imperial Mineral Resources Bureau has a display of raw materials and manufactured products illustrative of the mineral industry. A large map of the world shows the geographical positions of the more important of the Empire's mineral deposits. Below this are placed statistical diagrams, showing the mineral outputs of the different parts of the Empire for the year 1922, and also a comparison of the outputs of the British Empire as a whole with foreign countries. The Imperial Institute has an exhibit of various Empire minerals. The Geological Survey of Great Britain has a good display of minerals and photographs illustrating the mineral resources of Great Britain. The work of the Fuel Research Board is also well illustrated.

Near the Government Pavilion is a full-sized representation of a modern coal mine, showing actual working conditions. This exhibit is by the Mining Association of Great Britain, and includes a hall devoted to coal resources.

UNION OF SOUTH AFRICA.—Here are gold-mining exhibits, with a trophy illustrating the distribution of the wealth arising from gold production by the mining industry, as between dividends, wages, etc.; diamonds, including an apparatus for the treatment of diamantiferous earth, showing the way in which diamonds are concentrated by washing and trapping on grease tables. Other exhibits are coal, copper ore, corundum, asbestos, mica, magnesite, talc, and vanadium ore, the last mentioned including particularly fine specimens of descloizite from South-West Africa Territory.

RHODESIA.—There are exhibits of coal, gold, chrome ore, mica, asbestos, together with ores of tungsten, lead, zinc, and vanadium.

GOLD COAST COLONY.—Gold, diamonds, manganese ore, and bauxite constitute the mineralogical exhibits.

NIGERIA.—Tin ore, coal, and phosphates are shown.

CANADA.—Canada's metal exhibits include the following in order of importance as regards output values: gold, silver, lead, nickel, copper, and zinc. These and other metals represented about a third of the value of the total mineral production in Canada during 1922. The remaining two-thirds represented by the exhibits are non-metals, including the following in order of importance as regards output values: coal, cement, clay products, building stone, natural gas, asbestos, lime, sand and gravel, gypsum, salt, and numerous other minerals such as mica, graphite, magnesite, talc, pyrites, and fluorspar.

BRITISH GUIANA.—Gold, diamonds, and bauxite. British Guiana's bauxite output commenced in 1919 with an output of 1967 tons, and reached 22,084 tons in the following year. In 1923 the output was 100,346 tons, or about 10 per cent. of the world's output for that year. Bauxite mining in British Guiana seems

thus likely to become an important feature of the Empire's mineral industry.

NEWFOUNDLAND.—Ores of iron, copper, and lead are shown. Of these the iron ore represents an important and flourishing industry.

INDIA.—The exhibits include ores of gold, iron, manganese and chromium; coal, petroleum, mica, magnesite, monazite, and bauxite. The iron ore exhibits are of special interest in relation to recent developments in iron-smelting in India, where extensive deposits of high-grade ore have been discovered in Bihar and Orissa. The bauxite deposits are also of special interest as representing large and scarcely touched resources of much potential importance.

BURMA.—There are exhibits of ores of lead, zinc, tin, and tungsten; petroleum, jadeite, and ruby.

CEYLON.—Graphite, monazite, and precious stones are among the exhibits. Attention may be also directed to a fine exhibit of Ceylon graphite in the Imperial Mineral Resources Bureau Section of the Government Pavilion, illustrating the excellence of Ceylon graphite and its unrivalled quality as material for the manufacture of crucibles.

MALAY STATES.—Ores of tin, tungsten, gold, and iron; coal and china clay are shown. The exhibit illustrating the tin-mining industry in the Malay States is one of the more attractive features of the Exhibition, and of special interest as illustrating an important Empire industry.

BRITISH BORNEO.—Coal, petroleum; ores of gold, iron, and antimony are being shown.

AUSTRALIA.—Australian exhibits include ores of gold, silver, osmiridium, iron, manganese, copper, lead, zinc, cadmium, bismuth, tin, tungsten, molybdenum, uranium, arsenic, antimony, and cobalt; coal, oil-shale, bauxite, asbestos, mica, fluorspar, gypsum, graphite, magnesite, alunite, and phosphates. Visitors to the Australian section will find much to interest them in the exhibits illustrating the remarkable progress made by Australia towards making the Empire independent of foreign supplies of zinc. It is well known that during the War the Empire found itself dependent on foreign supplies of zinc in spite of the fact that it had large reserves of zinc ore. This unfortunate state of things no longer obtains, and the Empire will henceforth be independent as regards supplies of zinc.

NEW ZEALAND.—There are exhibits of ores of gold, silver, quicksilver, and iron; coal, petroleum, phosphates, and sulphur.

An important feature in connexion with Empire mineral resources at the British Empire Exhibition is the Empire Mining and Metallurgical Congress which has been arranged to take place at the Exhibition on June 3-6 inclusive, with the Prince of Wales as honorary president.

The inaugural session of the congress will open in Conference Hall No. 1 at the Exhibition with an address by the president, Viscount Long of Wraxall, on "Mineral Resources, and their Relation to the Prosperity of Development of the Empire." A large and varied programme has been arranged, including papers on mining, petroleum, metallurgy of iron and steel, and non-ferrous metallurgy. The general secretaries of the congress are Messrs. C. McDermid and G. C. Lloyd, at Cleveland House, 225 City Road, London, E.C.1.

A visit, or rather a series of visits, to the British Empire Exhibition, together with the above-mentioned evidence of the resolve on the part of British Empire engineers to press forward in the work of development, fills one with a feeling of confidence in the possibilities of this development. The next half-century will bring with it many serious problems as regards the resources available for industrial requirements, but it will presumably also bring with it much strenuous effort on the part of British Empire workers to ascertain the full extent of the Empire's resources, and to develop them. Already investigation has gone far enough to prove how wide are the possibilities of future discoveries, and how serious the need for such discoveries. In all parts of the Empire there are resources awaiting development, and large tracts of territory awaiting adequate exploration by scientific methods of prospecting, for the benefit of the Empire and of the whole world.

Obituary.

PROF. S. G. SHATTOCK, F.R.S., F.R.C.S.

BY the death of Samuel George Shattock, the Royal College of Surgeons of England loses an outstanding personality and the world of science a most distinguished man. Born on November 3, 1852, Samuel Shattock received his education at University College School and University College, where he entered the Medical Department, after matriculation at the University of London, in 1869. He was Liston Gold Medallist in 1875, and became M.R.C.S. in January 1875 and fellow by examination in December 1881.

Morbid anatomy having attracted Shattock from the first, he determined to devote himself to its study, and therefore he did not register as a medical practitioner, but soon after qualifying began work in the Museum of University College. Here Marcus Beck, then surgical registrar of University College Hospital, associated him with himself in the monumental task of supervising and cataloguing the surgical pathological specimens in the University College Museum. This catalogue when published proved of great value to pathologists, but the formidable task of compilation owed not a little to Shattock, and, later on, to Charles Stonham, whose names for some reason are not mentioned by the biographers of the 'eighties. The "Descriptive Catalogue of the Specimens illustrating Surgical Pathology in the Museum of University College, London," Part I., by Beck in collaboration with S. G. Shattock, was published in 1881, and Part II., by Shattock, in collaboration with C. Stonham, followed in 1887. This labour was the preliminary to his well-known edition of the Pathological Catalogue of the Royal College of Surgeons, begun with Mr. Beadles in 1909.

So early as 1878, Shattock had begun his long connexion with the Museum of the Royal College of Surgeons of England by assisting Sir William Flower, the Conservator. In 1880 his name appears in the

Council minutes as among the most liberal donors to the Museum, Jonathan Hutchinson and Frank Buckland being others in the like category. In 1884 his growing reputation led to his appointment to the curatorship of the museum at St. Thomas's Hospital in succession to Prof. Charles Stewart, who then succeeded Flower at the Royal College of Surgeons. In 1887 Shattock was appointed lecturer on surgical pathology in the Medical School at St. Thomas's, retaining the post until his death. There followed a period of ten years (1887–1897) during which he did work of high value.

Shattock was for many years one of the mainstays of the Pathological Society of London. As editor of its Transactions, after the Society had become a section of the Royal Society of Medicine, he did much to help on the cause of international science by publishing summaries in Latin of contributions which might otherwise not have been well understood by remoter foreigners. To enumerate the many positions of honour held by him in connexion with his particular branch of science would serve no purpose here. The crowning honour was reached when in 1917 he was elected a fellow of the Royal Society.

Shattock's best work was done at the Royal College of Surgeons of England, where under Stewart, and then under Keith, he laboured from 1897 to within a few months of his death in the cause of surgical pathology. Appointed pathological curator of the Hunterian Museum more than twenty-six years ago, he ceased not day and night—for he was often in his laboratory late at night—to carry on the noble tradition of John Hunter, whom he in some ways resembled, and of Hunter's famous successors. In 1923 the seal was set to his labours in Room III. of the Hunterian Museum, where the collection of general pathology will remain as his monument. His long last illness prevented his finishing the section of special pathology, which, however, his son and assistant, Mr. Clement E. Shattock, continues in his spirit.

Samuel Shattock will be remembered not only as the leading pathological anatomist of his time in England, but as a pioneer, with Sir Charles Ballance, in cancer research, and as one of the protagonists of bacteriology. Throughout his life, as his biographer in the *Lancet* points out, he fought vehemently against "the temptation to substitute conjecture and verbal formulæ for accurate knowledge," and of the latter he had accumulated during forty years of tireless activity an unusual amount. He died at his house at Wimbledon on Sunday, May 11, having borne a long illness with calm and self-effacing fortitude. Deeply religious, he may be said to have occupied an exceptional position in the world where, in old-fashioned popular opinion, there are two infidels among every three medical men. But he defended his beliefs in act rather than in speech, carrying into his work much of the single-mindedness, the unworldliness, the ascetic severity of his beloved Thomas à Kempis. Others even than his correligionists may have echoed in their hearts the closing phrase of the Requiem Mass with which he was honoured on May 15:

"Chorus angelorum te suscipiat, et cum Lazaro, quondam paupere, aeternam habeas requiem."

V. G. P.

PRINCE ROLAND BONAPARTE.

H.I.H. PRINCE ROLAND BONAPARTE died on April 15 last; he was a conspicuous scientific figure, and by his death we have lost a generous promoter of progress in science as well as a contributor himself to natural knowledge. Born at Auteuil, near Paris, in 1858, Roland-Napoléon was the son of Pierre-Napoléon Bonaparte and grandson of Lucien, second brother of Napoléon I. After having been a brilliant pupil of the Lycée St. Louis, he entered the military school of St. Cyr, and two years after he was appointed second-lieutenant. Although he had, as well as his father, throughout his life given many proofs of his respect for the republican form of government, he was compelled to retire from the army by the Act of June 22, 1886, which prohibited all members of families having reigned in France from being soldiers.

His military career being broken, Prince Bonaparte devoted all his activity to the studies of Nature and began, as a naturalist, to travel all over the world—through tropical lands as well as in the Polar regions. In all the countries he visited his inquiring mind brought him into contact with many branches of science: anthropology, ethnography, geography, zoology, and botany. From his voyages he brought home material for books on the discoveries of Tasman, on the inhabitants of Surinam, on the colonial work of the Dutch in New Guinea, on the people of Lapland, and specially on the geographical distribution of ferns. He had gathered together a magnificent botanical collection, and he died, pen in hand, just when he was writing the last word of his sixteenth pteridological paper, dealing specially with the ferns of Madagascar.

The library of Prince Bonaparte, containing more than a hundred thousand volumes, was of wide-world fame, and in his last years, during his long illness, it was with his books that he spent the most part of the day. His life was entirely devoted to science; once or twice every year, only, he used to go for a few weeks to Switzerland, where he loved climbing the peaks of the Alps—thus were spent his holidays. For many years he was president of the French Alpine Club.

Modest even to timidity, he was happy, thanks to his wealth, in being able to promote the progress of science. The "Fonds Bonaparte," given annually by the Paris Academy of Sciences, are well known, but many charitable gifts have been secretly made and have remained unknown even to his intimate friends.

Since 1907 Prince Bonaparte had been a member of the Institut de France, and of that he was proud, being the third Bonaparte belonging to the Academy of Sciences, his uncle, Prince Laurent Bonaparte, having been elected in the section of anatomy and zoology and Napoléon I. in the section of mechanical arts. He was also an honorary member of the Royal Geographical Society and an honorary doctor of science of the Universities of Cambridge and Uppsala.

Many scientific societies have had Prince Roland Bonaparte as president, but the association he was most intimately associated with was the Geographical Society of France, at the head of which he remained fourteen years, up to his last day, having had, three years ago, the joy of presiding at its centenary celebrations.

G. GRANDIDIER.

Current Topics and Events.

THE first of the French experimental explosions took place, as arranged, on May 15 at 7.30 P.M. (summer time). Ten tons of melinite, contained in 64 barrels, were exploded simultaneously, forming a crater more than 60 feet wide and nearly 20 feet deep. Observers at a distance of 600 yards were inconvenienced by the air pressure in their ears. Of a number of animals that had been placed in pits not more than 50 yards from the source, a guinea-pig was killed, the rest were unhurt. The first results are said to be disappointing, but the success or failure of the experiment cannot be decided at so early a date. The explosion was heard at Bordeaux (152 miles) at 7.43-7.47. Taking the earlier time, the velocity of the sound-waves would be about 1029 ft. per sec., a value less than the normal velocity in air but somewhat greater than the maximum value (978 ft. per sec.) obtained for the Silvertown explosion of January 19, 1917. At the village of La Courtine, less than four miles away, only a slight shock was felt, but the vibrations are said to have been recorded at Montpellier (167 miles) and Strasbourg (329 miles). As the latter distance is more than a hundred miles in excess of the greatest distance at which the Oppau explosion was registered, some good estimates of the velocities of the condensational and distortional waves in the superficial layers should be obtained. The remaining explosions take place in the same district on May 23 at 8 P.M. and May 25 at 9 A.M. (summer time).

IN connexion with the exhibits relating to pure science arranged by the Royal Society for the British Empire Exhibition, a valuable handbook has been prepared and is obtainable at the Exhibition. The handbook is very much more than a catalogue of exhibits. It represents an attempt, made by those who in Great Britain are chiefly responsible for recent advances in science, to explain to the unscientific visitor the scope of the main investigations in physics and biology which are now in progress. To the lay reader it will be of extraordinary interest to read the declarations of master minds expressed in simple language: and to the scientific worker also the book will be of serious interest, first as a model of lucidity in describing abstruse subject-matter, and secondly as giving a summary conspectus of the state of science at the present time, of the kind which it is sometimes difficult to formulate in clear perspective amidst a mass of more detailed information. Descriptions and explanations of the actual exhibits will be found in the second part of the book, and here it will be well to note the periods during which individual exhibits and demonstrations will be on view, as not all will be available at any one time. Of more permanent interest, however, is the first part of the book, which consists of 21 essays on the principal current topics in physics, geophysics, botany and zoology, and physiology, preceded by an article on the genesis of the Royal Society reprinted from NATURE of February 9. One cannot help wondering whether even these lucid expositions can convey to the minds of unscientific adults a picture which corresponds in any serious degree to the actualities of present-day knowledge: young students, however, whose imaginations have been aroused by scientific studies at school, will find here an earnest of the rich inheritance of thought and discovery which has been prepared for them by such men as the contributors. Perhaps the best way of describing this part of the handbook is to mention the names of the latter, which are as follows: Prof. Irvine Masson, Sir J. J. Thomson, Sir William Bragg, Sir Ernest Rutherford, Dr. F. W. Aston, Sir Frank Dyson, Prof. A. S. Eddington, Sir Richard Glazebrook, Prof. J. A. Fleming, Prof. A. Fowler, Prof. J. C. McLennan, Mr. J. E. Sears, Sir Napier Shaw, Dr. G. C. Simpson, Lieut.-Col. E. Gold, Dr. C. Chree, Dr. A. Smith Woodward, Prof. E. H. Starling, Prof. D. T. Harris, Profs. A. V. Hill and E. P. Cathcart, Prof. E. B. Poulton, and Dr. D. H. Scott.

AN expedition organised by the National Geographic Society of Washington will begin excavations at San Cuicuilco, a site south of Mexico city, early in June. The expedition is under the direction of Prof. Byron Cummings, who will be joined later by Mr. Nelson H. Darton of the U.S. Geological Survey. San Cuicuilco is situated in the lava-covered plain known as the Pedregal or Stony Place, which is some fifteen miles in length and about three miles wide. Preliminary investigations made by Prof. Cummings and Dr. Manuel Gamio, Director of Anthropology in the Bureau of Agriculture and Public Works in Mexico, have disclosed the existence of an artificial mound 412 feet in diameter and fifty-two feet high. The lava flow from the crater Xitli forming the Pedregal has here preserved the remains of a pre-Toltec people, but investigation has revealed the existence of another underlying stratum of lava in which are relics of a much earlier civilisation. Mr. Darton's work will be directed in particular to the lava flow and will aim at determining its age. For the earlier remains an exceedingly high antiquity is claimed, and it is anticipated that these investigations will go far to elucidate the question of the earliest development of culture, and of the history of man in America. It remains to be seen whether excavations will support the contention that this site contains remains dating back many thousands of years. It may be hoped, however, that they will provide valuable material towards determining problems of chronological succession on sites in Mexico and Central America, the lack of which is at present seriously felt in the prosecution of American archæological studies.

MUCH alarm was caused a few years ago among those unversed in astronomy by the views of a certain "Prof." Porta, who predicted violent disturbances in the sun as a result of certain planetary conjunctions. The daily press unwisely gave wide publicity to these announcements, and only consulted astronomers when the mischief had been done. Another mischief-maker is now at work in the person of Mr. W. Gornold; an article by him is referred to in the *Christian Herald* of May 8. Being led by his interpretation of some of the

cycles in Daniel to expect cosmic convulsions in the year 1926, he then looks round to see what planetary configurations can be worked in with this idea. He finds a conjunction of Mars and Jupiter, with Neptune distant 180° from them, and Saturn 90°. This is in the regular astrological manner; but he seems not to have troubled to estimate the actual tidal influence of the planets. Since Jupiter is never nearer to us than 4 units, its tidal influence is $1/(4^3 \times 1000) = 1/64000$ of that of the sun; that of Neptune is, say, 1/4000 of Jupiter; further, when bodies are 90° apart their tidal effects tend to neutralise each other. Such are the insignificant forces which Mr. Gornold uses to build up a prediction of stupendous convulsions. There is even less reason in this prediction than in that of Mr. Porta; it will be remembered that the sun was quite undisturbed at the date when he predicted gigantic sun-spots.

THE report of the Council of the Iron and Steel Institute on the proceedings and work of the Institute during 1923 was submitted at the fifty-fifth annual general meeting held on May 8. From this it appears that there are 2001 ordinary members, 81 life members, and 47 associates. Special reference is made to the death of the immediate past president, Dr. J. E. Stead, on October 31. The income for the year under review was 8095*l.* exclusive of the Carnegie scholarship funds and of the interest received from the investments constituting the Special Purposes Fund, while the expenditure was 8012*l.* Two general meetings were held during the year, the annual one as usual in London on May 10 and 11, the other in the autumn in Milan, by the kind invitation of the Italian Association of Metallurgical Industries. At the conclusion of the meeting members were entertained with generous hospitality in Milan itself, and afterwards visited Florence, Rome, Leghorn, Piombino, Pisa, Genoa, Savona, and Turin. At Rome the members were received by the Prime Minister. Thirty-eight papers were contributed to the proceedings of the Institute during the year, and have been reprinted, together with the discussions and correspondence thereon, in the Journal. The Bessemer Gold Medal was awarded to the late Dr. W. H. Maw. Various grants were made by the Council on the recommendations of the Carnegie Scholarship Committee for the purpose of assisting researches in iron and steel.

THE remarkable pallor of white men living in the tropics is well known, and has given rise to the belief that white races show a tendency to develop anæmia to a marked degree after some months of residence in tropical climates. According to Dr. C. Eijkman, of Utrecht, who dealt with the subject in a lecture on May 2 (*Lancet*, May 3), researches carried out when he was principal of the medical laboratories at Weltevreden (Dutch East Indies) show that in all probability this belief is without any foundation in fact. The red blood cells and the hæmoglobin content, the specific gravity, the water content and the osmotic pressure of the blood of white sojourners, white new arrivals and natives, are all identical, within the usual limits of personal variation; the regeneration of blood after hæmorrhage also occurs as quickly and completely in the tropical dweller of white race as in other normal men. In all probability the pallid skin is to be accounted for by the direct effect of constant warmth; in temperate zones it is only the exposed parts of the skin that exhibit freshness of colour, and this is frequently lacking even in that climate when the individual is much confined indoors. Dr. Eijkman was able to discover only one definite point of difference in the heat-regulating mechanism between whites and blacks, namely, that the water exchanges, by kidneys and skin, are more active in the whites. We agree with him that the problem of acclimatisation of the white man is not yet solved.

WE have received from Prof. Osborn of New York a pamphlet setting forth the constitution of the International Commission on Eugenics. This constitution was adopted at the International Congress of Eugenics held in New York in September 1920. Eugenics is both a science and an art. As a science it occupies itself with all the ascertainable facts about the laws of heredity in the human races; as an art its purpose is to devise methods of regulating reproduction so as to improve the human species. The importance of eugenics has impressed itself on the public mind both in Europe and America in very marked degree since the War, and some even consider that one of the main underlying contributory causes of the War was race-pressure, which it is the object of eugenics to avoid. With the object of spreading eugenic principles and of enabling eugenists from different countries to compare notes, it has been the custom to hold international congresses at intervals of five years. The last of these was that in New York already referred to. Major Leonard Darwin, president of the parent society (the Eugenics Education Society of London), attended as representative of Great Britain and was at once elected president of the Congress. It was felt to be necessary to institute some body to make continuity between one congress and the next and to represent international eugenics when no congress was sitting, and for this purpose the International Commission was set up. Its purpose is to call together the quinquennial congresses and to organise eugenic propaganda in all countries, and it consists of four permanent officers and not more than three representatives from each co-operating country. At present there are twenty-three representatives from fifteen countries. The president is Major Darwin; the vice-president, Prof. Osborn, and the secretary and treasurer, Dr. Govaerts of Belgium; Mrs. Hodson, secretary of the Eugenics Education Society, is assistant secretary. Thus by the establishment of this Commission a permanent framework for eugenic organisation has been provided, and we have no doubt that it will prove of the utmost value to eugenic propaganda all over the world.

AT a meeting of the New York Academy of Sciences on April 14, Dr. William K. Gregory described three jaws of the Miocene ape, Dryopithecus, recently discovered by Dr. Barnum Brown in the Siwalik Hills of northern India. According to the report in *Science*, each of the jaws lacks some teeth, but is sufficiently

well-preserved to show that "Dryopithecus is a forerunner of man as well as the apes." The three specimens are said to have been found in three successive horizons, and represent three different stages in the evolution of the ape. They are particularly important, because the only remains of great apes previously known from the Siwalik formation are one portion of upper jaw in the British Museum and some teeth and fragments in the Indian Museum. Dryopithecus itself has hitherto been found only in the Miocene of Europe, and is not represented by skeletons (as the American report states) but merely by imperfect lower jaws and teeth. One of these jaws from Lérida in Spain, which was described by Dr. Smith Woodward in 1914, displays well the front end or symphysis. In the latter feature it "resembles the large modern Anthropoids no more closely than it agrees with the earliest known true man. By slight changes in two different directions it may have passed into the one as readily as into the other." The conclusions to be drawn from the known Indian and European fossils are thus the same.

IN reply to a question in the House of Commons on May 15 relating to conditions at the Museum of Practical Geology, and asking whether the advisability of moving the collection to South Kensington, and selling the valuable site in Piccadilly, had been considered, Mr. Trevelyan, president of the Board of Education, stated that the questions involved in the development of the Museums at South Kensington were all necessarily postponed during the War. Steps are now being taken to put the existing Geological Museum into constructional and decorative repair, but the Board of Education and the Committee of the Privy Council for Scientific and Industrial Research intend in due course to reconsider the Bell Committee's report, which proposed to house the Geological Museum on a site contiguous to the collections of the Natural History and Science Museums.

SIR WILLIAM J. POPE, professor of chemistry in the University of Cambridge, has been elected a corresponding member of the Academy of Sciences of the Institut de France.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 7, when the Observatory will be open for inspection at 3.30 P.M.

THE annual visitation of the National Physical Laboratory, Teddington, will be held on June 24, when the chairman and general board of the Laboratory will receive the guests.

THE Right Hon. Winston Churchill will deliver the Oration in the Great Hall on Oration Day, Friday, June 27, at the London School of Economics and Political Science.

THE annual general meeting of the Institute of Physics will be held on Monday, May 26, at 4.30 P.M., in the rooms of the Royal Society, Burlington House, when Sir Charles Parsons will deliver his presidential address.

AT a meeting of the Anthropological Society of Washington on April 15, the following officers were re-elected: *President*, Truman Michelson; *Vice-Presidents*, J. P. Herrington; *Secretary*, Rev. John Cooper; *Treasurer*, J. N. B. Hewitt; *Members of the Council*, N. M. Judd, Felix Neuman, and C. F. Anderson.

THE Society of Engineers is convening two conferences of the members and their friends (including ladies) of the institutions associated with it, to be held at the British Empire Exhibition on Friday, June 6, and Monday, September 15. From 10.30 A.M. to 1 P.M. short papers on engineering subjects will be read and discussed. Application for tickets should be made at once to the Secretary of the Society of Engineers, 17 Victoria Street, Westminster, S.W.1.

AT the meeting of the Royal Society on May 15, the name of Mr. Henry Balfour, curator of the Pitt Rivers Museum, Oxford, was added to the list of elections into the Society, the list of selected names having been reduced to fourteen by the death of Dr. T. Nelson Annandale.

WE are asked to announce that there may be some delay in the appointment of a director of the National Poultry Institute at Harper Adams Agricultural College, as the governors have decided to invite applications from Canada and the United States. It is unlikely, therefore, that any appointment can be made before the middle of June.

ON the occasion of the celebrations in connexion with the centenary of the birth of Lord Kelvin which will be held at the University of Glasgow on Commemoration Day, June 25, Dr. Alexander Russell, president of the Institution of Electrical Engineers, will give the Memorial Oration. Lord Kelvin was three times president of the Institution of Electrical Engineers, and Dr. Russell is an old pupil of his.

AT the annual general meeting of the Manchester Literary and Philosophical Society held on April 29, the following officers and members of council were elected: *President*, Prof. H. B. Dixon; *Vice-Presidents*, Mr. T. A. Coward, Mr. Francis Jones, Prof. T. H. Pear, Prof. F. E. Weiss; *Secretaries*, Mr. John Allan, Prof. S. Chapman; *Treasurer*, Mr. R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. W. Robinson; *Curator*, Mr. W. W. Haldane Gee; *Other Members of the Council*, Prof. W. L. Bragg, Rev. A. L. Cortie, Dr. A. W. Crossley, Mr. W. E. Kay, Prof. Arthur Lapworth, Prof. F. L. Pyman, Mr. C. E. Stromeyer, Mr. R. L. Taylor, Mr. W. Henry Todd; *Ex-Officio*, the chairman and the secretary of the Chemical Section.

BRITISH exporters of plant nursery stock, and the plant pathologists to whom falls the duty of inspecting this stock before exportation, will both take a lively interest in the report of a committee on crown-gall inspection which was adopted by the American Phytopathological Society on December 31, 1923. This report, which is published in *Phytopathology*, vol. 14, No. 3, March 1924, requests that distinction should be made between crown-gall and excessive callus formation. It also finds that in general "the injurious effects of crown-gall have been over-estimated, particularly in the case of the apple," states

that "hair-splitting methods of inspection are unnecessary," and that "except as a penalty for law violation, the rejection of an entire shipment because some plants in it are affected by crown-gall is unwarranted."

THE Ministry of Agriculture and Fisheries has awarded the following travelling research fellowships to research workers in agricultural science: (1) 250*l.* to Mr. F. L. Engledow, of the Cambridge University Plant Breeding Institute, for a visit to the United States to investigate American work on barley genetics, cereal yield testing, and the quality, storage, and production of wheat; (2) 50*l.* to Mr. E. S. Salmon, of the South-Eastern Agricultural College, Wye, Kent, for a visit to Czechoslovakia to investigate the growing of hops in that country; (3) 60*l.* to Dr. A. G. Ruston, of the University of Leeds, for a visit to Switzerland and Denmark for the purpose of investigations into agricultural costings. In addition to these fellowships, the Ministry has awarded grants to workers in agricultural science to enable them to represent Great Britain at international conferences and congresses. This is a new and welcome development. Grants for the present financial year, amounting to 175*l.*, have already been awarded to Sir John Russell, Prof. R. C. Punnett, Dr. B. A. Keen, Mr. G. W. Robinson, and Dr. N. M. Comber.

RESEARCH and education will benefit by the surplus of just over 780*l.* which the local committee organising the Liverpool meeting of the British Association has realised from receipts for excursions, subscriptions, etc. Subject to the approval of subscribers, the money will be allotted as follows: 300*l.* to the Tidal Institute of the University of Liverpool towards the fund which is being collected for the purchase of a tide-predicting machine; the profits from the exhibition of scientific apparatus, with an additional sum to make 200*l.*, to the Technical and Commercial Education Sub-Committee of Liverpool for the endowment of a prize called the British Association Exhibition, to be awarded annually in the Central Technical School; and the balance to a fund to assist scientific workers from Liverpool to attend meetings of the British Association in the British Isles.

A PRELIMINARY programme has been issued of the thirty-fifth congress of the Royal Sanitary Institute to be held at Liverpool on July 14-19 under the presidency of the Marquess of Salisbury. The congress will meet in the following sections, the names of the sectional presidents being in brackets: sanitary science (Sir William Leishman); engineering and architecture (Mr. J. A. Brodie); maternity and child welfare, including school hygiene (Dr. E. W. Hope); personal and domestic hygiene (the Lady Mayoress of Liverpool); industrial hygiene (Dr. T. M. Legge). There will also be a number of conferences of sanitary authorities, veterinary inspectors, health visitors, etc. Prof. H. R. Kenwood, Chadwick professor of hygiene and public health in the University of London, will deliver a popular lecture on July 16 on "Modern Civilisation from the Health Standpoint," and an exhibition of apparatus and appliances relating to public health and domestic use will be open throughout the congress. The local secretaries for the meeting are Mr. Walter Moon and Dr. A. A. Mussen, and the local offices, Municipal Buildings, Dale Street, Liverpool.

A MEETING of the Biochemical Society was held in the Department of Physiology of the University of Manchester on May 10. This, the first meeting of the Society in Manchester, was well attended by members from various localities and proved thoroughly successful. There were eleven communications embracing a wide range of subjects from organic chemistry on one hand to biology on the other. The communication of greatest general interest was that of Prof. J. C. Drummond and Miss K. H. Coward, "Studies on the Chemical Nature of Vitamin A." This vitamin has not yet been isolated and evidently is present only in the smallest traces even in cod-liver oil, where it is most abundant; but the evidence brought forward by these workers demonstrates that it must be a definite and stable chemical individual. It can be distilled *in vacuo* without loss of activity at a high temperature, and comes over as a definite fraction along with the complex alcohols with which it is associated. Another communication of general interest was that of Prof. R. Robinson, "Note on the Constitution of Evodiamine," showing that to elucidate the chemical constitution of certain alkaloids, biological arguments are of considerable help.

THE April number of *Scientia* contains an article by Prof. D. Fraser Harris, of the University of Halifax, N.S., entitled "A Defence of Philosophic Neo-Vitalism." The article appears to have been written some few years ago, and in several particulars it is not brought up-to-date. It is a vigorous statement of the case against materialism, but it is rather like flogging a dead horse. We are all now convinced that if the great nineteenth-century biologists were still with us, they would not be upholding the materialism which appeared to them then to offer the only possible working hypothesis. What, after all, was Huxley's "Epiphenomenon theory" but a tentative effort, brilliant in its conception, to rationalise a contradictory and peculiarly disconcerting phenomenon? It is not philosophy, but the progress of science and particularly the new theory of matter, which has discredited materialistic biology. What we are waiting for is a clear and consistent philosophy of the organism. The neo-vitalist has an easy task in exposing the weakness of the old mechanism, but the least he can do is to make clear what his own theory is, if he has one, of the relation of structure to function and of the nature of the noumenal reality behind phenomena.

THE "little Becker balance on the bench" was immortalised many years ago by a chemist-poet who sang of "The Indestructibility of Matter" in the strain of Kipling's "Absent-minded Beggar"; and time has in no way detracted from its renown. The makers, Messrs. F. E. Becker and Co. (W. and J. George (London) Ltd., Proprietors), "Nivoc" House, 17-29 Hatton Wall, London, E.C.1, have recently issued a new catalogue of balances and weights which will doubtless force itself on the attention of those

who live or learn by having to "put the weights on the balance-pan and weigh, weigh, weigh." Scientific workers may, indeed, be grateful that their really good balances outlive them by many years (we wonder which balance holds the time-record for continuous service!), but the makers can also be thankful that the ever-increasing development of scientific instruction in our schools and colleges ensures a perennial demand for their wares. They may even smile when they reflect that although these balances are used to illustrate the great law of indestructibility, their ephemeral "up and down" existence at the hands of schoolboys affords some welcome evidence to the contrary. Some of the illustrations in the catalogue are very well executed in natural colours; and the prices quoted compare very favourably with those demanded a few years ago. Thus the "little Becker balance," well known to nearly every schoolboy, is now obtainable at a price less than 50 per cent. above the pre-War price and 30 per cent. below the price asked in 1918; and the prices of the more costly balances appear to have fallen to a similar extent.

UNDER the title "Iter Turcico-Persicum," Dr. Fr. Náběl is publishing the results of his botanical explorations, during 1909–1910, in the countries of Palestine, Mesopotamia, Kurdistan, and Armenia. Part I., Plantarum Collectarum Enumeratio (Ranunculaceæ-Dipsacaceæ), appears in the Publications de la Faculté des Sciences, de l'Université Masaryk, 1923.

MESSRS. SIDGWICK AND JACKSON, LTD., announce the publication in July next of "A Human Geography of Cambridgeshire," by J. Jones, the aim of which is to encourage the closer geographical study of the home area. It will endeavour to show how this may be done, by presenting the human geography of an English county, as deduced from an examination of maps and Government returns.

MR. JAMES THIN, South Bridge, Edinburgh, has just circulated Catalogue No. 200 of upwards of 5000 books of science offered for sale by him in new or second-hand condition. Practically all branches of science are represented. There is also a section devoted to scientific journals and proceedings of learned societies. The list may be had free upon application to the publisher.

MESSRS. W. HEFFER AND SONS, LTD., Petty Cury, Cambridge, have just started an interesting and useful serial publication entitled *The Recorder*, being a list of "remainders" on sale by them in new condition, at greatly reduced prices. It is, we understand, the intention of the publishers to issue the list some six times a year, and it will be sent post free upon request. Among the books offered for sale in No. 1 are "The Life of Alfred Newton" (the ornithologist), by B. F. R. Wollaston; "Wild Creatures of Garden and Hedgerow," by Frances Pitt; and "The Natives of the Loyalty Group," by E. Hadfield.

Our Astronomical Column.

THE TRANSIT OF MERCURY ON MAY 8.—Fine weather favoured the observation of this phenomenon at Greenwich, Ipswich, and several other stations. Egress took place 1¼ hours after sunrise; owing to the low altitude the limbs were somewhat tremulous, which made it difficult to time the contacts with accuracy, but they were concluded to have taken place some seconds earlier than the predicted times, which were, for Greenwich, $5^h\ 36^m\ 13^s$ A.M. for internal contact, and $5^h\ 39^m\ 12^s$ for external contact. Mr. E. H. Collinson, at Ipswich, made them $5^h\ 36^m\ 5^s$ and $5^h\ 38^m\ 30^s$. He noticed a "black drop" before internal contact, and also saw a somewhat lighter ring surrounding the planet when wholly on the sun's disc. This effect has been noted before, and is probably optical.

May transits usually occur at intervals of 13 and 33 years alternately, but on the present occasion there are two consecutive 33-year intervals, the dates being 1891, 1924, 1957. Several books state erroneously that there will be a transit in May 1937. There will, however, be an extremely near approach, and the planet may not improbably be seen with a spectroscope projected on the chromosphere.

DENSITY OF DWARF STARS.—Prof. Eddington's paper, in Mon. Not. Roy. Ast. Soc. for March, on stellar masses contains a suggestion as to a possible means of verifying the great density of certain dwarf stars which was indicated by his research. The companion of Sirius is of type F, and is of about the solar mass; if its surface brightness is really that associated with type F, its density must be very high and its diameter small. Calculation indicates that on these assumptions the Einstein spectral shift at its surface would correspond to a speed of some 20 km./sec. This is an amount that should be quite easy to detect were it not for the disturbing effect of the very brilliant primary; it must be practically impossible to obtain a spectrum of the faint star without some diffused light of the bright one. The Mt. Wilson observers are attempting this research, and their conclusions will be awaited with interest.

STAR DISTRIBUTION.—The *Scientific Monthly* for May contains an article by Prof. Harlow Shapley, in which he discusses the bearing of recent researches on our view of the stellar system. He considers that this contains numerous subsidiary systems, one being the Cygnus star-cloud, on the edge of which he supposes the sun to be; the dark patches in Taurus, Ophiuchus, and Sagittarius are ascribed to nebulous clouds a few hundred parsecs from us. He goes on to determine the numbers of stars of different types in a million cubic parsecs; they are given as Giant M 22, Giant K 160, B 4½, A 250, Dwarf F 680, Dwarf G 7600. The Dwarf K, M stars are presumed to be much more numerous than Dwarf G, but they are mostly too faint to come into our catalogues. The very small number of B stars indicates that only those of very exceptional mass can attain this type.

A diagram is given of the degree of galactic concentration for different types. This is practically zero for types F and G, showing that the stars considered are mostly dwarfs at a moderate distance; it is very pronounced for types B and A, and evident, though to a less extent, for K and M. It is welcome news that the Henry Draper Catalogue of Spectra is now being extended to much fainter stars in the galactic region. Thus in a field in Aquila, Miss Cannon has recorded 1567 spectra, of which less than 200 were previously classified.

Research Items.

THE ORIGIN OF MAN.—An article by the late Dr. A. A. Mendes-Corrêa which appears in the issue of *Scientia* for May, deals in an acutely critical manner with current theory as to the origin and evolution of man. His conclusions are that too great reliance is placed upon the evidential value of the teeth of fossil man, particularly of the so-called Hesperopithecus tooth from Nebraska. The various conclusions relating to the classification of Pithecanthropus, and to the relation of man to the anthropoids, are contradictory or inconclusive; nor have the attempts to affiliate man to the fossil apes yielded any more satisfactory result. While the theory of a single line of descent presents difficulties, that of a convergence of different lines of descent requires repeated coincidence in conditions unlikely to occur in Nature. While one theory holds that causation in evolution is to be sought in the formation of the Himalaya range and consequent changes in climate, another sees it in differentiation in adaptation of the organism to local conditions. It is probable that both internal factors as well as external environment each play a part in development. The place of origin and the date in geological time are equally indeterminate. In both cases no trustworthy conclusion has yet been attained.

STONE BATTLE-AXES FROM TROY.—In *Man* for May Mr. V. Gordon Childe has an interesting note discussing the possible derivation of the perforated battle-axes of stone which occur in some numbers in the lower levels at Hissarlik, although extremely rare in the Ægean area. The Trojan examples, some of which correspond closely to northern types, fall into two classes. One, in its semicircular section and overhanging butt-end, corresponds closely to the "Silesian" type of Eastern Germany and Moravia, and belongs to the late neolithic and early bronze age, being related more or less to the Fatianovo axes of Central Russia. The second type, with cylindrical butt end and expanding blade, is represented in the oldest separate graves of Jutland, and appears intrusively with corded ware in Central Europe at a relatively late date. The distribution can be explained from a focus in the direction of Scandinavia; but even the latest date for Troy II., say 1800 B.C., is incompatible with Äberg's typology, which starts from a type found in Britain, mainly in barrows of Bronze II. The classical view of the priority of metal types therefore remains the more probable, and the origin of the series should perhaps be sought ultimately in Mesopotamia under Sumerian influence, where socketed battle axes were in use from the beginning of the second millennium B.C., and immediately in the ochre-graves of Kuban.

WATERMARKS OF OLD MAPS.—In the *Geographical Journal* for May Mr. E. Heawood has an article on the use of watermarks in dating old maps and documents. The subject is not a new one, but relatively little has been done for recent centuries or in the study of printed books and maps even of earlier times. Briquet's work, published in 1907, left English watermarks out of account and was devoted chiefly to manuscript documents before 1600. Mr. Heawood's paper deals principally with the three centuries 1500–1800, and besides English includes many French, Dutch, and Italian watermarks. Briquet concluded from the evidence available that the life of an individual mark was not more than fifteen years. Mr. Heawood has tested this conclusion by a number of marks from dated books, and finds that if the dating was dependent on the mark, the probable error would be less than ten years. Another interesting line of research on which he touches is the range in space of different marks. This obviously may have bearing on the authenticity of doubtful documents. The paper is illustrated by reproductions of a large number of watermarks.

SURVIVAL OF THE AMERICAN BISON.—Until recent years there seemed to be little likelihood that the American bison, that once roamed in enormous herds through the plains of North America, still survived in the continent. Reports then came to hand of its existence in the Peace and Athabaska river districts of Canada, but doubt was expressed as to the identity of the species. In the *Geographical Journal* for May Mr. F. H. Kitto describes visits he paid to this district on behalf of the Dominion Government which have enabled him to say that the animals are the true American bison and that they are thriving and multiplying well. The area in which the wild bison roam lies between the Caribou Mountains on the west, the Slave River on the east, the Great Slave Lake on the north, and the Peace River on the south. It is a fairly level area with some wood, plenty of grass, and ample water. Mr. Kitto estimates that in 1922 there were 1500 to 2000 bison in this area and that the numbers were growing. They are equal in size and strength to the best specimens of early days, but in colour they are somewhat darker. The Government of Canada has set aside as a national park and game sanctuary an area of 10,500 square miles in this region, which more than covers the present range of the bison. The extermination of this species would thus appear to have been definitely stopped.

EFFECTS OF BREATHING "ACTIVATED" AIR.—Thomas Arthur Webster and Leonard Hill have investigated the alleged effect of the breathing of air which had been irradiated with ultra-violet light in promoting growth (*Biochemical Journal*, vol. 18, No. 2). They come to the definite, though not surprising, conclusion that it has no effect at all on growth.

WEEDS OF SOUTH AFRICA.—As reprint No. 45, 1923, the Division of Botany, Dept. of Agriculture, South Africa, has brought out in bulletin form Miss K. A. Lansdell's descriptions of the chief S. African weeds, their methods of spreading and the steps best calculated to eradicate or control them. Each weed is illustrated by a coloured plate as well as by figures of fruit or seed and stages in life-history. The five weeds described in this bulletin, which is to be followed by others on similar lines, are the spear thistle, *Cnicus lanceolatus*, L., the dodder, *Cuscuta chinensis*, Lam., *Acanthospermum hispidum*, D.C., *Centaurea Melitensis*, L., and *Opuntia aurantiaca*, Gilles. A vigorous campaign against these weeds, which are "proclaimed" in many provinces throughout S. Africa, will be materially assisted by this well-illustrated bulletin.

FEEDING VALUE OF SOUTH AFRICAN GRASSES.—Chemical, ecological, and agricultural interests are all involved in such studies as the recent examination of the chemical composition of South African indigenous grasses, published by A. J. Taylor, assistant chemist, School of Agriculture, Cedara, in the *South African Journal of Science*, vol. 19, and issued separately by the South African Department of Agriculture, Division of Chemistry Series, No. 4. From the very large mass of data obtained, if the grasses are placed in inverse order to their crude fibre content, this would appear to place them according to relative feeding value, and thus Prof. Bews's

suggestion, that a transverse section of the grass leaf under the microscope provided the quickest and simplest method of appraising nutritive value, would seem to be justified. Mr. Taylor finds that the typically pioneer and post-climax classes of the native grass formation are coarse and inferior in feeding value to the ruderal species commonly found on waste lands, such as *Eleusine indica* and *Panicum proliferum*.

VEGETATION IN NORTHERN GREENLAND.—The botanical results of the *Thule* expedition to the north coast of Greenland are presented by Ostenfeld in four papers. The first two of these deal with plant lists, the third with taxonomic notes, the fourth with the general characteristics of the vegetation and the habitats (*Medd. om Grønland*, lxiv., 1923, pp. 163, 191, 209, 223). From this high latitude (83° N.) seventy species of flowering plants were obtained, a number which serves to throw into relief the comparative sterility of similar Antarctic regions. Of the species obtained, twenty are represented in Britain, though most are of Arctic American origin. A new species of Braya and new combinations of Deschampsia, Melandryum, and Potentilla are described. There is also an interesting summary of the vegetation and habitat conditions in the neighbourhood of the inland ice.

GOLGI APPARATUS IN THE NERVE-CELLS OF HELIX.—Mr. F. W. R. Brambell and Prof. J. B. Gatenby (Sci. Proc. R. Dublin Soc., March 1924, pp. 275-280) have examined the nerve cells of *Helix aspersa* with special reference to the Golgi apparatus. In the smallest cells the Golgi apparatus consists of a large number of curved rods lying on an archoplasmic sphere. Later this apparatus divides and the resulting portions—each consisting of an archoplasmic disc surrounded by three or four rods—tend to pass round the nucleus. At the end of the division the rods, each with a portion of archoplasm filling its concave side, are dispersed around the nucleus. After this no further change takes place except that with the growth of the cell the rods greatly increase in number, so that in a large neurone the number of Golgi rods is enormous. They form a zone around the nucleus and pass some distance into the dendrons but are not found in the axone-hillock or in the axone. This apparatus occupies a position corresponding to that of the true Golgi apparatus in young and old mammalian nerve cells and is revealed by a similar technique. Embryological evidence shows that the so-called Golgi bodies of eggs are, during cleavage and histogenesis, divided out among the blastomeres and their tissue derivatives, including the nerve cells.

FAUNA OF THE SIJU CAVE.—Vol. xxvi. part 1 of the Records of the Indian Museum is devoted to a report on the Siju Cave, Garo Hills, Assam, and its fauna. In the general account Dr. Stanley Kemp and Dr. B. Chopra describe the topography of this underground watercourse running in a tunnel of nummulitic limestone about three-quarters of a mile in length. During the rainy season the greater part of the cave must be flooded, and the torrents which pour through its narrow tunnels must make the inner parts extremely difficult of access to animals. The caverns, which are mostly above flood level, are inhabited by bats and contain deposits of bat guano, and afford food and shelter to those animals which have been able to reach them. The true cave fauna consists of 86 species, but of these only 33 penetrate beyond a depth of 600 feet. A considerable part of the collection consists of species which are known to occur in daylight, and most of the hitherto undescribed forms resemble their outdoor relatives and are not modified in response to their peculiar environment. A large cavern about 400 feet from the entrance contains a rich fauna—68 species, the greater number of which breed and spend the whole of their lives there. Bat guano affords a plentiful supply of food to a brown mite (which occurs in incredible numbers), to a cricket and a cockroach, to the larvæ of a moth, to beetles, to the mollusc *Opeas cavernicola* and to two oligochætes, all of which are abundant. Most of the animals in the cavern paid no attention to a lamp placed quite close to them, but certain of the insects were definitely attracted by light. The only species which exhibit definite adaptation to cavernicolous existence are (1) the mollusc Opeas—six per cent. of the specimens examined show no trace of retinal pigment and the lens is absent; (2) the prawn *Palæmon cavernicola*, the cornea of the eye in which is less than half the normal size but the eye is functional; (3) two isopod crustacea with reduced eyes. The authors suggest that the cave fauna is in an early stage of evolution, and that the cave is of comparatively recent origin.

CLASSIFICATION OF SPIDERS.—In a recent paper, "On Families of Spiders" (Ann. N.Y. Acad. Sci. xxix. 145-180), Prof. A. Petrunkevitch proposes a system of classification which differs from those of Simon and of Dahl. He splits the order first into three sub-orders, the Liphistiomorphæ, Mygalomorphæ, and Arachnomorphæ. The first of these includes the living Liphistiidæ and the Carboniferous Arthrolycosidæ and Arthromygalidæ. The Mygalomorphæ embrace eight families, the Atypidæ of all authors, and the Pycnothelinæ of Chamberlin, raised, with six sub-families of the Avicularidæ of Simon, to the rank of families. The Ctenizidæ, however, have an enlarged scope. The large sub-order Arachnomorphæ is treated with admirable emphasis on the relation between taxonomy and evolution. Three lines of descent are noted. The first, characterised by a primitive respiratory system, includes a dozen families, of which eleven are familiar, while the twelfth is the Telemidæ, separated from the Leptonetidæ. The second line contains thirteen families with two claws and ungual tufts. Two of these are the living Attidæ and the Tertiary Parattidæ. The rest include the former heterogeneous Clubionidæ and Drassidæ, very considerably subdivided. Of the remaining twenty families of three-clawed spiders, the Zodariidæ and Palpimanidæ are slightly re-arranged, and the Psechridæ and Uloboridæ are modified. The Amaurobiidæ become a new family, removed from the Dictynidæ. The large Argiopidæ is undivided, but the arrangement of subfamilies is considerably altered. At a time like the present, when several scientific expeditions are likely to make collections of spiders, Prof. Petrunkevitch's paper deserves to be widely known. It concludes with a table for the separation of the families and subfamilies which is invaluable to any worker classifying a large collection.

AN APPARATUS FOR TESTING CONTACT INSECTICIDES.—In the March issue of the *Bulletin of Entomological Research* Messrs. F. Tattersfield and H. M. Morris, of the Rothamsted Experimental Station, describe an apparatus for testing the toxic values of contact insecticides under controlled conditions. The apparatus is so arranged that successive batches of insects are sprayed under conditions as similar as possible, so that on using various substances at different concentrations the results are directly comparable. The apparatus consists of a glass receptacle in the lid of which an atomiser is fixed. By means of compressed air, at known pressure, the

atomiser discharges a constant quantity of fine spray upon insects placed in a glass dish within the receptacle. For the immediate purposes of the research undertaken, the factors varied were the poisons used and their concentrations. A number of chemical substances at different strengths have been tested by means of the apparatus, and curves plotted indicating how toxicity varies with the concentration and chemical constitution. From some suitable point upon each of these curves, a direct comparison of toxicity between various chemical compounds can be made. Statistically the 50 per cent. death-point, *i.e.* that concentration of a given poison which kills 50 per cent. of the insects sprayed, is the best. If, for example, the concentration of a standard poison such as nicotine giving a 50 per cent. mortality is known, the ratio of this amount to the amount of another substance giving the same mortality may be regarded as an insecticidal index for that substance. Also, if the curves be continued from their lower to their upper limits, indications will be obtained of the concentrations that the insects can sustain without injury, and of those required to kill up to 100 per cent. Relative toxic values of a large number of substances can be obtained with comparative rapidity. It is then easy to select promising compounds for more extended trials in the field.

A FOUR-YEAR SEISMIC PERIOD.—In a recent investigation on a 21-minute period of earthquake frequency, Prof. H. H. Turner found that there was also a period of nearly four years in the occurrence of earthquakes in Jamaica. He has afterwards examined other catalogues (Mon. Not., Roy. Astr. Soc. Geoph. Suppl., vol. 1, 1924). From a long series of Chinese earthquakes (A.D. 80–1880) he estimates the period at 3·981 years, and from a series for Japan (1669–1820) at 3·985 years. Other catalogues of briefer duration give similar results. There is some evidence of a progression in the maximum-epoch with increase of latitude, the "most suitable hypothesis" being "a regular travel of the maximum from the South Pole to the North in the 4-year cycle."

RAINFALL IN THE DUTCH EAST INDIES.—The Royal Magnetic and Meteorological Observatory in Batavia has published Regenwaarnemingen in Nederlandsch-Indië for 1922. As in the previous issues of this publication the rainfall data are given for many hundred stations in Java, Sumatra, Borneo, the Celebes, the Moluccas, and the smaller Dutch islands, including twenty stations in Dutch New Guinea. In each case the data recorded are the total falls for each month in the year, the number of rainy days in the month, and the amount of the heaviest fall in the month. Only in a very small number of the stations are the statistics incomplete. There is no discussion of the observations or comparison with other years.

CORN CROPS AND RAINFALL IN SICILY.—A study of the correlation between harvest-yields and annual and seasonal rainfall on qualitative lines, that is to say, without the computation of coefficients of correlation, for the period 1909–1923, is given by Prof. F. Eredia in a paper entitled "Correlazione tra la produzione del frumento e l' andamento delle pioggie in Sicilia" [Rendiconti della R. Accademia Nazionale dei Lincei, vol. xxxii. ser. 5a, 1923]. In Sicily, rainfall is negligible between June and September, and is small in April and May, but the crops are especially susceptible to variations in the fall of these two months. The major relationship brought out by the tables and diagrams is that whereas years of scarcity are always those of low rainfall, the converse does not always hold, which points to an optimum quantity of rain, put by Eredia at 840 mm. (33·6 inches), above which rain is damaging. Certain discrepancies come out as between different districts of Sicily in connexion with differences in agricultural methods and the use of manures, which tend to complicate the simple climatic influences. Much work of this kind has been done in Great Britain, Sweden, and other countries, and nothing would throw so much light on the important subject of agricultural climatology as a geographical co-ordination of the results.

A METAL VACUUM PUMP.—The May issue of the *Philosophical Magazine* contains a short résumé of the advances which have been made in recent years in the construction of high vacuum pumps, and a description of an all-metal pump system which has been designed by Mr. I. Backhurst and Dr. G. W. C. Kaye of the National Physical Laboratory. The principle used is that of Langmuir—the gas or vapour to be removed is driven along a cooled solid surface by a blast of mercury vapour produced by boiling mercury. In the new pump the evacuation is carried out in two stages, and it requires a fore vacuum at a pressure not exceeding 0·4 cm. of mercury to give the highest vacua. In the first stage the mercury vapour is driven through a jet, and drags along with it the gas or vapour around it as in a filter pump. The pressure is in this way brought down to 0·0001 cm. of mercury. In the second stage the mercury vapour rising from the mercury in the boiler is deflected downwards by a curved plate against a water-cooled surface. The combination gives pressures of the order 10^{-7} cm. of mercury, and evacuates at the rate of 6000 c.c. per second. At the Royal Society Conversazione on May 14 a further improvement was shown. The two stages are now combined into a single operation and the pump itself has no welded joints.

USE OF PULVERISED COAL IN AMERICA.—The Fuel Research Board of the Department of Scientific and Industrial Research has just issued a third edition of the Special Report No. 1 by L. C. Harvey, entitled "Pulverised Coal Systems in America." The use of pulverised fuel offers some of the advantages associated with gaseous fuel without the expenditure of heat and money necessary to produce the gas. Nevertheless, though its use in Great Britain is well established in the cement industry, it has developed only slowly in others. In America the use of powdered coal has developed widely, and especially for the generation of steam in large power-station practice. Some of the largest steam-driven power stations in the world are being constructed for operation with powdered fuel, and at Milwaukee, following protracted experience, a new 200,000 kw. station has been constructed with this system of combustion in the boiler house. Mention is also made in the report of recent European experience, and in this connexion the power station at Gennevilliers, Paris, may be mentioned. The difficulties, dangers, and demerits attendant on the use of the fuel are discussed, but the author is inclined to think they are exaggerated or are obviated by suitable design and skilled operation of the plant. Thus it is known that much if not most of the ash of the coal is carried out of the boiler chimney, but it is stated that no nuisance is caused because the ash is so fine as to be carried a long way, and it is not known where it is deposited. Little or no economy is claimed for the substitution of pulverised fuel for efficient mechanical stokers (the capital outlay is considerable), but where a new installation is being made, the author is a strong advocate for the dust firing. The use of low grade and special fuels and possible application to domestic practice are mentioned.

The Spectrum of "Nebulium."[1]

By HARVEY B. LEMON, Ryerson Physical Laboratory, University of Chicago.

THE papers of Prof. J. W. Nicholson which appeared in the Monthly Notices of the Royal Astronomical Society about ten years ago seemed to hold, at the time, great promise of explaining the lines of unknown origin in the nebulæ, and of co-ordinating these phenomena with those of new stars and with that other class of curious and intriguing celestial objects, the Wolf-Rayet stars.

That analytical connexions exist between the spectra of the latter and of the nebulæ still remains an outstanding and unexplained contribution of this work, although the hypotheses underlying it seem to have been abandoned completely in the light of subsequent developments in a large number of fields. These by reason of the atomic number relationships seem to deny the possibility of the existence of transitional elements lying between hydrogen and helium. Although the striking confirmation of Nicholson's work by Fabry and Buisson with respect to the mass of the centres radiating the green nebular line of the Orion nebula is not now regarded as significant, the discovery of unknown nebular lines by Wright and Wolf in the positions actually foretold by Nicholson still remains a source of admiration to those who recall it, and a fact not attributable to coincidence.

Plaskett, in NATURE for September 15, 1923, suggests the hypothesis, very attractive in the light of recent work on band spectra, that the origin of unknown lines in the nebulæ may be molecular. But, as he clearly points out, his identifications contain relatively so few lines in any given series that the correctness of his assignment seems still open to question.

Whatever the nature of the source, whether atomic as assumed by Nicholson, or molecular as suggested by Plaskett, the following paper clearly indicates that *the entire set of unknown lines* can be arranged in a parabolic form which differs from any atomic series now known, and presents a set of relations that differ from those of any molecular band spectrum hitherto studied.

Taking the list of lines given by Wright in the Publications of the Lick Observatory, vol. 13, 1918, compiled from nine different nebulæ, as being the best available source of information, we find 70 lines, 35 of which are of unknown origin and 18 of which are ascribed either to the Balmer series of hydrogen or to the Pickering series of ionised helium. The resolution in nebular spectra is utterly inadequate to distinguish between the Balmer hydrogen lines and the alternate members of the Pickering series which lie very near them in wave-length. Of the remaining lines, there are those of neutral helium, two ascribed to carbon and one to nitrogen.

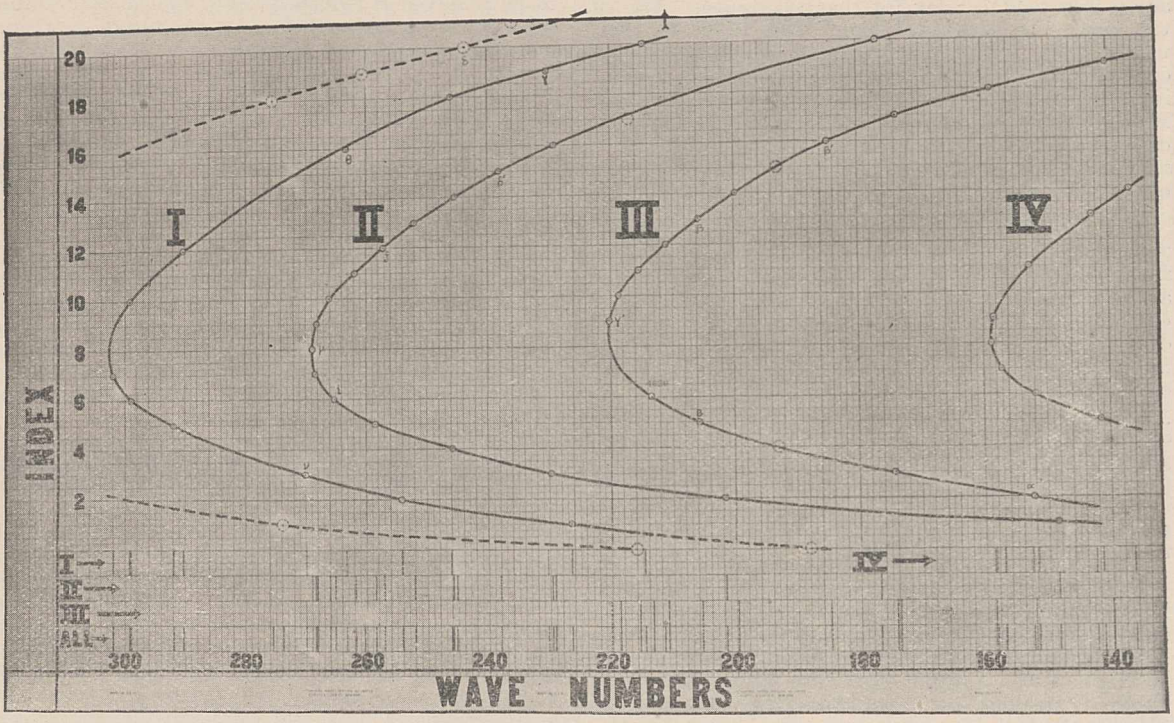

FIG. 1.

Since the relationships described below were formulated, Dr. Wright has directed our attention to 11 other lines, 4 discovered by him in the red, and announced in Publications of the Astronomical Society of the Pacific, vol. 32, and 7 from other sources and less accurately known.

These 46 unknown lines (except one referred to later) are plotted in Fig. 1 according to wave numbers in the bottom row of the figure, together with 13 of the lines of ionised helium shown dotted. Taken all together they locate 61 points on five parabolas which cover the entire visible region. The wave numbers are plotted against consecutive integers (index number), and the vertices of the different parabolas have been arbitrarily placed at the same horizontal level, *i.e.* represented by the same index number, 8.

With the exception of I, these parabolas are as exactly alike as can be determined graphically where the scale is so large (three feet in the original) that

[1] Substance of a communication to the American Physical Society at Washington on April 25.

the accuracy of locating a point on it corresponds to the accuracy with which the wave number is known. The uncertainty of the less well known lines is indicated by dotted circles around their points.

Parabola I is slightly wider than the others. The axes of all are somewhat inclined, and all have quite closely the same inclination.

Curves I to IV were completed with some gaps before information of the 11 additional lines was at hand. Some of these fitted in the gaps awaiting them, and the others appeared to confirm the suspicion that there was one curve with vertex lying well into the ultra-violet which has been dotted in.

The individual branches contain 13 + (2), 18 + (2), 16 + (1), and 8 + (1) points respectively, for I, II, III, and IV. The dotted curve contains 6 + (2) points, of which but one is known with precision of more than three significant figures. The numbers bracketed are doubtful identifications of points on the parabolas which lie so nearly in the same vertical line with other points, either on the other arm of the same curve or on one of the arms of another curve, as to make the resolution of these as two separate lines in nebular photographs wellnigh impossible.

Thirteen out of a total of 18 of the lines of ionised helium lie somewhat irregularly distributed on the same set of curves. It seems doubtful if the occurrence of so large a number as this can be attributed to an accidental occultation by an ionised helium line of a nebulium line that falls very close to the same position. We incline to the interpretation that the radiation of the unknown lines is connected with that of ionised helium in some fashion.

There is but one apparently fortuitous occultation by a neutral helium line, λ3820 Å.U. of a possible position of a nebulium line, on curve II. The other lines of neutral helium, carbon or nitrogen, have no relations to the curves. One of the lines of Wright's tables has not been included; this is λ4711·4, given as occurring in but one of the nine nebulæ from which he assembles the table, and it would seem that it cannot be differentiated with certainty from helium λ4713·3, for which there seems to be no place in this arrangement. Of the 61 points on these curves, only one line has been assigned twice to different curves, and Hβ has been used twice, on opposite branches of the same curve.

Because of the slight inclination of the axes of the parabolas, it would appear that their lower branches might intersect in the infra-red. Such extrapolation is very uncertain, but would appear to be not far from the position of the first line of the Pickering series λ10126·6 Å.U.

Just what extension of our present atomic theories or what further contributions to our present theories of band spectra will provide an interpretation of these relationships is not clear. The quantising of at least one other property of the radiating source would appear necessary to obtain inclined parabolas in the latter field. We can only emphasise the fact that these are analytical relations distinctly suggestive of those hitherto attributed to molecular radiations. Furthermore, if there be significance in the fact that the ionised helium lines, themselves regulated by a Rydberg type formula, fit also on these parabolic lines, this suggests certain possibilities of analytical cross relationships between these two radically different types of equation.

Detailed wave-lengths and wave-numbers and the individual line assignments are given in the tables appended.

Acknowledgments are due to Mr. Jarde K. Morse, fellow of the National Research Council, who collaborated in the initiation of this work and in the discovery of parabolas II and III.

SUMMARY OF NEBULAR LINE ARRANGEMENT.

No.	λ.	1/λ.	H or He^+.	Curve. O.	I.	II.	III.	IV.
1	3313	3018–			(i) h (j)			
2	3342	2992–			k			
3	3346	2989–			g			
4	3426·2	29817			f			
5	3445	2903–		(e)	m			
5′	3629	2755–		f				
5″	3652	2738–		b				
5*b*	3712	2694–	ν		d			
5*c*	3722	2687–	μ			h		
6	3726·16	26837				g		
7	3728·91	26817				i		
8	3759	2660–				j		
8*a*	3771	2652–	ι			f		
8*b*	3798	2633–	θ		q			
8*c*	3820	2618–	(He)			k		
9	3840·2	26040		g				
10	3868·74	25848				e		
10*a*	3888·96	25714	ζ			l		
11	3935	2541–			c			
12	3967·51	25202				m		
13	4064	2461–			s			
14	4068·62	24578				d		
15	4076·22	24532				n		
15*b*	4101·74	24380	δ	h				
15*e*	4200	2381–	δ′			o		
15′	423–	236··		(i)				
15*g*	4340·46	23039	γ		t			
16	4353	2297–				c		
17	4363·21	22919				b		
18	4416	2264–			b			
18*b*	4541·4	22020	γ′				(g) h	
19	4571·5	21875					i	
19′	459–	217··				q		
19″	461–	216··		a				
20	4640·9	21547					j	
21	4658·2	21467			u			
22	4685·76	21314	He^+				e	
24	4725·5	21162		j				
25	4740·2	21096					k	
25*a*	4861·32	20574	β			(r)	d & l	
26	4958·91	20166				b		
27	5006·84	19973					m	
27′	518–	193··				(s)	c & n	
27″	531–	188··			a			
27*b*	5411·3	18480	β′				o	
28	5655	1768–				t		
29	5737	1743–					b	
30	5754·8	17377					p	
31	6302	1587–					q	d
32	6313	1584–						e
33	6364	1571–						c
34	6548·1	15272						g
34*a*	6562·8	15237	α				a	
35	6583·6	15189						b
36	6730	14859				a		(h)
37	7009	1426–						i
38	7065	1415–						a
39	7138	1401–					r	
40	7325	1365–						j
Totals	45 Nu	He+13	He_1	6+(2)	13+(2)	18+(2)	16+(1)	8+(1)

DETAILS OF MISSING LINES.

		1/λ.	λ.
o	(c-d)	3000	3333
I.	e	2824	3542
	l	2952	3388
	n	2848	3511
	o	2788	3587
	p	2720	3676
III.	f	2182	4583
IV.	f	1560	6410

The Royal Society Conversazione.

ON Wednesday evening, May 14, the first of the two conversaziones given by the Royal Society each year was held in the Society's rooms at Burlington House. The president, Sir Charles Sherrington, and other officers of the Society received the fellows and their guests.

The history of science was represented by exhibits by Mr. G. H. Gabb and the Science Museum. The former showed a coloured portrait of Joseph Priestley, F.R.S., in wax, in high relief, and signed "S. Percy, 1788." The portrait is of recent discovery. Percy was a well-known modeller in wax of that period and has represented Priestley in his robe as Unitarian minister, with white stock and grey full-bottomed wig. The Science Museum showed replicas of telescopes of Galileo. The originals were made by Galileo probably about 1610, and are now preserved in the Museo di Fisica at Florence. With these, Galileo saw the moons of Jupiter, Saturn's rings, sun-spots, and details of the moon's surface. The longer telescope gives a linear magnification of 14, with a field of 15 minutes of arc, and a resolving power of about 17 seconds of arc. In the shorter telescope the magnification is 20 with a field of 15 minutes and a resolving power of about 10 seconds.

The Department of Zoology, British Museum (Natural History), had a number of exhibits. Ambicoloration in flatfishes was illustrated by Mr. J. R. Norman. Flatfishes are typically pigmented on the eyed side and white on the blind side, but in certain species of different groups the blind side may be partly or wholly coloured. Complete ambicoloration is accompanied by other variations towards symmetry, such as the assumption by the scales of the blind side of the structure of those of the eyed side, and the delayed migration of the eye, which interferes with the growth forward of the dorsal fin. Rhombosolea has normally only one pelvic fin. In a completely ambicolorate specimen both pelvic fins are present. The Royal College of Surgeons of England (Mr. R. H. Burne) had an interesting exhibit, including madder-stained preparations illustrating the process of bone-growth in young pigs. Madder when taken into the system stains red any bone in the act of formation, but has no effect on bone already formed. It is thus possible by feeding young animals on madder root to observe the progress of the addition of new bone and absorption of old.

Prof. E. W. MacBride's exhibit illustrated post-larval stages in the development of the common irregular urchin, *Echinocardium cordatum*. When the larva metamorphoses into a young urchin, it is still very unlike the adult. In the adult the mouth is situated at one side of the under surface and is crescentic; the anus is situated at the posterior end. In the young imago the mouth is situated in the centre of the under surface and is circular or pentagonal in outline, whilst the anus is near the centre of the upper surface. In these respects the young heart-urchin resembles the regular urchin Echinus. The development of accessory branchial apparatus in some Indian fishes was dealt with by Mr. B. K. Das. In Indian waters there occur certain types of fishes that, in addition to gills, have acquired during post-larval stages accessory breathing organs which vary considerably in different forms in correlation to their habits. Thus in Saccobranchus the apparatus is an elongated highly vascular sac extending to about $\frac{3}{4}$ of the length of the fish, while in Amphipnous it is like an Amphibian "lung"; in Ophiocephalus it is a large dorsal chamber with highly vascular puckered walls; in Clarias it is a highly vascular tree-like organ; in the climbing perch it consists of vascular laminated plates projecting into an air chamber. These air-breathing organs have no relation to the air-bladder, which is chiefly hydrostatic in function. If these fish are prevented from coming to the surface of water to breathe in air directly, they become asphyxiated. Prof. J. Piiper's exhibit illustrated the development of the vertebra of the common gull (*Larus canus*). In most of the lower vertebrates, the vertebra develops around 4 pairs of centres of cartilage formation—1 pair dorsal and 1 pair ventral at the anterior and posterior ends respectively. In birds the posterior dorsal pair has not been observed previously. In the developmental stages of the common gull all the 4 typical pairs of centres of cartilage formation have been discovered. Another exhibit from the Department of Zoology, British Museum (Natural History), was a radiograph of *Gymnomuræna vittata* shown by Mr. C. Tate Regan, demonstrating the "pharyngeal jaws" that are characteristic of the Murænidæ, but are not developed in other apodal fishes. The Forestry Commission's exhibit was largely concerned with the green oak tortrix moth (*Tortrix viridana*, L.). This moth is the cause of periodic defoliation in British oak woods. The eggs of the moth, shown by Dr. J. W. Monro, are laid in pairs and concealed with lichen and bark debris. They have only recently been found in Britain.

Tissue cultures *in vitro* showing living cells in course of division were demonstrated by Mr. T. S. P. Strangeways. Cultures of the choroid are placed in a thermostat at body temperature and observed under a high power objective. By this method it is possible to watch the actual process of cell division in the living tissue.

Prof. P. Groom had interesting cultures of fungi causing dry rot in buildings. Some of the fungi (e.g. *Coniophora cerebella*) can attack only wood that is thoroughly damp, as they cannot manufacture water sufficient for their growth; others (e.g. *Merulius lacrymans*), when once established, can attack the driest wood, as they can render it moist by means of the water that they excrete. Only certain of these fungi (e.g. *M. lacrymans*, *C. cerebella*) can also advance over or through other materials (*e.g.* brick walls) and thus cause rapid destruction of the woodwork of a building. Some of the activities of Rothamsted Experimental Station were represented by exhibits by Dr. W. E. Brenchley and Miss K. Warington showing the effect of boron on plant growth. Boron, in very minute quantities, appears to be essential for the perfect development of certain plants, 1 part of boric acid in 2,500,000 parts of nutrient solution being sufficient to satisfy their needs. *Vicia Faba* is particularly sensitive in this respect, and in the absence of boron, growth is adversely affected and fewer root-nodules are formed.

Leaving now the biological side, we turn to the exhibits in physical science. Sir George Greenhill showed some echelon pulleys in which the sheaves are swivelled so as to take up a position automatically, with the parts of the cord all parallel and a simple pendulum, suitable for elementary instruction and for exact experiment. There is a sphere in which a diametral hole is bored, and if the pendulum is supported by a smooth thread held at two points in the same horizontal, then l the length of the simple equivalent pendulum is the depth of the centre of the sphere below the line of the supports, and l is regulated by the distance between the supports. No correction is required for centre of oscillation. The determination of gravity on a submarine was illustrated by

records from the voyage of the Dutch Submarine K II described in NATURE of December 1, 1923, p. 788, March 1, p. 308, and May 3, p. 641. Another interesting exhibit was Mr. F. Hope-Jones's free pendulum astronomical regulator. This pendulum has nothing to do but to swing. It has no escapement. The only "interference" is that inevitable in giving impulse, which is derived from the fall of a gravity lever every half-minute. It is therefore uniform in quantity and is imparted mainly at zero. The duties of (*a*) time counting and (*b*) releasing the gravity arm are performed by a "slave" clock so firmly held in synchronisation with the master pendulum that the phase difference can never exceed 1/240th of a second. The "hit and miss" synchroniser is the invention of Mr. W. H. Shortt, in combination with the Synchronome System.

A method of measuring ultra-violet radiation was shown by Mr. A. Eidenow, Mr. Leonard Hill, and Mr. A. Webster. A solution of acetone and methylene blue is exposed to light in a standard quartz tube and bleached by the ultra-violet rays. The amount of bleaching is determined by comparison with a set of standard tubes containing varying strengths of methylene blue. A striking exhibit from the National Physical Laboratory was an all-metal annular-jet vacuum pump (Dr. Kaye and Mr. Backhurst). It is constructed wholly of metal, and combines the advantages of the jet and condensation principles in a single and readily accessible unit. The pump will produce a vacuum of the order of 0·00001 mm. mercury or less when working against a back pressure of 1 mm. mercury. The annular jet has a total area of nearly 3 sq. cm. and the speed of pumping varies between 1000 and 7000 c.c./sec. depending on the pressure conditions. The Explosives Branch, Research Department, Woolwich, exhibited a new type of isothermal calorimeter used to measure the rate of heat evolution from compounds undergoing slow decomposition. The substance is placed in a container of non-corrodible metal mounted in the centre of a massive bomb of a special alloy-steel of low thermal diffusivity. The bomb is immersed in a thermostat. Rise of temperature of the central container through evolution of heat is counteracted by the cooling action of an electrical current passing junctions of different metals in contact with the container. This current gives a measure of the rate of heat evolution.

A simple apparatus for the measurement of peak voltage was shown by Prof. J. T. MacGregor-Morris and Mr. L. E. Ryall. Use is made of the fact that an ordinary neon lamp strikes at a definite voltage provided the frequency of the source of supply is more than seven cycles per second. A variable condenser in parallel with the neon lamp is placed in series with a fixed condenser. This system is placed across the alternating supply, and the variable condenser is gradually reduced in capacity until the neon lamp strikes. From a knowledge of the two capacities in series and the striking voltage of the lamp, the overall maximum voltage is obtained. Another National Physical Laboratory exhibit was an electrical method of hardening the ends of standard gauges (Mr. Bloxam and Mr. Buckley). If the whole of the gauge is hardened, there is the possibility of different gauges having different coefficients of thermal expansion. This uncertainty may be reduced by hardening the ends only. The method shown confines the hardening to a layer of about $\frac{1}{4}$ inch at each end of the gauge and is produced by making the gauge one electrode in a circuit which includes three graphite resisters. When traversed by a current of about 750 amperes (A.C.) the contact resistance at the two surfaces of the central graphite resister produces a high temperature in the central graphite. Thus the end of the gauge is heated to a temperature slightly above the critical temperature. Dropping into cold water hardens the end of the gauge only. With circular gauges of 1 inch diameter, 750 amperes for about 2 minutes gives hardening down to about $\frac{1}{4}$ inch in the gauge.

The Cambridge Instrument Company, Limited, exhibited a torsionmeter invented by Mr. E. B. Moullin. Two saddle pieces are clamped to the shaft at a fixed distance (about 4 ft.) apart, one of which carries a laminated armature, and the other an electro-magnet, the armature being arranged close to the electro-magnet. Any torsional movement of the shaft between the saddles thus causes variations in the air gap between the armature and the core, and the design of the electro-magnet is such that its reactance and the air gap are connected by a linear law. Through the electro-magnet winding is passed alternating current supplied from a generator giving an electromotive force bearing a constant ratio to the frequency. Hence the current through the electro-magnet is independent of the voltage and gives a direct measure of the twist or torque in the shaft.

During the evening Mr. F. E. Smith lectured on some modern navigational devices, and Mr. R. Campbell Thompson on travel and archæology in Mesopotamia.

In the above brief account, we have made no attempt at a complete account of the exhibits. There were, in addition, solar photographs and magnetic records by the Rev. A. L. Cortie, apparatus by the International Western Electric Company and the English Electric Company, explosion records by Prof. W. A. Bone, anthropological material by Dr. F. G. Parsons, an attractive demonstration representing the effects of lightning by the Anglo-Persian Oil Company, Ltd., and so on, all of which contributed to the interest of the display.

The Empire Mining and Metallurgical Congress.

THE Empire Mining and Metallurgical Congress, to be held at the Exhibition at Wembley on June 3–June 6, is the first "all British" function of its kind, although its promoters hope that from time to time other similar congresses will be held, and that the Empire Council of Mining and Metallurgical Institutions, which is to be created as the outcome of the Congress, will become a permanent and influential professional body. The objects of the Conference cover, as a matter of fact, much more than the mere reading and discussion of papers. Occasion has been taken of the opportunity afforded by the British Empire Exhibition to invite the co-operation of all the most important mining and metallurgical institutions in the Dominions and in India to meet together to discuss such important questions of mutual interest as the mineral resources of the Empire and their development, the promotion of technical efficiency, and the vital if vexed question of professional status.

It would appear that mining and metallurgical engineers are being faced with the same problems and difficulties that their civil and mechanical brethren, and that chemists, to say nothing of doctors and lawyers, have had to solve in the past. Both, therefore, in the interests of the public, and in their own, the convening bodies hope to be able to evolve a scheme which shall ensure, so far as possible, that persons holding themselves out as mining or metallurgical engineers shall be duly qualified, and it is

proposed, with this object, to establish, if it be found necessary or desirable, a proper Register of those possessing the requisite qualifications.

The Congress, of which the Prince of Wales is honorary president, and Viscount Long of Wraxall president, has been convened by the Institution of Mining and Metallurgy and the Institution of Mining Engineers, which will be responsible more especially for Section A, which is devoted to mining, and by the Institution of Petroleum Technologists, which will organise Section B, devoted to petroleum. The other convening bodies are the Iron and Steel Institute, to which is committed Section C, the metallurgy of iron and steel, and the Institute of Metals, which will be responsible for Section D, non-ferrous metallurgy. With these technical bodies, the secretaries of which are the honorary secretaries of the Congress, the Mining Association of Great Britain and the National Federation of Iron and Steel Manufacturers have associated themselves.

The presidents of the technical institutions concerned will act as vice-presidents, and will preside over the sectional sessions of the Congress, while the Secretaries of State for the Colonies and for India, the Secretary for Mines, the Prime Ministers and High Commissioners of the Dominions, the Lord Mayor of London, and the president of the Iron and Steel Trades Confederation, have consented to become honorary vice-presidents. The treasurer is Sir Robert Hadfield.

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Thirty-four papers have been contributed for discussion in the various sections. They cover nearly every phase of their respective subjects. Of the twelve down for reading before the Mining Section, papers by Mr. Evan Williams and by Prof. H. Louis and Mr. H. F. Marriott deal with the economics of coal and of metal mining respectively. A brilliant symposium of memoirs is grouped in the paper on "Safety Problems in Mining," and papers are presented by Dr. Haldane on "Physiological Problems in Mining," and by Dr. Lister Llewellyn on "Miners' Nystagmus." A number of other papers deal with special mining problems and the treatment of minerals. "The Economics of Petroleum" are dealt with in Section B by Sir Robert Wally-Cohen, and there are seven other papers in this section on economics, mining, and other subjects, amongst the authors being Mr. Beeby Thompson and Sir Frederick Black. Sir William Larke deals in Section C with the "Economics of the Iron and Steel Industry," and Sir Robert Hadfield contributes two papers on fuel and on alloys respectively. Blast furnace practice is dealt with by Mr. Fred Clements. In Section D a valuable review of metallurgical educational facilities is contributed by Prof. Carpenter, assisted by many other authors, and Dr. Rosenhain deals with "Aluminium and Light Alloys."

University and Educational Intelligence.

BIRMINGHAM.—The Huxley Lecture is to be delivered at Mason College on May 29, at 5.30 P.M., by Prof. F. Gowland Hopkins, professor of biochemistry in the University of Cambridge, who has chosen as his subject "The Present Situation and the Future Outlook of Biochemistry."

At the Degree Congregation on July 5, the following will be among the recipients of the degree of LL.D.: Sir Charles Sherrington (president of the Royal Society), Sir John Bland-Sutton, Sir Arthur Keith, Sir Graham Balfour (Director of Education for the County of Stafford), Sir Henry Fowler, Emeritus Prof. P. F. Frankland, Prof. G. H. Hardy (Oxford), Prof. S. Alexander (Manchester), and Prof. F. Gowland Hopkins (Cambridge).

CAMBRIDGE.—Mr. J. Mills, research student of Gonville and Caius College, has been re-appointed to the Nita King Research Scholarship for research in the etiology, pathology, and prevention of fevers. The Council of the Senate has issued a report proposing regulations for a Pinsent-Darwin Studentship in mental pathology, for research into any problem which may have a bearing on mental defects, diseases, or disorders. It is proposed to endow this studentship from the sum of 5000*l.* recently offered to the University by Mrs. Pinsent, Sir Horace Darwin, and the Honourable Lady Darwin. It is further proposed that the Studentship be tenable for three years, that the student may be of either sex and need not be a member of the University of Cambridge.

The Financial Board has issued a report to the Senate on the subject of pensions for persons holding office in the University. Money will not be available to meet all the arrears necessary for superannuation under the Federated Superannuation System of the Universities, but it is proposed to place fully under the scheme certain classes of University officers who apply to come under it and are under the age of sixty. It is proposed to set up a supplementary Pension Fund from which to meet so far as possible the cases of those professors, readers, and University officers who are more than sixty years of age.

The Special Board for Agriculture and Forestry has reported that Prof. Buxton has been informed that the Development Commissioners are recommending a grant of 34,000*l.* for the purchase of land and the erection of buildings in connexion with his investigations in animal pathology. It is expected that a further grant will be received for an extension of the School of Agriculture to accommodate the Institutes of Plant Breeding and Animal Nutrition.

LONDON.—Applications for a Bucknill scholarship (value 160 guineas) and two exhibitions (each of the value of 55 guineas) are invited from students entering University College in October next. There will be an examination of competitors, in chemistry, physics, botany, and zoology. The latest date for sending applications is June 3. They should be addressed to the Secretary, University College, Gower Street, W.C.1.

APPLICATIONS are invited for the headship of the chemical department of Chelsea Polytechnic, necessitated by the impending retirement of Mr. J. B. Coleman. Particulars of the duties of the office, together with a form of application for the appointment, may be had from the Principal of the Polytechnic, S.W.3. The completed form must be received by, at latest, June 10.

APPLICATIONS for grants from the Chemical Society Research Fund must be sent, upon a special form obtainable from the Assistant Secretary of the Society, Burlington House, W.1, to reach the society by June 2 at latest. The income from the donation of the Goldsmiths' Company is more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry; that from the Perkin Memorial Fund is applied to investigations relating to problems connected with the coal-tar and allied industries.

RESEARCH Studentships and Advanced Study Studentships up to twelve in number are being offered by the Empire Cotton Growing Corporation. Each

will be of the annual value of 250*l.* with additional allowances. The Research Studentships are intended to enable graduates to receive training in methods of research in Great Britain. The Advanced Study Studentships are intended to enable men to receive such specialised instruction as their previous qualifications and experience show to be most desirable in order to equip them for agricultural posts in cotton-growing countries wherever opportunities for employment may present themselves. Candidates must be of British nationality. Those applying for a Senior Studentship must hold a degree from some university of the British Empire, or the diploma of the Imperial College of Science and Technology. In addition, candidates, since taking their degree, must either have had at least one year's training in research methods or carried out other advanced post-graduate studies or, since taking their degree, they must have completed a course of training in agriculture. In the case of candidates for Junior Studentships, it is desirable that they should have passed the examinations required for a degree at some university of the British Empire or for the diploma of the Imperial College of Science and Technology. In making application for the studentships it should be stated which grade is applied for. Further particulars and forms of application may be obtained from the Secretary, Empire Cotton Growing Corporation, Millbank House, 2 Wood Street, Millbank, S.W.1. The completed forms of application must be received by June 16 at latest.

"NATIONAL BOARDING SCHOOLS" versus slum schools is the theme of a striking article by Mr. Ernest Remnant in the March number of the *English Review*. It is suggested that boarding schools in the country and by the sea, hygienically equal in all respects to those existing for the children of the upper classes, can be made generally available for "working-class" children of industrial urban areas without any appreciable additional expenditure. To any one familiar with preparatory and public school charges the idea may seem fantastic. It is argued, however, that the cost of maintenance of groups of, say, 250 children or more, with the advantages of wholesale buying of food, milk, and country produce from local farmers, the bulk of the fruit and vegetables being grown in the school gardens and largely by the labour of the children themselves, would be no greater than the aggregate of the costs to the individual parents of their maintenance at home. The problem of accommodation is to be solved—and this is the most original part of the scheme—by acquiring those great country mansions which their owners are year by year finding it more and more embarrassing to keep up, and are consequently glad to dispose of at comparatively low prices. The scheme aims not only at raising the low physical standard of the nation, but also at "removing one of the root causes of the class jealousy which is poisoning our national lives." The evil environment of the slum school child has recently been the subject of comment by speakers at conferences of the National Union of Teachers and the National Association of Schoolmasters, but without reference to any constructive suggestion such as Mr. Remnant now offers. Further articles by medical and educational authorities are promised, but the scheme cannot be expected to make substantial headway until some enterprising local authority undertakes to put it to the test of experiment. Meanwhile those engaged in promoting it might find it useful to consult Bulletin, 1922, No. 12 of the Bureau of Education, Washington, which describes American experiments with dormitories in connexion with public secondary schools.

Early Science at the Royal Society.

May 18, 1664. The Secretary produced a roll of some skins of parchment sent by Mr. Beal for the use of the society, made by one Matthew Wills of Yeovil, esteemed by many the best parchment-maker in England. This roll was accompanied with a description of the art of making parchment, together with the figures of the several tools used in this art. It was ordered, that the said description be read at the next meeting.

1676. Mr. Aubrey acquainted the Society that he had received . . . some manuscripts of Mr. [Samuel] Foster [of Gresham College] for their perusal. Hereupon the Society ordered, that Mr. Collins should be desired to peruse these manuscripts, and make a report of them to the Society.

1681. Ordered that Sir John Hoskyns, Mr. Hooke (and others) be a committee to meet on Friday afternoon at half an hour after three, to go to Chelsea, and discourse the neighbourhood there in relation to the Society's interest in the public way.

1687. Sir Robert Gourdon delivered to the Society by the King's order a receit to cure the bite of a mad dog, being under the hand of Mr. Thomas Frazier, his majesty's chirurgeon. The chief ingredient of this medicine was a plant, which grows plentifully about Thetford, and is there called the "star of the earth."—Sir Robert related, that Dr. Plot had lately proposed to the King the barking of all timber, designed for the use of the navy, in the spring, and then to let the trees stand so barked till autumn before they are felled; which he conceived would very much harden the wood, and make it much more durable by drying and evaporating the sap during the same. This, Sir Robert said was the practice of the French in felling their timber; but he knew nothing of the effect.

May 19, 1670. It was ordered, that a weather-clock should be bespoken by Mr. Hooke, such a one, as Dr. Wren has formerly contrived, for observing not only the winds and their quarters and degrees of strength, but also the quantities of rain, and other particulars relating to the temperature of the air.

May 20, 1663. Mention being made of toads infecting sage, Mr. Waller [the poet] alledged, that it had been observed in a microscope, that sage hath little cavities, used to be filled with small spiders; and that this was the cause which made the plant noxious, if not well washed.

1685. Dr. Robinson communicated a draught of proposals to be made for printing Mr. Ray's *General History of Plants*.

May 22, 1679. A stranger being present, the weather-clock now finished by Mr. Hooke was omitted to be shewn till the next meeting, when it was to be carried to Mr. Hunt's lodging, that he might attend it and supply it with fresh papers.

May 23, 1667. The lord Berkeley mentioned, that the duchess of Newcastle had expressed a great desire to come to the society and to see some of their experiments; but that she desired to be invited. Put to the vote, it was carried in the affirmative.

May 24, 1677. Mr. Oldenburg produced Signor Cassini's printed discourse concerning a new theory of the moon invented by him: which being read, Mr. Flamstead was desired to take it with him, and to consider it.

1682. The experiments tried were about the strength of several pieces of timber, by examining what weight was necessary to break a prism of each, a foot long, one inch and an half broad, and an inch thick, of which size they were all made.

Societies and Academies.

LONDON.

Faraday Society, April 14.—Sir Robert Robertson, president, in the chair.—T. A. **Heppenstall** and W. J. **Shutt**: Conditions of the appearance of anode effect in the electrolysis of fused chlorides. Anode effect is an irreversible condition at the positive electrode which manifests itself during the electrolysis of fused salts by a sudden drop of the current passing through the cell; simultaneously gas evolution at the anode ceases, and the latter has the appearance of being "unwet" by the electrolyte. The effect is reproducible at constant current density at a given temperature. When an alternating current was superimposed upon the direct current used for electrolysis, the effect was produced at a lower direct current density.—R. Ashton **Hill**: The photochemical decomposition of gaseous sulphur dioxide. The decomposition of sulphur dioxide gas under the action of light radiated from a uviol mercury vapour lamp has been investigated, and the resulting photostationary state, characteristic of a given set of conditions, determined, using a number of different light filters. The wave-length chiefly responsible for such decomposition is 313 $\mu\mu$, which lies within the first absorption band of sulphur dioxide (at a pressure of 600 mm.), but does not correspond with the head of the band (296·1 $\mu\mu$). The actual wave-length producing maximum decomposition depends on the nature of the source of radiation, *i.e.* upon the intensity distribution of the emission spectrum. Of the radiation emitted from the uviol lamp the longest wave-length capable of decomposing sulphur dioxide is the 313 $\mu\mu$ line itself. Probably any wave-length within the absorption band of the substance is capable of bringing about decomposition, provided the intensity is sufficiently great. The bearing of the photochemical decomposition of sulphur dioxide upon the critical increment of the *thermal* union of oxygen aud sulphur vapour is discussed. The molecule S_2 as distinct from the atom seems to be involved in this process.—F. C. **Thompson** and W. H. **Dearden**: Note on an experiment in solid diffusion, and its possible bearing on the structure of solid solutions. The experimental work consisted in the determination of the relative rates of diffusion of copper into gold, silver, and an alloy of those metals in equal proportions. These particular materials were chosen since their atomic volumes are almost identical. It was found that diffusion takes place much more readily into a pure metal than into a solid solution. This is more easily understood on the assumption that the added atoms in the solution are accommodated in spaces in the lattice than if they replace atoms in the lattice itself.—J. P. **McLare**: The repair of worn components by electro-deposition. This method of repair was first adopted on a considerable scale during the War. Success depends primarily on the condition of the cathode surface. Electrolytic methods of cleaning are indispensable.

Zoological Society, April 15.—Dr. A. Smith Woodward, vice-president, in the chair.—R. T. **Leiper**: Parasitological work at the Zoological Society's Gardens.—G. C. **Robson**: On the Cephalopoda obtained in South African waters by Dr. J. D. F. Gilchrist in 1920–1921.—Basanta Kumar **Das**: On the intra-renal course of the so-called "renal-portal" veins in some common Indian birds.

Aristotelian Society, April 28.—Dr. W. R. Matthews in the chair.—F. **Aveling**: The Thomistic outlook in philosophy. The viewpoint of St. Thomas is that the object of knowledge is first known merely as a bare and confused entity, and that this intuition is only gradually filled in and completed by a laborious course of investigation as to what that entity does, how it acts. The subject, knowing itself, is object also in the relation of knowing. Only by a "diligent research" can it come to the knowledge of its nature, or essence, or definition. But from the first act that it performs its existence is known, and, inchoately, its essence. This is of the greatest importance for the logical theory of St. Thomas, since for him all demonstration requires that the thinker as an essence, and the knower as a reality, exists.

May 5.—Dr. F. W. Thomas, treasurer, in the chair. A. A. **Cock**: Prayer, psychologically and metaphysically considered. Prayer is the act of attention directed upon God. It may be of a pantheistic character, directed upon a universe increasingly apprehended as divine, and union therewith of a highly æsthetic nature will develop. Or the progressive differentiation of the presentation-continuum may assume for the subject an increasingly unsatisfying and unsatisfactory character, so that the subject, withdrawing attention from objects presented, concentrates more and more upon a presented transcendent object. Precisely because prayer is attention directed upon God, or upon any object of religious aspiration, belief, worship, awe, it is necessarily petitionary in character though not wholly so nor for ever so.

MANCHESTER.

Literary and Philosophical Society, May 13.—F. **Nicholson**: The history of the Manchester Literary and Philosophical Society during its first seventy years. The paper, which was based on the minute books of the Society, dealt largely with the domestic history of the Society, including its library, an exclusively scientific one, for the last 100 years. The Society had acquired a world-wide reputation by its publication of the early volumes of its Memoirs and its connexion with Dr. Dalton, and often used its influence both locally and nationally. It encouraged the formation of the short-lived College of Arts and Sciences, 1783, and its members founded, though the Society disclaimed responsibility, the Manchester Academy, 1786, still existing as the Manchester College, Oxford. It invited the British Association on its first visit to Manchester, 1842, and took a leading part in securing the exemption of scientific and literary societies from taxation, 1843. Owing entirely to its representations to the Government, the northern counties were surveyed by the Ordnance Survey on an adequate scale, 1841. It established meteorological recording stations in Manchester, 1843, and in its rooms the founders of medical education in Manchester delivered their lectures prior to the establishment of the Pine Street School of Medicine. —W. H. **Lang**: On some deviations from the normal morphology of the shoot in *Osmunda regalis*. Some young plants of the Royal fern had been wounded at the apex in order to induce branching, which was related to the leaf-bases, and here and in unwounded plants was sometimes clearly axillary. Others had apparently been ill-nourished, had failed to get the normal winter rest, and had perhaps suffered from the Aphides which lived through the winter. Under these conditions some of the young plants continued to produce leaves of the juvenile type, or even simpler cylindrical growths in place of leaves. In some cases apospory was induced, the tip of the leaf, or the tip of each vein of this, growing out as a prothallus, while still attached to the plant. In other cases a bud was

developed on the adaxial face of the leaf-stalk. Other more completely transformed leaves had the form of a cylindrical stalk that became transformed into a shoot at the tip. In these last cases it was of interest that the first leaf of the new shoot could be regarded in one sense as the subtending leaf of an axillary bud, and in another as the first of a sequence of leaves constituting the bud. These deviations from normal form a connected group or series, and the consideration of the plasticity in the young plant of *O. regalis* leads us a little beyond taking the shoot for granted as a developmental unit. They appear on the whole in favour of regarding the shoot of the fern, and therefore of plants generally, as constructed by the developmental association of phytonic segmental units.

PARIS.

Academy of Sciences, April 28.—M. Guillaume Bigourdan in the chair.—The president announced the death of J. E. B. Warming, correspondant for the section of botany, at the age of eighty-three.—André **Blondel** and Henri **Harlé**: The experimental demonstration and exact measurement of the phenomena of resonance peculiar to the crank shafts of combustion motors; rôle of the flywheel; favourable influence of an elastic coupling.—Pierre **Weiss** and R. **Forrer**: Magnetocaloric phenomenon. Apparent magnetisation and true magnetisation. The rise of reversible temperature Δt can be expressed as $\Delta t = A(\sigma^2 - \sigma_0^2)$, where σ_0 is the spontaneous magnetisation in the absence of the field, and σ the magnetisation due to the field. Above the Curie point, 357°·6 C. for nickel, $\Delta t = A\sigma^2$. The results of experiments on nickel are given in three diagrams.—Paul **Vuillemin**: The bifurcation of leaves by coherence.—Octave **Mayer**: A remarkable surface of the fourth order.—Boris **Delaunay**: The representation of numbers by binary forms.—Charles **Platrier**: The integration of linear differential equations.—Marcel **Riesz**: Conjugated functions and Fourier's series.—A. **Marchaud**: Differences and differentials of a function of two variables.—Emile **Jouguet** and Maurice **Roy**: The paradox of d'Alembert in the case of compressible fluids.—René **Baillaud**: An optical self-recording micrometer for the prism astrolabe.—M. **Salet**: The absorbing power of the atmospheres of the stars. The measurements of Coblentz have shown that the ratio (R) of the intensity of the light radiation to the total energy received from the stars is, on the average, twice as great for stars of the A and B types as for those of the solar type. Theoretically, R should diminish when passing from the solar stars to the hotter stars, and Nordmann has suggested that this discrepancy is due to the absorbing powers of the atmospheres of the stars. This view the author considers untenable, and suggests another possibility, that if the star temperature exceeds 10,000° the maximum of the energy spectrum passes into the ultraviolet where the radiations cannot pass our atmosphere.—Louis **Dunoyer**: Experiments by which the mechanism of light emission may be attained under the simplest conditions. Comments on a recent note of Edmond Bauer, with a description of some further experiments.—A. **Dufour**: Recording electromagnetic waves of high frequency (Hertzian frequencies).—P. **Lejay**: A three electrode valve electrometer and its application to the measurement of the electrical gradient of the atmosphere.—N. **Perrakis**: Volumes in the neighbourhood of the critical state of miscibility. A study of the variations of volume produced in mixtures of benzene with methyl, ethyl, propyl, and butyl alcohols. The results of the experiments are given in four curves, with volume changes as ordinates and molecular concentrations as abscissæ.—A. **Chassy**: The physical laws of the formation of ozone by the silent discharge. In an ordinary ozoniser the numerical ratio between the heat disengaged and the quantity of ozone obtained is constant, whatever may be the voltage or the frequency of the current used.—S. **Stefanescu**: The mechanism of the expulsion of the lower molars of mastodons and elephants.—E. F. **Terroine**, Mlle. S. **Trautmann**, R. **Bonnet**, and R. **Jacquot**: The culture of moulds on the amino acids and the mechanism of the specific dynamical action. Experiments showing that the loss of energy observed is essentially due to the removal of the amino group from the amino acids.—MM. **Aversenq**, **Delas**, **Jaloustre**, and **Maurin**: The action of thorium-X on the maturation of eggs, the germination of seeds, and the growth of plants. In all cases small doses of thorium-X exert a favourable influence, large doses having a contrary effect.—Armand **Dehorne**: Remarks on some figured elements of the blood of the Glycera.

ROME.

Royal Academy of the Lincei, February 3.—V. Volterra, president, in the chair.—B. **Grassi** and M. **Topi**: Inconsistency of the two species of vine Phylloxera distinguished by Börner. Neither the morphological differences pointed out by Börner, nor the divergent susceptibility of the various American vineyards, suffice to demonstrate the existence of two distinct species of vine Phylloxera.—E. **Bompiani**: Notions of projective-differential geometry relative to a surface of ordinary space.—E. **Fermi**: Reflection and diffusion of resonance. The variation with pressure of the ratio between the intensities of the diffused and reflected light in the phenomenon of optical resonance is considered theoretically. The intensity of the diffused light is shown to be proportional to the number of atoms per unit volume of the gas and that of the reflected light to the square of this number.—L. **Castaldi**: First results of experiments on the effects of the cortex of suprarenal glands on the somatic growth of young guinea-pigs. The effects produced in the young animals by the addition of this cortex to their diet are (1) increased weight, (2) lengthening of the skeleton, this being more marked in the body than in the limbs, and (3) increased development of the fur, particularly with the females. Administration of the material during pregnancy results in increased weight of the young at birth.—A. **Foà**: Morphological and biological cycle of *Nosema bombycis* Nägeli.—A. **Herrera**: Imitation of the structure of protoplasm, and cellular division.—A. **Chiarugi**: Embryology of the Cistaceæ.

February 17.—V. Scialoja, vice-president, in the chair.—A. **Angeli**: Reactions of certain aromatic and aliphatic derivatives. Further examples are given of the chemical analogies between a compound formed by the direct union of two groups, A-B, and the compound with the same two groups in ortho- or para-positions of a single aromatic nucleus, $A\text{–}C_6H_4\text{–}B$.—L. **Lombardi**: Potential energy of magnetic circuits including imperfectly polarisable materials.—L. **Sabbatani**: Pharmacological investigations on iron. V. Colloidal ferrous sulphide prepared in the presence of gelatin. The toxic agent of this colloidal sulphide or of ordinary ferrous sulphate consists of the cation $Fe^{\cdot\cdot}$. The sulphate, although partly oxidised, may in large doses produce a comparatively high concentration of this cation and hence cause rapid death; in small doses, however, the colloidal sulphide is considerably the more active.—F. **Sbrana**: Potential of a disc with symmetrical distribution.—A. **Korn**: The second fundamental

problem of elastic statics.—N. **Spampinato**: Physical bases of relativity.—G. **Agamennone**: Further researches on the earthquake of March 15, 1923.—C. **Di Capua**: Hardness of tin-cadmium and tin-bismuth alloys. The hardness curves for both these series of alloys are abnormal but become normal after the alloys have been reheated.—C. **Riccomanni**: Relationships between chemical constitution and taste. For a compound to exhibit a taste resembling that of pepper, the presence of the piperidine grouping in the molecule is shown to be unnecessary.—E. **Grill**: Crystalline magnesite of the Valle della Germanasca.

March 2.—V. Volterra, president, in the chair.—M. **Cisotto**: Viscous rotations.—S. **Franchi**: Concealed strata of Mount Ausoni and Mount Lepini and of the pre-Apennine districts of Campania and Latium.—E. **Soler**: Gravity measurements in the Carso region.—G. **Albanese**: Arithmetical nature of algebraic varieties of four dimensions.—B. **Segre**: Linear systems tangential to any system of forms.—M. **Maggini**: Measurements of the distances of double stars by means of the micrometer and of the interferometer. The results of preliminary tests indicate that the interferometer method may be useful in investigating the systematic errors of measurements made with the micrometer.—E. **Fossa-Mancini**: So-called shaly clays of the pre-Apennine district near Modena.—C. **Porlezza**: Arc spectrum of silicon in relation to spectrographic analysis. Descriptions are given of the appearance of the band spectra of silicon in the spectrograms of rocks with different contents of silicon. When silica is present in large proportions in material to be subjected to spectrographic analysis, its preliminary removal is advisable.

Official Publications Received.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 482: Gravitational Anisotropy in Crystals. By Paul R. Heyl. Pp. 307-324. (Washington: Government Printing Office.) 10 cents.

The Rockefeller Foundation: a Review for 1923. By George E. Vincent. Pp. 48. (New York City.)

Records of the Survey of India. Vol. 17: Memoir on Maps of Chinese Turkistan and Kansu, from the Surveys made during Sir Aurel Stein's Explorations 1900-1, 1906-8, 1913-5. By Aurel Stein; with Appendices by Major K. Mason and J. de Graaff Hunter. Pp. xv+208+30 plates +48 maps+12 charts. (Dehra Dun: Trigonometrical Survey Office.)

Instituts scientifiques de Buitenzorg "'s Lands Plantentuin." Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 5, livraison 1-3, février 1924. Pp. 298. (Buitenzorg.) 2.50 f.

Tanganyika Territory Exhibition Handbook. Pp. iv+215+xxiii. (Wembley: Issued by the British Empire Exhibition Central Committee of Tanganyika.) 1s.

County Borough of Eastbourne. Annual Report of the Meteorological Observations for the Year 1923. Pp. 40. (Eastbourne: Public Health Department, Town Hall.)

Smithsonian Miscellaneous Collections. Vol. 76, No. 10: Explorations and Field-Work of the Smithsonian Institution in 1923. (Publication 2752.) Pp. iii+128. (Washington: Smithsonian Institution.)

Falmouth Observatory. Report of the Joint Observatory Committee to the Royal Cornwall Polytechnic Society and to the Falmouth Town Council for the Year 1923. Pp. 4. (Falmouth.)

Falmouth Observatory. Meteorological Notes and Tables for the Year 1923. By Joshua Bath Phillips. Pp. 8. (Falmouth.)

Studies from the Research Division, Connaught Antitoxin Laboratories, University of Toronto. Vol. 1: 1917-1922. Pp. 176. (Toronto.)

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 14, Article 10: On the Numbers and Local Distribution of Illinois Land Birds of the Open Country in Winter, Spring and Fall. By Stephen A. Forbes and Alfred O. Gross. Pp. 397-453. (Urbana, Ill.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 59: Schools and Classes for Feeble-minded and Subnormal Children, 1922. Pp. 22. (Washington: Government Printing Office.) 5 cents.

Classified List of Smithsonian Publications available for Distribution, March 1, 1924. Compiled by Helen Munroe. (Publication 2755.) Pp. v+30. (Washington: Smithsonian Institution.)

Department of the Interior: United States Geological Survey. Bulletin 750-B: Origin of certain rich Silver Ores near Chloride and Kingman, Arizona. By Edson S. Bastin. Pp. 17-39. 5 cents. Water-Supply Paper 489: The Occurrence of Ground Water in the United States; with a Discussion of Principles. By Oscar Edward Meinzer. Pp. xi+321+31 plates. 60 cents. Water-Supply Paper 492: Summary of Hydrometric Data in Washington, 1878-1919. By Glenn L. Parker and Lasley Lee. Pp. viii+363+8 plates. 40 cents. Water-Supply Paper 497: The Salton Sea Region, California; a Geographic, Geologic, and Hydrologic Reconnaissance, with a Guide to Desert Watering Places. By John S. Brown. Pp. xv+292+19 plates. 50 cents. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, MAY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. W. Alcock: Musical Ornamentation: Its Origin and Development.

MONDAY, MAY 26.

INSTITUTE OF PHYSICS (Annual General Meeting) (at Royal Society), at 4.30.—Hon. Sir Charles Parsons: Presidential Address.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Col. H. Biddulph: The True Harmony of Man.

ROYAL GEOGRAPHICAL SOCIETY (Anniversary Meeting) (at Æolian Hall), at 5.—Presidential Address—Presentation of Annual Report—Presentation of Gold Medals and other Awards.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (at Royal College of Surgeons), at 5.30.—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—W. H. Winch: Should Poems be learnt by School Children as Wholes or Parts?

TUESDAY, MAY 27.

SOCIETY OF GLASS TECHNOLOGY (Joint Meeting with the British Society of Master Glass Painters) (at University College), at 3.—Miss Ethel Mellor: The Decay of Window Glass from the Point of View of Lichenous Growths.—N. Heaton: The Decay of Mediæval Stained Glass.—Prof. W. E. S. Turner: The Weathering and Decay of Glass.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Dr. C. G. Cullis: The Geology and Mineral Resources of Cyprus.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Major W. S. Tucker: Acoustical Problems (I.): Indoor Problems.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. L. Emanuel: Etching.

WEDNESDAY, MAY 28.

ROYAL SOCIETY OF ARTS, at 4.30.—Mrs. A. McGrath (Rosita Forbes): The Position of the Arabs in Art and Literature.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—Major H. P. T. Lefroy: Wireless in British Military Aircraft up to August 1914 (Lecture).

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications of the Microscope Section), at 7.—J. E. Barnard: Lecture Demonstration on Technical Microscopy.—E. S. Leicester: The Use of the Microscope in the Examination of Paper.—K. MacLennan: The Microscopy of Soaps.—R. and J. Beck, Ltd.: Exhibit of a New Analysing Prism for Use over the Object Glass, which does not possess any Astigmatism.—Ogilvy and Co.: Exhibit of Leitz Binocular Tube Attachment for Monocular Stands, and New Leitz Dissecting Microscope.

THURSDAY, MAY 29.

ROYAL SOCIETY, at 4.30.—Prof. D. M. S. Watson: The Origin of the Amphibia (Croonian Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. C. G. Seligman: Divine Kings and Rainmakers of the Sudan.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Annual General Meeting.

FRIDAY, MAY 30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Prof. The. Svedberg, O. H. Schunk, and H. Andersson: The Relation between Exposure and Number of Developable Centres.—F. F. Renwick: Factors affecting Grain Size in Emulsions.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—L. Bull: Recent Developments in High Speed Cinematography.

SATURDAY, MAY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Nabokoff: Shakespeare in Russia.

PUBLIC LECTURES.

MONDAY, MAY 26.

KING'S COLLEGE, at 5.30.—Prof. A. J. Toynbee: The Saviour King in Greek Tradition.

TUESDAY, MAY 27.

BEDFORD COLLEGE, at 8.—Miss Constance Smith: Women in Dangerous Trades (Chadwick Lecture).

WEDNESDAY, MAY 28.

KING'S COLLEGE, at 5.30.—Prof. A. J. Sargent: The Trade of the Empire.

THURSDAY, MAY 29.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Dr. G. M. Holmes: The Ductless Glands and Personality.

UNIVERSITY COLLEGE, at 5.30.—Prof. A. N. Whitehead: The Nature of Science.

FRIDAY, MAY 30.

BRITISH EMPIRE EXHIBITION (Conference on Science and Labour), at 11 A.M.—Rt. Hon. Sidney Webb, Sir Richard Glazebrook, Major A. G. Church, and others: The Place of Science in Government. Chairman: Sir Richard Gregory.—At 3.—H. Hirst, Sir Oliver Lodge, Sir Daniel Hall, A. P. M. Fleming, and others: Scientific Research in Relation to Industry. Chairman: Rt. Hon. Lord Askwith.—At 8.—Rt. Hon. Lord Ashfield, Sir Hugh Bell, Bt., W. Straker, and others: Co-operation of Science and Labour in Production. Chairman: C. T. Cramp.

UNIVERSITY COLLEGE, at 5.15.—Prof. A. Haas: Objective and Subjective Physics.

SATURDAY, MAY 31.

BRITISH EMPIRE EXHIBITION (Conference on Science and Labour), at 11.—Sir Arthur Newsholme, Dr. C. S. Myers, Dr. Cyril Burt, Miss May Smith, and others: Science and the Human Factor. Chairman: Miss Margaret Bondfield.—At 3.—R. H. Tawney, Sir Thomas Holland, Dr. R. P. Scott, and others: Science in Educational Organisation. Chairman: Rt. Hon. Arthur Greenwood.