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The Social Influence of Science.

SOME controversy has taken place lately as to the part played by science in promoting social progress, and an American book appeared in the autumn specially contesting any such claim. The argument is difficult to follow. To those who take a broad view of history it seems obvious that the growing stability of societies, the wider organisation of all kinds of human activities, the quicker transport and closer communication between nations, are all due mainly to the spread of science. To those who look critically at details it seems doubtful whether our societies are really stable, whether life is now happier or nobler than it was in less scientific days, whether the evils and destruction wrought by modern instruments do not outweigh the undoubted advantages that science has brought.

Our judgment in this great debate will be dictated largely by our temperament. The critical, the melancholy, the disappointed will be inclined to think that the rush, the complexity, the vastness of the modern world have brought more evils than they have removed. The young and vigorous, those who enjoy life and hope for its continuance, will take another view, and these, with the improvement in health which still goes on and the increase in prosperity which was continuous until the war, form a large normal majority. The current depression of spirits, which is not perhaps so widespread as is commonly supposed, is due partly to a reaction against the exaggerated optimism of the Victorian age, partly to the troubles due to the war. It ought to be possible to put aside these disturbing influences and take a broad calm view of social progress. In any such survey the influence of science in recent centuries is necessarily a leading feature.

Now the first condition of such a review is to make it wide enough. The processes of life develop by minute changes, and when a violent change does occur, it has to be readjusted and equilibrium set up again by counterbalancing changes. Hence it would be a gross distortion of the truth to judge—and condemn—the industrial revolution by comparing peaceful rural England with the horrors of the early years of the factory system. The latter were new and unforeseen facts which called for special remedial measures. It is equally absurd at the present day to declare modern civilisation bankrupt because the German financial system has broken down and no one has yet seen how to re-establish international trade and credit. These things are momentary, unexpected shocks: the world has passed through far worse storms in its time and we shall weather the less as we have the greater. A sound judgment can be based only on a wide view, and in a matter so vast as social progress affected by science, the view should be as extensive as the subject itself.

People have lately been using the term "science" in a looser and more comprehensive sense than heretofore. Its roots might be found in the practical skill, the mother-wit and sharp senses of the primitive savage. In any case the beginnings may be seen in the settled communities of the great river-valleys, in Egypt, Babylonia, the Yangtze, as well as in Mexico and Crete. Can one doubt that the science involved in the drawing up of the first calendars by the priests of Egypt and in the marvellous structure of the pyramids was a factor of the first importance in preserving the social order and cohesion of those early theocracies, the first great permanent aggregations of mankind upon the planet? The power of prediction involved in science, and first exemplified in the making of the calendar, was intimately bound up with the power of securing obedience, and the acceptance of their lot by the millions who worshipped the Pharaoh.

The Greeks were, of course, the founders of science in the stricter sense, which seeks the law of change, the principle of unity in the manifold; and it might be thought that the constant disunion of ancient Greece disproved the social or unifying effect of science. But this would be to take a narrow and short-sighted view. Greek science had from the first a strong social value. It formed a link between the early philosophers in the Ionian cities of its birth, and in the case of the Pythagoreans it was the basis of a brotherhood which aimed as much, or more, at social reformation than it did at increasing the scope of abstract thought. In fact all the early Greek philosophers were also interested in social and political problems. They saw that true wisdom was a practical thing, fit to inspire, as Anaxagoras said, "a calm religion free from fear."

But the chief moral and social effect of Greek science came later, first, when Hellenism was spread over the Middle East by the arms of Alexander, secondly, when, in the Greco-Roman world, Greek science and Roman law combined to lay the foundation for the medieval and modern world. The younger Pliny, when proconsul in Asia Minor under Trajan, gives an interesting illustration. He points to the effect of astronomy in allaying the fears and composing the minds of the mass of the people.

In estimating the social influence of science, however, the mind turns naturally to its greatest expansion in the last few centuries. When in the sixteenth century the mind of Ancient Greece awoke again and men began to seek in Nature herself for the answer to the problems of life, there were two new factors in the world which affected the results of their inquiries. One was the discovery of new lands, the expansion of the West. The other was the decay of slavery, the recognition of manual and mechanical work as a worthy occupation of good brains. This the Greeks had never recognised, and their failure limited the application of science to industry in ancient times. But with the advent of a New World and a new spirit in industry, from the sixteenth century onwards, the transformation of society by science went on apace. From the middle of the eighteenth century it has become apparent as the dominating force in the world.

Hence the question of the intrinsic value and the social influence of science is primarily a discussion of the effects of the Industrial Revolution in which we still live. The fact that we are living in it now and making it more complete every moment, adds enormously to the difficulty of valuation. It is a part of ourselves and influences almost every act and thought, and therefore to deplore and condemn the tendency, or to wish it away as Ruskin did, is futile in practice and pessimistic in philosophy.

Two or three main points stand out clear in the contemporary picture. They are, in the first place, facts with which the student of social life has to concern himself to understand the movement; and, in the second place, guides to action, indicating the line which those must take who are pressing for the stability and betterment of society.

The world is one in a new—if you will, an artificial—sense, due to the application of science to transport and communications of all kinds. This process is being accelerated by every possible means and is pre-eminently a social one. It must find its issue in complete international trade and a really comprehensive League of Nations, acting as the organ of common interests and opinion. It is most important to remember that the League of Nations, which we already possess, is the fruit of the historical evolution due to science and was only precipitated and not caused by the war. The unification of the whole world is only the result on a large scale of a process which has knit up every particular society in a closer organisation than before. Science, being itself a social product, due to the intercourse of active minds, finds its expression in a social organisation impossible without the application of science. This is seen not only in the organisation of industry but also in every activity of the community from the government downwards. All are closer and more complicated, just in proportion to the extent that the given society has created, imbibed, and applied the results of scientific thinking. Expressed briefly and broadly, but with perfect truth, humanity is the counterpart of science, the practical obverse of the abstract reverse of thought.

To make this process more effective by conscious effort is therefore the supreme task of those concerned in social progress at the present time. The growth has hitherto been mainly automatic. We have to understand it, grasp it, and turn it to the still greater good of mankind. Science having made the modern world, with all its strength and its weaknesses, let men of science inspire a social will into the whole community, to use this master-instrument for its highest end, the salvation and elevation of the humanity to which it belongs.

F. S. MARVIN.

Phantasms of the Living.

Proceedings of the Society for Psychical Research. Vol. 33, Part 86, October. (London: F. Edwards; Glasgow: MacLehose, Jackson and Co., 1922.) 16*s*. 6*d*. net.

A BOOK entitled "Phantasms of the Living," by Edmund Gurney, F. W. H. Myers, and Frank Podmore, was published in 1886. Under this title were included all experiences where there was reason to suppose that the mind of one living person had affected the mind of another otherwise than through the recognised channels of sense. The chief aim of this book was to produce a cumulative quasi-statistical proof of telepathy.

In the thirty-six years which have elapsed since the publication of this book the Society for Psychical Research has received and published in its Journal many accounts of happenings similar to those recorded by Gurney, and in its Proceedings of October last Mrs. Henry Sidgwick has submitted the best of these cases to a careful examination and analysis.

While Gurney and his collaborators were chiefly concerned to prove telepathy to be a fact of Nature, Mrs. Sidgwick thinks we have arrived at a stage when, if our knowledge of telepathy is to grow, we must seek light on its process and the conditions under which evidence of it can be obtained. She says: "We may now, for the sake of argument at least, assume that Gurney's book has accomplished its object, and that telepathy is proved, and starting from that point may devote ourselves primarily to seeking for light on the occasions and mode of its operation." Mrs. Sidgwick does not mean to imply that telepathy is yet accepted by the scientific world; but she thinks something more than the mere piling up of facts is required, and that "our facts will be the more readily accepted, the more we can compare them, and, provisionally assuming telepathy, show when and how it occurs."

Many of the best cases received by the Society during the past thirty-six years have already been published in various works on psychical research, and fifty-four have appeared in the Proceedings of the Society for Psychical Research. All these, being therefore already before the public, are excluded from this collection. The cases included have appeared only in the Journal of the Society, which is printed for private circulation among members. The value of the present collection is considerably diminished by the exclusion of so many cases which were of course selected for earlier publication, because they were regarded as being specially important or interesting. Even without these, however, we have here some two hundred cases, many of which are important as affording evidence that telepathy does occur, and all of which help to throw some light on the occasions and mode of its operations.

The broad lines of classification adopted in the description of telepathic phenomena may be gathered from the headings of the four chapters into which Mrs. Sidgwick's volume is divided: (1) Experimental and semi-experimental cases; (2) Spontaneous cases in which the percipient's impression is not externalised; (3) Spontaneous cases in which the percipient's impression is externalised as a waking hallucination; also dreams of the same character; (4) Collective and reciprocal cases without evidence of any agency external to the percipient.

In all modern records of telepathic experiences the person whose mind receives the impression is called the percipient, and the person from whose mind the impression comes is called the agent; but it would appear from the evidence that the percipient is very often the "active" party, and that the so-called agent plays a purely passive part. This is seen in the semi-experimental cases in which a percipient is trying to get an impression from another person who is quite unaware that any such attempt is being made. In experimental cases, properly so-called, the agent is deliberately trying to impress telepathically a particular percipient, and that percipient is deliberately trying to receive an impression. It is doubtful, however, what part, if any, the concentrated effort of the agent plays in the success of such experiments.

The experimental and semi-experimental cases recorded in this collection can scarcely be regarded as representative of the group because of the number excluded, owing to their having been already published; but even had these been included there would still have been occasion for Mrs. Sidgwick's comment that "more experiments carefully conducted and well recorded are greatly needed."

Of spontaneous cases in which the percipient's impression is not externalised as a hallucination, Mrs. Sidgwick says: "As a whole the class is not a strong one as evidence of telepathy," because the triviality or vagueness of the impression in many cases makes tricks of memory very likely to occur. Of more importance as providing evidence of the occurrence of telepathy are the spontaneous cases in which the percipient's impression is externalised as a waking hallucination. The first case recorded under this heading (p. 152) is one of the most striking in the whole collection. It is one of the many cases of "death coincidences" which form an important part of the evidence for telepathy. (Apparitions or other hallucinatory experiences occurring within twelve hours of the death, before or after it, are classed as phantasms of the living.) The apparition in this case was that of an officer of the Royal Air Force, who was killed in a flying accident on December 7, 1918, and the percipient was a fellow-officer who spoke of his experience to another person before it was realised that it was not the living man who had appeared.

Another interesting case in this section is a dream experience, first recorded in the *Times* of July 21, 1904, by Mr. Rider Haggard, the percipient (p. 219). The dream was to the effect that a favourite retriever dog was lying on its side among brushwood, or rough growth of some sort, by water. The recorder says: "In my vision the dog was trying to speak to me in words, and, failing, transmitted to my mind in an undefined fashion the knowledge that he was dying." Investigation showed that the dog had been killed by a passing train, and had fallen into a stream where reeds grew, at or about the time of the dream experience. The case is well authenticated, and all the circumstances point to the improbability that "mere coincidence" is the true explanation. Another striking case is one reported by Sir George Beilby (p. 243), in which a percipient had a visual hallucination of her brother in Australia at a time when he had fallen into unconsciousness which lasted until his death some days later.

"Collective and reciprocal cases" are dealt with by Mrs. Sidgwick in her final chapter. These are cases in which "two or more persons have at the same time spontaneous psychical experiences—either hallucinations or dreams—which seem to be related to one another, but where no evidence of any agency outside the two percipients exists." When the percipients were in the same room we must consider the possibility that one percipient may have influenced the other through the senses (suggestion), but where the percipients were in different rooms or in different houses, the relation of the one hallucinatory or dream experience to the other can scarcely be accounted for in this way. Here either chance or telepathy must be invoked.

In concluding her examination of this collection of phantasms of the living, Mrs. Sidgwick describes two cases of reciprocal dreams, in both of which the dreamers were in separate houses, and in both of which the reciprocality seems to have been very complete. Reciprocal cases are rare, and the small number recorded hitherto has raised some doubts as to the genuineness of the type; but Mrs. Sidgwick thinks they are very important as throwing light on the whole process of telepathic communication. She says: "I think the kind of union of minds, the thinking and feeling together, here shown, may be regarded as the type or norm of telepathic communication to which all other cases conform in varying degrees." This implies a merging together of minds, a "transfusion" of thought rather than a transmission or transference. We have the physical analogy of "contact" in place of "transmission-through-space."

It can scarcely be maintained that the cases here passed in review afford by themselves very strong proof of the occurrence of telepathy, but taken in conjunction with the body of evidence brought forward by Gurney, and the many well-attested cases published in the Proceedings of the Society for Psychical Research and elsewhere, they help to strengthen the conviction, to which many competent observers have been forced, that these accounts of apparent action of mind upon mind in the absence of any physical medium of communication, bring to our notice some fact of Nature which students of science can no longer ignore.

The most obvious, and perhaps the most serious defect in the evidence for telepathy afforded by these cases is the long interval which so frequently elapsed between the experience and the recording of it. In only 11 out of 191 tabulated cases was the record made on the day of the experience, and 4 of these were semi-experimental cases, in which one might have supposed immediate record to have been a necessary part of the experiment. In 15 instances the record was made "next day." In most of the cases the interval extended for months or years, but all cases in which it exceeded five years are omitted from this collection.

After all that has been written about the importance of immediate record and attestation of any presumably super-normal experience, it is astonishing that those who are subject to such experiences should so often neglect this elementary rule. T. W. MITCHELL.

The Synthetic Colour Industry.

The Manufacture of Dyes. By Dr. John Cannell Cain. Pp. ix+274. (London: Macmillan and Co., Ltd., 1922.) 12*s*. 6*d*. net.

THE author of this treatise, which is published posthumously, was one of a small band of British chemists, who long before the war placed their services at the disposal of the home industry in synthetic dyes. But, largely owing to lack of appreciation of the value of scientific knowledge on the part of manufacturers, the result in almost all cases was disillusionment and disappointment, so that this group of trained investigators, including Dr. Cain, were compelled by force of adverse circumstances to transfer their activities to other branches of chemical enterprise. In 1915, however, the Government became aware somewhat tardily of our national deficiencies in regard to the manufacture of dyewares, and Dr. Cain was appointed a member of the technical committee of British Dyes, Limited, afterwards holding the position of chief chemist in the newly erected Dalton works of this firm. His experiences in these two phases of the English colour trade, extending over twenty-five years, are embodied in the manual under review.

It is obvious that in a handbook of some 260 pages all the important colouring matters cannot be included, and among the notable omissions are such well-known synthetic dyes as the Hessian purples, formyl violet, rhodamine S, the acridine yellows, and the first representatives of the anthraquinone vat dyes, namely, indanthrene blue and yellow. Nevertheless, a judicious and typical selection has been made, and the author has given full working details wherever he has possessed first-hand practical knowledge of the factory operations.

This impress of realism is especially noticeable in the informative chapters on azo and triphenylmethane dyes; for in both these branches of colour production Dr. Cain ranked as an expert. As, however, this work will be read by students, it is perhaps permissible to point out that the somewhat unnecessary rubrics at the beginnings of the chapters on monoazo and disazo dyes do not tally with the arrangement adopted in the text. Fast red B contains two naphthalene nuclei, although classed as a mixed benzene-naphthalene dye, and diamond black F, placed in the purely naphthalenoid section, contains a benzene nucleus, and there are several other similar discrepancies in classification. In a future edition these headings might with advantage be omitted.

In spite of the apathy prevailing before the war in this branch of chemical industry, British chemists had developed a sound technique in the manufacture of certain standard dyes such as magentas, aniline blues, and safranines. The manual contains useful information in regard to these intricate preparations. On the theoretical side it will be noticed that the author has not adopted the prevailing view that the oxazines, thiazines, and azines are ortho-quinonoid derivatives. The future may show that this conservatism is well grounded.

The two closing sections of the book present a marked contrast. The penultimate chapter on anthraquinone and allied colours is, with two exceptions, already noted, detailed and comprehensive; the last chapter on indigoid colours is an unfinished fragment constituting a sad reminder of the sudden and premature close of an active life devoted to the theory and practice of colour chemistry.

To the student of organic chemistry this work offers a concise introduction to the fascinating though complex subject of synthetic dyes. To the expert colour-maker or user it supplies a full bibliography with copious references and an adequate index. Both classes of readers will find the book to be an excellent supplement to the author's earlier volume on the manufacture of intermediates.

G. T. M.

Rea's "British Basidiomycetæ."

British Basidiomycetæ: A Handbook to the larger British Fungi. By Carleton Rea. (Published under the auspices of the British Mycological Society.) Pp. xii+799. (Cambridge: At the University Press, 1922.) 30*s*. net.

EVERY mycologist will welcome the appearance of this volume, which is issued under the auspices of the British Mycological Society and represents thirty years of careful and continuous field-work on the part of its author. The author, whose skill in distinguishing our fleshy agarics one from another has been freely placed at the disposal of so many students of fungi in this country, is to be congratulated heartily upon having crowned his life's labours with the publication of a work at once so comprehensive and so valuable for reference.

Massee's "British Fungus-Flora" appeared in the years 1892–1895. In the interval some hundreds of Basidiomycetæ, either new or new to Britain, have been discovered in this country—many of them by Mr. Rea himself—and descriptions of all these species are included in the present volume. In accuracy of description the book is an immense advance on anything previously produced in Britain.

There are a number of commendable features in the work: (1) Every species is numbered, Rea's last number being 2546; (2) the species actually seen are indicated by the letters *v.v.* (*vidi vivum*); (3) in the description of species the essential characters are placed in italics; and (4) the derivation and meaning of the name of each genus and species is given, philology thus illuminating mycology.

The classification adopted is based chiefly on the well-considered system set forth by Patouillard in his

"Essai taxonomique" (1900), and it therefore differs in many important features from that of Massee, which was based on the work of Fries. It is new to British mycologists, and will doubtless puzzle somewhat many of the older workers; but it represents an important attempt to incorporate in a systematic treatise the anatomical and microscopical data which various investigators have brought to light during the last half-century.

In the classification adopted by Fries, Berkeley, Massee, and others, the main divisions of the Agaricineæ were based on spore-colour. We were thus at the outset provided with Leucosporæ, Rhodosporæ, Ochrosporæ, Porphyosporæ, and Melanosporæ; but in the present volume these groups have disappeared and spore-colour has become a character of relatively minor importance. In Rea's classification, the Agaricales are divided into (1) the Agaricineæ, containing the bulk of the lamellate fungi in one sub-order Agaricaceæ; (2) the Cantharellineæ; and (3) the Boletineæ, the last named including Paxillus and Boletus. The divisions of the Agaricaceæ are based first on the nature of the receptacle, then on the presence or absence of a ring, etc.; and it is only the final distinctions, separating the genera from one another, which for the most part are based on spore-colour. No doubt this new classification has its advantages; but some of its defects are sufficiently obvious. Thus, while Anellaria differs from Panæolus in little more than the possession of a membranous, often fugacious, ring, we find that Anellaria is placed close to Lepiota and Panæolus close to Collybia. For Fries, the genus Panæolus included the species subsequently placed by Karsten in Anellaria. The reviewer cannot but feel with Fries that the species of Panæolus and Anellaria are closely related to one another and that these genera should not be so widely separated.

The writer is inclined to doubt whether spore-colour is only of such minor importance as is now supposed. There is every reason to believe that the genus Coprinus, with its parallel- or subparallel-sided gills and the ripening and discharge of its spores from below upwards on each gill, followed by autodigestion of the gills from below upwards, is monophyletic. Now the spores in this genus are all black or blackish fuscous. In it there are no species with white spores or spores that are pink, purple, ochraceous, or ferruginous. Yet in the genus there are species with rings, *e.g. Coprinus comatus*, and without rings, *e.g. C. picaceus*; species with fairly thick flesh, *e.g. C. atramentarius*, and species with membranous flesh, *e.g. C. plicatilis*; species with dimorphic basidia and species with quadrimorphic basidia; species with large and numerous cystidia and species without cystidia; species which live exclusively on dung and species which live exclusively on wood, etc.; yet, while the genus Coprinus was evolving, the colour of its spores remained constant. It is evident that, in the genus Coprinus, spore-colour is a more fundamental character than ring-formation. If this is so with Coprinus, it may well be the same with other genera of Agaricineæ. Rea's system of classification, although in some of its details it does not satisfy the writer, has the advantage that it will stir up thought and thus make for further progress.

"British Basidiomycetæ" is distinctly Mr. Rea's own book; and, in writing it, he has adopted as regards species a somewhat conservative and independent attitude. Thus he includes descriptions of certain species which are now known to be identical with others —*e.g. Coprinus oblectus*, which is undoubtedly identical with *C. sterquilinus*, and *Coprinus radians*, which is generally considered as identical with *C. domesticus*. His independence is further shown by the fact that in certain groups he has adopted his own views rather than those of his fellow-workers in this country. Thus, in treating of the Clavariæ, he has not followed entirely the revision of the British Clavariæ as given by Cotton; while, in some instances, in treating of the Thelephoreæ, he has accepted American views rather than those of Miss Wakefield.

The volume is indispensable to all students of fungi on both sides of the Atlantic; for it is only by a clear understanding of the first-described European species that New World plants can be correctly named. The task of describing two thousand five hundred Basidiomycetæ is no mean one; and botanists generally, as well as mycologists, are under a deep debt of gratitude to Rea, not merely for having accomplished it, but for having accomplished it so well.

A. H. REGINALD BULLER.

An Index to Periodical Literature.

(1) *The Subject Index to Periodicals.* Issued by the Library Association. K: Science and Technology. Pp. 555. (London: Library Association, Stapley House, 1922.) 35*s*. net.

(2) *The Subject Index to Periodicals, 1920.* Issued by the Library Association. A: Theology and Philosophy (including Folk-Lore). Pp. 98. (London: Library Association, Stapley House, 1922.) 6*s*. net.

WE congratulate the Library Association on this welcome addition (1) to the valuable subject indexes to periodicals which it has already published. The present index contains the titles of 15,000 papers, published during the years 1917–19, obtained from the examination of 400 periodicals. It would appear that more than half the papers indexed are in the English language, having been published in the British Empire or in the United States. The language next in evidence is French.

The period covered—the second half of the war and the following year—was not very fruitful in scientific research, except in regard to subjects bearing upon the great conflict, but it is clear, both from the number of entries and from the number of journals consulted, that the index does not claim to be a complete record of all scientific and technical papers published during that period, but that a selection has been made. It would add to the value of these publications if the editors could see their way to include a list of the periodicals indexed in each section of these indexes when it is published. The inclusion of the name of a journal in such a list would not, of course, mean that all the papers printed in that journal had been indexed, but the omission of any journal from the list would definitely warn the reader that no papers in that journal had been included, and thus leave him to look up that journal if he thought it likely to contain papers on the subject of his study. It would also save the reader who wished to make a more exhaustive study of any subject from referring to journals which had been already examined. This is the plan followed in the lists of journals at the end of each volume of the "International Catalogue of Scientific Literature." In the present case, a list of the titles of the 400 journals examined would probably take up no more than three or four pages.

The usefulness of these indexes depends entirely upon a wise choice of the headings under which the titles are grouped. It may be assumed that the Library Association is partly guided in its choice of headings by experience of the inquiries made by readers asking for books.

The various headings are not arranged in any systematic way, and are not even divided according to the several sciences, but they follow one another in alphabetical order. The difficulty of this plan is that, when using such an index, it is not always possible to guess what heading will be chosen for a particular subject. This difficulty is, to a great extent, overcome in these subject indexes of the Library Association by the addition of numerous cross-references. Thus, under the heading "Refrigeration" we find a cross-reference to "Cooling Gases" indexed under "C." We might, however, not be so fortunate had we begun by looking up the subject of cooling gases under the heading "Gas." No doubt, the majority of those who use these indexes find a simple alphabetical arrangement of subjects more easy to understand than any systematic plan, and for that reason its use is justified.

In the preparation of this Index special attention has been paid to applied science and technology. Among headings which have a large number of entries of titles of papers are aeronautics; alloys; artillery; automobiles; coal; electric apparatus, power, heating and lighting; electroplating; fish and fishing; gas and oil engines; glass; iron; metals; mines; petroleum; photography; ships and shipbuilding; soils; wireless signalling.

(2) We are glad to find that the Library Association is continuing the publication of these subject indexes in other departments. Thus it has just issued a subject index for theology and philosophy (including folklore), indexing the literature of these subjects published in 1920, and occupying about ninety-six pages. This index contains titles of papers on psychology and psycho-analysis, as well as on philosophy and religion, and will therefore be of use to students of these subjects.

Our Bookshelf.

(1) *Boiler Plant Testing: a Criticism of the Present Boiler Testing Codes and Suggestions for an Improved International Code.* By D. Brownlie. Pp. xi+168. (London: Chapman and Hall, Ltd., 1922.) 10*s.* 6*d.* net.

(2) *Steam Power Plant Auxiliaries and Accessories.* By Terrell Croft. Pp. xv+447. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 15*s.* net.

(1) MR. BROWNLIE has done great service in recent years in directing attention to uneconomical methods of steam production, and he has backed his criticisms by copious results of tests. The present volume contains an appeal for more rational methods of boiler testing, and criticises several existing codes, including that of the Institution of Civil Engineers. "A general impression also, on reading through the 'Civils'' code, is that boiler plant testing is an extremely complicated and difficult operation, which involves a knowledge of chemistry and mathematics quite beyond the ordinary engineer, and can only be carried out by the University graduate." Mr. Brownlie shows that boiler testing must be regarded as a thoroughly practical proposition which is necessary for the strictly utilitarian purpose of saving money. His criticism is constructive in that he gives full directions for carrying out practical tests, and includes a typical set of report sheets, with figures showing the results. The book is a distinct contribution to the subject, and it is to be hoped will lead to an early discussion and revision of the present codes.

(2) Considerable attention has been given recently to the formerly neglected auxiliary appliances connected with steam production. Pumps, feed-water heaters, fuel-economisers, condensers, steam pipes and traps are now taken seriously by the majority of engineers, and this consideration has led to the reduction of wasted heat. The engineer will find a great deal of useful information in this volume, which is of the nature of a joint effort on the part of a number of concerns and individuals. The matter included is not only serviceable for the purposes of the design and

arrangement of auxiliaries, but also conveys much useful information regarding their working and maintenance in practice. The subject is treated very thoroughly, and contains much that could only be found otherwise by searching through periodicals and the transactions of engineering societies.

Heat. By W. J. R. Calvert. Pp. viii + 336. (London: Edward Arnold and Co., 1922.) 6*s.*

IT is sometimes difficult to justify the publication of a new text-book on a branch of elementary science, but Mr. Calvert has been so successful in presenting the subject of heat in an attractive and yet scientific manner that his book deserves a special word of commendation. The first part is intended to cover the ground of a general school education, and the second part brings the work up to University scholarship standard. The author realises that the majority of those who begin the subject will have little or no interest in experimental determinations unless it is made clear to them, at the outset, that objectives which appear to them reasonable cannot be reached without dealing with such measurements. He quotes with approval an appropriate sentence from one of J. B. Biot's works—"Toutes ces choses ne peuvent se déterminer sûrement que par des mesures précises que nous chercherons plus tard; mais auparavant il fallait au moins sentir le besoin de les chercher."

While practical applications have been emphasised, attention has been kept fixed upon the underlying principles. In all the experimental work the degree of accuracy likely to be attained has been carefully considered. In this connexion mention may be made of the details and dimensions which have been given in the case of many experiments of the laboratory or lecture type. We think the author is to be congratulated on having had the courage, even in so elementary a book, to give references to original papers. The few readers who look them up will gain a great deal, and even those who do not will at least be able to use the dates to get some idea of the chronological development of the subject. The book is the work of a teacher who has given much thought to the treatment of a familiar subject, and the result of his labours forms a valuable addition to the elementary literature of an important branch of physics.

(1) *Guide to the University Botanic Garden, Cambridge.* By H. Gilbert-Carter. Pp. xvi + 117 + 24 plates. (Cambridge: At the University Press, 1922.) 3*s.* 6*d.* net.

(2) *An Alpine A B C and List of Easy Rock Plants.* Arranged by A. Methuen. Pp. x + 35. (London: Methuen and Co. Ltd., 1922.) 1*s.* 6*d.* net.

(1) IN this attractive little handbook is a systematically arranged account of a number of the more interesting flowering plants which are cultivated in the University of Cambridge Botanic Garden, which should be of service to students in the Botany School of the University. The sequence is the familiar modern German one, and under each family is a short description of some of the genera and species which are regarded as specially worthy of mention. The plates, which are good full-page photographic reproductions, add to the value and attractiveness of the book. A clear plan of the garden indicating the larger plants with page-references to the trees, and an index of the genera and species mentioned in the book, enables the student to make full use of it. In deference to the oriental scholars who have loved and befriended the garden, the author has included the eastern names of some of the plants, with quotations illustrating the use of these names. A historical note gives the date of the foundation of the Cambridge Garden as 1762, and in 1831 the removal to the present site was authorised.

(2) Mr. Methuen's notes are for the beginner and the amateur. Their purpose is to give a list of the most attractive and the most easily grown Alpine flowers and to guide in their placing and cultivation. A few general rules are given for making a rock garden and planting and tending Alpines. The greater part of the book is an alphabetical list of the species recommended, with indication of the colour of the flower and very brief notes on cultivation. The book is the outcome of the compiler's own experience and conveys a good deal of useful information in a very small space.

The Origin and Development of the Nervous System: from a Physiological Viewpoint. By Prof. C. M. Child. (The University of Chicago Science Series.) Pp. xvii + 296. (Chicago: The University of Chicago Press; London: The Cambridge University Press, 1921.) Price 1.75 dollars net.

IN the preface to his book, Prof. Manning Child points out that, considered from a physiological viewpoint, the origin of the nervous system must be sought in conditions present before the appearance of a morphological nervous structure. In accordance with this, the earlier chapters are devoted to a discussion of the origin and nature of the pattern which constitutes the organism as a whole, and to a consideration of the experimental investigation of some of the physiological conditions which antedate the appearance of the nervous system. A brief summary is given of the evidence for the existence of physiological axial gradients—*i.e.* graded differences in the organism in the rate of the fundamental activities of protoplasm and in the conditions associated with these activities—as the essential factors in the organismic pattern. An attempt is made to show that the nervous system is the physiological and morphological expression of the excitation-transmission relations, first with respect to the primary physiological gradients, and later with respect to the progressive developmental complications as they arise.

Prof. Child admits that with many of his points only suggestion, inference, or weighing of probability is at present possible. For this reason, and on account of the necessary technical detail, the book is more suitable for the biologist and physiologist than, as suggested in the note on the University of Chicago Science Series, to which this volume belongs, for the educated layman.

The Life of the Weevil. By J. Henri Fabre. Translated by Alexander Teixeira de Mattos. Pp. viii + 278. (London: Hodder and Stoughton, Ltd., 1922.) 8*s.* 6*d.* net.

GATHERED together in this volume are the various essays on weevils contained in the "Souvenirs entomologiques" of Fabre. Chapters i. and vi.-ix. have already appeared wholly or in part in a previous translation, as have also chapter v. and parts of chapters vi.

and xii. They are, however, retranslated by permission of the publishers for the purpose of the present collected edition of English translations of Fabre's entomological writings. There is no doubt that the rendering of the latter into English will do something towards arousing interest in the phenomena of insect behaviour. We may even be permitted to express the pious hope that it will tempt the collector to turn aside from the mere acquisition of specimens and to observe the living more than the dead insect. The great family of the Curculionidæ, with more than 20,000 described species of weevils, provides a rich store of material for observation. Some of the most interesting features in the life-habits of these insects are discussed in the pages before us. Although lacking in the dramatic incidents so inseparably associated with the Hymenoptera, the behaviour of weevils as told of Fabre, and reproduced in this translation, will provide entertainment both to the general reader and the entomologist. A. D. I.

Modern Microscopy: a Handbook for Beginners and Students. By M. I. Cross and Martin J. Cole. Fifth edition, revised and rearranged by Herbert F. Angus. Pp. x+315. (London: Baillière, Tindall and Cox, 1922.) 10*s.* 6*d.* net.

THAT there has been a call for a fifth edition of this book we can well understand, as it gives an excellent introduction to all branches of microscopy. In the opening chapters the mechanics and optics of the microscope are described, and instructions are given on the general method of using the instrument, illumination, drawing and measuring apparatus, and for tests of the optical system.

In the second portion of the book, chapters written by specialists in their respective subjects deal with various aspects of microscopy. Thus, Mr. Barnard and Drs. Cooke and Drew describe the use of the microscope in medicine, including dark ground illumination; histology is dealt with by Mr. Cole, including hardening and embedding tissues and section cutting; and Prof. Cheshire writes on the microscope in geology and discusses simply and clearly the polarisation of light. Another interesting chapter is that by Mr. Cutler on the microscope in agriculture, particularly the protozoa of the soil. Pond life, foraminifera, mycetozoa, mosses and liverworts are some of the other subjects dealt with, and a final chapter by Mr. Cole describes the preparation and mounting of common objects. A useful glossary of technical terms is included, together with details of the Royal Microscopical Society's standards, the specifications of the British Science Guild, and microscopical societies and clubs. The book is very readable and well illustrated, and the information contained in it is accurate and up-to-date.

The Wirral Peninsula: an Outline Regional Survey. By W. Hewitt. Pp. x+293. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1922.) 7*s.* 6*d.* net.

MR. HEWITT has selected a small and well-defined area, and in successive chapters has considered its physical, biological, and human aspects, in an endeavour to explain the geographical evolution of the area. The social and economic conditions of any region must necessarily depend to a large extent on its position, natural features, soil, climate, and vegetation. Wirral is only some 130 square miles in extent and until the middle of the nineteenth century was almost entirely agricultural. But the rapid increase of manufacturing industries across the Mersey and growing commercial importance of the Mersey estuary have resulted in an industrial invasion of the left bank of the river. Industries promise to show a steady increase in importance. Agriculture will probably retain its hold, but considerable changes in methods and conditions are taking place. The social evolution which Wirral is now undergoing can be adequately understood only by a study of its regional geography in the light of the past.

The volume is an example of the growing attention that is being paid to regional survey, and is a welcome addition to the small number of studies of this kind which have been prepared in this country. We gather that the author regards it as a preliminary sketch, and that a fuller survey is in course of preparation.

An Experiment in Synthetic Education. By Emily C. Wilson. With Chart for Five Years' Work. Pp. 62. (London: George Allen and Unwin, Ltd., 1921.) 4*s.* 6*d.* net.

MORE than one hundred years ago, Herbart sketched out his ideal system of education, which was to utilise all knowledge for the formation of character. For this purpose the knowledge was to be presented as a unity instead of in the usual way which drew a hard and fast line between each subject. Since his day the specialisation of knowledge has increased so much that the problem, difficult though it was then, is infinitely more difficult now; the intelligent teacher who would put his children into touch with all aspects of modern knowledge, while yet giving the requisite historical background for the understanding of that knowledge, is faced with difficulties at every stage.

This little book shows how one school attempted to deal with the problem. Each subject for convenience demands a name standing for particular aspects of knowledge, but it should be treated in relation to the other subjects. A chart giving details of a five years' scheme is appended. It is an interesting and suggestive experiment.

Leçons sur les Invariants Intégraux: Cours professé à la Faculté des Sciences de Paris. Par Prof. E. Cartan. Pp. x+210. (Paris: A. Hermann et Fils, 1922.) 20 francs.

AN account of Poincaré's theory of integral invariants with special reference to analytical dynamics is given in the volume under notice. It opens with Hamilton's principle of least action and contains detailed discussions of such questions as differential systems admitting infinitesimal transformations. There are also chapters on the application of Poincaré's theory to the problem of *n* bodies and to Fermat's principle in optics. Much matter collected here can only be found scattered elsewhere in scientific journals.

Rayonnement et gravitation. Par Félix Michaud. Pp. viii+62. (Paris: Gauthier-Villars et Cie, 1922.) 6 francs.

AN attempt which does not go into details to trace all physical phenomena back to radiation, gravitation for example being ascribed to ultra X-rays.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Element of Atomic Number 72.

DANS le numéro du 20 janvier 1923 de NATURE, MM. Coster et Hevesy annoncent qu'ils ont obtenu le spectre de haute fréquence de l'élément de nombre atomique 72.

Ce résultat très important marque un progrès dans la question que nous avons ouverte (A. Dauvillier, *Comptes rendus*, t. 174, p. 1347, mai 1922 ; G. Urbain, *Comptes rendus*, t. 174, p. 1349) ; il est seulement regrettable que MM. Coster et Hevesy se soient efforcé de jeter le discrédit sur nos propres résultats.

Il nous paraît d'abord nécessaire de préciser les faits :

Deux raies [1] de haute fréquence caractéristiques de l'élément 72 ont été observées avec les oxydes provenant des queues de fractionnement des nitrates du groupe ytterbique, c'est-à-dire dans les mêmes oxydes où l'un de nous, il y a douze ans (G. Urbain, *Comptes rendus*, t. 152, p. 141, 1911) avait observé des raies d'arc qui, n'étant attribuables à aucun élément connu, ont été considérées comme appartenant à un élément nouveau, le Celtium.

De leur côté, MM. Coster et Hevesy ont observé dans des produits zirconifères d'origine norwégienne six raies de haute fréquence caractéristiques de l'élément 72.

Ce résultat a été immédiatement contrôlé par l'un de nous avec un échantillon de zircone. Les raies attribuables à l'élément 72 coïncident exactement [2] avec celles observées avec les terres ytterbiques, avec cette seule différence que la proportion de l'élément 72 y est notablement plus grande.

Nous concluons de ces faits que MM. Coster et Hevesy sont mal fondés à revendiquer la découverte de l'élément 72 alors que nos publications sont de 8 mois antérieures à la leur, et qu'il s'agit bien du même élément.

Les clichés que nous possédons n'ont pu être reproduits et publiés à cause de la faiblesse des raies, mais nous les tenons à la disposition de MM. Coster et Hevesy qui pourront les examiner de concert avec nous au laboratoire de M. de Broglie où ils ont été obtenus.

Eu égard aux considérations théoriques qui forment la base de l'argumentation de MM. Coster et Hevesy il nous suffira de dire :

1°. Dans sa première note de 1911, Urbain a pensé pouvoir s'appuyer sur des variations de propriétés magnétiques et chimiques pour attribuer au celtium des propriétés intermédiaires de celles du lutécium et du scandium. Les faits observés depuis imposent de faire des réserves sur cette question d'interprétation, d'ailleurs secondaire au point de vue qui nous occupe.

2°. L'examen du spectre de haute fréquence dans les produits celtifères a précisément eu pour but de rechercher si cet élément pouvait être identifié à l'élément 72. Il eût été dès lors singulier après avoir observé ce spectre de haute fréquence de ne pas l'attribuer au celtium. Mais quand bien même le spectre d'arc et le spectre de haute fréquence en question ne seraient pas attribuables au même élément, comme nous l'avons logiquement admis, il n'en resterait pas moins vrai que nous avons découvert les premiers l'élément 72. En conséquence MM. Coster et Hevesy n'avaient pas le droit de lui donner un nom nouveau.

3°. MM. Coster et Hevesy attribuent à l'élément 72 la valence 4, ce à quoi nous n'avons à faire aucune objection. La question est de savoir si un élément tétravalent peut accompagner les terres rares de manière à se retrouver dans les dernières eaux-mères des fractionnements. Or le cas se présente constamment pour le cérium, à la fois trivalent et tétravalent. Il y a même, entre ces deux états du cérium, un constant équilibre. Le cas se présente encore pour le thorium qui, dans les minerais, accompagne toujours les terres rares trivalentes et dont on retrouve toujours des traces, après traitements, à la queue des fractionnements qui classent les terres rares dans l'ordre de leur solubilité.

De même on retrouve constamment le germanium avec l'arsenic ou le molybdène, l'indium avec le zinc, etc.

On ne saurait donc affirmer, comme l'ont fait MM. Coster et Hevesy, que l'élément 72 ne peut se retrouver dans les dernières eaux-mères des fractionnements des termes ultimes de la série des terres rares si ce n'est pour en conclure que nous n'avons pu observer son spectre là où cet élément ne pouvait se trouver. Un tel raisonnement est évidemment sans valeur et ne présente d'autre intérêt que d'être tendancieux.

G. URBAIN.
A. DAUVILLIER.

Paris, le 27 janvier.

[1] Les autres raies de cet élément coïncident avec des raies du lutécium et du néoytterbium.

[2] Un cliché effectué avec un autre fractionnement de terres ytterbiques, en améliorant les conditions expérimentales (oxydes fortement comprimés et calcinés dans le vide, foyer anticathodique linéaire, etc.), nous avait déjà fourni des lignes plus nettes et plus intenses, mesurables avec plus de précision. Nous trouvions ainsi : $\beta_2=1322{\cdot}8$ et $\alpha_1=1564{\cdot}1$ U.X., chiffres coïncidant avec les valeurs interpolées. La recherche du zirconium, effectuée par le spectre d'arc et le spectre de haute fréquence, a donné un résultat négatif.

Meteorological Nomenclature and Physical Measurements.

WITH concern, not unmixed with amusement, I have read in the issue of NATURE for January 27 the desponding reports about the "Position of the Scientific Worker" on p. 132, and Dr. Mill's playful banter about "Progressive Meteorology" on pp. 107-109. The uninitiated can scarcely fail to regard the latter as deriding some recent meteorological work as regards the choice of appropriate names and units of measurement for the physical quantities involved ; while I have good reason for regarding it as a serious effort to make plain some rough places in the path of future students of meteorology.

By way of illustrating the importance of units let me say that this week-end, by the accident of having to revive past memories of the physics of the atmosphere at a lecture in the University of Birmingham, I have happened upon two generalisations, new to me and perhaps also to other readers of NATURE, which Dr. Mill may regard as important for the comprehension of the general problem. One is that at the level of eight kilometres (all over the world, so far as our limited knowledge extends) normal isobars are also normal isotherms and the temperature is everywhere numerically two-thirds of the pressure. The other is that the range of temperature during the year at a selected locality of the earth's surface, possibly at any locality, is the saturation-adiabatic projection upon the surface of the range of temperature at any level above ground. The language is horrifying in its technicality ; but if the two propositions are true, even for comparatively restricted areas, they present a view of the normal state of the atmosphere which is worth remembering. With the terminology and units which I have employed they are easy to remember. If Dr. Mill will translate them into the vernacular which he favours he will find the statements much more difficult to word.

As to terminology, can any one estimate the debt which meteorology owes and will continue to owe to Bjerknes for the happy inspiration of the name "polar front"? What its real meaning is we have not yet found out; but it is a banner under which knowledge is enlarged. Or can any one say how the fate of Scott's Antarctic expeditions would have been affected if the meaning of "katabatic" had been understood in 1900. The development of the science of meteorology is a strenuous task. I do not suppose that Dr. Mill intended his criticism to be as destructive as uninitiated readers will think it to be. Somehow the picture which his review calls to mind is that of the three jovial huntsmen: "We'en powlert up and down a bit and had a rattling day." There are occasions when there are obvious discontinuities in psychology. Once upon a time, years ago, as college tutor in Cambridge I went down to see the boat-races. Being late, I found the leading boats of the first race already past the winning post, among them one of my own college which I had gone down to cheer. It was a perfect summer's day, and I found the crew in lonely solitude, lolling about in the boat after their labours, in all the attitudes of summer idleness. I went up to them and by way of being cheerful remarked, "You seem to be having a picnic." To my astonishment no one spoke; and presently the man nearest to me grunted, "It's been grim earnest here, Sir." They had been chased all over the course and were too exhausted to stand and too despondent to speak.

I am not yet come to that pass; but I feel in like manner that Dr. Mill in his dignified position has not really appreciated what the stress of meteorological work means. It is only too true that our craft rows its course in continual danger of being bumped by a crew that bases action upon its ignorance of the subject and not upon its knowledge. That is precisely the situation which the National Union of Scientific Workers finds so depressing, and to me, with a full experience of every phase of success and failure in boat-racing, the cheers from the bank to the boat that is pressing us are a reminder that science in this country might be encouraged rather than depressed if the members of its own household would visualise the situation a little more deftly.

I have never supposed that new units and new terminology can be anything but distasteful to the veteran, even to myself. I am not so self-confident as to assume that the ultimate solution will be found in the way that seems to me the most direct. All I ask is that those who criticise should face the problem with a policy. I find it difficult to regard the ordinary British attitude as indicating a policy: it is our income-tax which goes to teach every child in the country the metric system, and every child who learns science is taught at our expense to use the metric system and to "chuck it" as soon as he leaves school. If that is really an educational policy I can find no polite adjective in the dictionary which will describe it.

NAPIER SHAW.

January 30.

The Identity of Geber.

I AM glad to see that Mr. Holmyard (NATURE, vol. 110, p. 573) has also been led to doubt the validity of much of the criticism of the authenticity of the Latin works attributed to Geber. In the recent work of Prof. A. O. von Lippmann "Die Entstehung und Ausbreitung der Alchemie," the destruction of the Latin authorities has passed all bounds of restraint. A treatise which refers to Geber, or gives doctrines resembling his, which could possibly have been written before 1300, the date of the earliest Geber MS., is *pseudographisch*, *untergeschoben*, or the work of *Fälscher*. Important treatises are dismissed in footnotes without discussion as spurious. Geber's fall is bringing down many other authors. In some fairly early authorities there are references to *a* Geber, but in quoting these in other parts of his book, von Lippmann has left out the text containing the name of Geber. In other places, in his quotations, the omission of "et" (=and) is marked by a row of dots, and in giving the *content* of the opinions of other writers, Lippmann's book becomes quite untrustworthy when it reaches the Latin authors.

The discovery of the original MSS. is the final test. Boerhaave ("Elementa chemiæ," 1732, i. p. 15) says that the Arabic works of Geber were translated by Golius, who was professor of oriental languages at Leyden; in Shaw's translation of Boerhaave's book (1741, i. p. 26, note 3) it is stated that Golius presented the MS. of Geber to the Leyden library, translated it into Latin, and published it in the same city, first in folio and afterwards in quarto, under the title "Lapis Philosophorum." In the catalogue of Golius's library I find that there is mention of an Arabic MS. bearing the name of Geber and treating of alchemy, but the few MSS. examined by Berthelot, including MSS. from Leyden, were quite different from the works in Latin. The Leyden MS. may have been lost (as some of the Greek ones at Paris have been).

In the Latin Geber there are long arguments refuting those who deny the possibility of the Great Work. Berthelot says that an Arabic writer of the previously assumed period of Geber (*c.* 750–800 A.D.) would have had no doubts as to this possibility. This is incorrect. Prof. Wiedemann, whose services in this branch of historical research have been extremely valuable, has published MSS. of this period, in which it is said that the failure of alchemists to carry out their work of transmutation had become "proverbial" (Abu Jusuf, d. 798; Aldschaziz, d. 869, who said there was no alchemy; Alkindi, d. 873, who said all alchemists were liars). This argument, therefore, falls to the ground.

The logical arguments are, said Berthelot, reminiscent of the Schoolmen of a later period (say 1200–1250, in which he puts the Latin author). He does not say what these arguments are, but those I have met with are taken largely from Aristotle, whose works were translated into oriental languages at an early period.

Geber, according to Berthelot, showed an advanced rationalism in contesting the influence of the planets, which was accepted by the Arabic Jâbir, whose works are extant in Arabic, but are different from Geber's. A belief in astrology cannot be used to date any historical period, and apart from this, the Latin Geber explicitly admits the influence of the stars, but says "The work will be duly performed by Nature *under a due site* convenient for it, without any previous considerations of it."

"The ideas and facts developed in the writings of the pseudo-Geber," said Berthelot, "are frequently expressed in the same terms in the authentic works of Roger Bacon." I do not wish to enter into a discussion of the authenticity of these particular works of Bacon; it is only necessary to remark that in the one to which Berthelot's remarks seem to apply the name of Geber is cited, through Avicenna's "De Anima" (the phrase is given by Hoefer, i. 329, as Bacon's), which work is, naturally, condemned by Lippmann, on quite inadequate grounds, as "pseudographisch." That it differs in style from the "Canon" is probably correct, but Newton's "Daniel and the Apocalypse" differs in style from the "Principia." Avicenna's "De Anima" was condemned as spurious by Dr. James in his "Medical Dictionary" (London, 1743, vol. i., unpaged). The quotation in Avicenna is not to be found in the Latin works of Geber.

According to Berthelot the "Liber Septuaginta" (the Latin MS. of which was noted by Hoefer, whose valuable pioneer work has been considerably underestimated) is entirely different in style and content from the Latin Geber, although he attributes it, on what seem insufficient grounds, to Jâbir. There are some strikingly similar passages in the above work and in the Latin Geber, though I do not assert that they had the same author.

For some years I have asserted in my lectures that the criticisms of Berthelot were unsatisfactory. There are many other reasons why the arguments of Berthelot should be rejected and a new start made. Mr. Holmyard inclines to the original view that the Arabic Jâbir and the Latin Geber are one; my own view, which like his is still hypothetical, is that a Greek, Syriac, or Hebrew MS. may be as likely to be the *original* source as an Arabic one. The details of the life of Geber are very contradictory, but he is said to have been "a Christian who afterwards became a Mohammedan," or "of Tarsus." This is suggestive.

The "Summa perfectionis" is probably the earliest Latin work of the group attributed to Geber. It differs only little from the Greek writings of Alexandrine authors in its ideas, and the doctrines it teaches do not seem to represent that remarkable advance which is held to throw doubt on its early date. The "Testamentum" referred to by Mr. Holmyard differs in content and outlook from the "Summa"; it does not appear in the earliest printed edition of Geber's works (British Museum, catalogued as possibly printed at Venice in 1475, but I am informed by the authorities in the Incunabula Department it was probably printed at Rome not before 1480–1490). The "Testamentum" first appeared in the Vatican edition (? 1525; the 1480 was also a Vatican edition; Kopp, Hoefer, and Berthelot have been confused by editions of Geber which they have not seen). The "Liber de investigatione" may be a compilation by some later writer. The "Alchimia Geberi," of which Kopp, Hoefer, and Berthelot speak, is not a separate work, but merely an edition of Geber's works. As Mr. Holmyard seems to have gone some distance in another direction, I thought it useful to state briefly what conclusions I have reached; the detailed justification of these would take up far too much space. The "pseudographic" school, however, do not seem to have made out their case. J. R. PARTINGTON.

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Mile End Road, E.1.

The Stoat's Winter Pelage.

A FRIENDLY stoat, which has made our flower-garden and rockery his hunting-ground for mice and voles during the last three years, has donned his winter livery of ermine, and become very conspicuous—a snow-white little athlete—amid the greenery of the present exceedingly green winter.

This seasonal change of the stoat's brown summer pelage to creamy white is regulated, not by winter temperature, but by latitude. Invariable in the stoats of the Scottish Highlands, nearly so in those of the Scottish Lowlands, it becomes gradually less frequent towards the English Midlands; until in the southern counties a complete change of hue is exceedingly rare. This change is not due to the growth of a new coat; it is the old fur that becomes white. Nor is prevailing temperature the cause of change. Here, on the western Scottish seaboard, winter is usually very mild; snow seldom falls and still more seldom lies. *Clianthus puniceus*, from the north island of New Zealand, and *Abutilon megapotamicum*, from Brazil, have been flowering profusely on walls in the open all through this winter; yet our stoats regularly assume the protective winter garb of circum-polar animals; while in Warwickshire and Leicestershire, where the average winter temperature is far more severe, a complete change in the stoat's pelage very rarely occurs.

May we not recognise in this a heritage from the last ice age? So long as the land so far south as Herts lay under the ice, stoats in the Thames valley and south thereof must have worn the ermine pelage—at least in winter, and so did those which followed the ice in its northward retreat. But some thousands of temperate seasons have enabled the race of stoats that remained in the southern counties to dispense gradually with a costume which has become the very reverse of a protective disguise.

A few thousand years more and it may be as difficult to find a white ermine in Caithness as it is now in Cornwall! HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire.

Stirling's Theorem.

FOR very large values of n, Stirling's theorem,

$$i.e.\ \text{Lim}\ \frac{\lfloor n}{n^n \epsilon^{-n} \sqrt{n}} = \sqrt{2\pi},$$

reduces in its logarithmic form to

$$n \log n - n = \log \lfloor n.$$

It is in this form that the formula is required in Planck's radiation theory. Wanting to use this formula, and unwilling to make my students go through the proof of Stirling's theorem as given, for example, in Chrystal's "Algebra," I thought of the following deduction, and should like to know if it is sound or if it has been given before.

When $dn = 1$

$$\log n = \frac{d}{dn} \log \lfloor n,$$

and since n is to be very large the value of dn is an infinitesimal. Therefore we may say

$$\log n\, dn = d \log \lfloor n$$
$$\therefore \int \log n\, dn = \int d\,(\log \lfloor n)$$
$$\therefore n \log n - n = \log \lfloor n,$$

which is the form required. JOHN SATTERLY.

University of Toronto,
Toronto, Canada,
January 1.

Stonehenge: Concerning the Four Stations.

JUST within the surrounding earthwork of Stonehenge there are two stones symmetrically placed with reference to each other on opposite sides of the centre. There are also two low earth heaps or mounds in corresponding complementary or reversed positions. A general description of these "Four Stations" was given by me in NATURE for April 1, 1922 (vol. 109, p. 410), with a plan (reproduced herewith, Fig. 1) drawn to scale and photographs of the stones.

The two so-called mounds are of very slight elevation, and are scarcely noticeable on the ground: each has a sort of hollow or crater in its centre. By Petrie's system the two stones are numbered 91 and 93, and the corresponding pair of mounds Nos. 92 and 94.

In the hollow of mound No. 94 Colt Hoare reports that he found "a simple interment of burned bones" ("Ancient Wilts," i. p. 145). On the strength of this discovery it has been assumed that the two mounds are Round Barrows, and (based on this assumption) it is inferred that Stonehenge was constructed probably near the end of the Bronze Age or perhaps even later.

The advocates of a Bronze Age date for Stonehenge specially rely upon this as conclusive evidence in support of their theory. Dr. Rice Holmes, for example, makes the somewhat positive assertion as follows:

> "The stones [of Stonehenge] were certainly not standing when Round Barrows were first erected on Salisbury Plain; for one is contained within the *vallum*, which, moreover, encroaches on another" ("Ancient Britain," p. 476).

In my letter in NATURE (April 1, 1922), I gave evidence for the opinion that these two earth heaps are not the remains of barrows, but are the sites of a pair of stones that had been removed. These stones, when in position, corresponded exactly with the pair of stones which still remain in place.

In the *Antiquaries Journal* for October 1922 (p. 344, footnote), Dr. Rice Holmes, in reference to this matter,[1] remarks:

> "Round barrows were erected towards the end of the Neolithic Age in Scotland, Yorkshire, and Derbyshire; but Mr. Stone is, I believe, the first to suggest that a round barrow of that period exists at Stonehenge."

But I made no such suggestion—in fact, the special purpose of my communication was to show that the so-called mounds were *not* barrows. Perhaps Dr. Rice Holmes will re-read my letter in NATURE of April 1 last.

The fact that "a simple interment of burned bones" was found by Colt Hoare in the hollow of site No. 94 is, of course, no evidence that the place was a barrow. Similar casual interments of burned bones were also found deposited in the adjacent "Aubrey Holes," which obviously were not the sites of barrows.

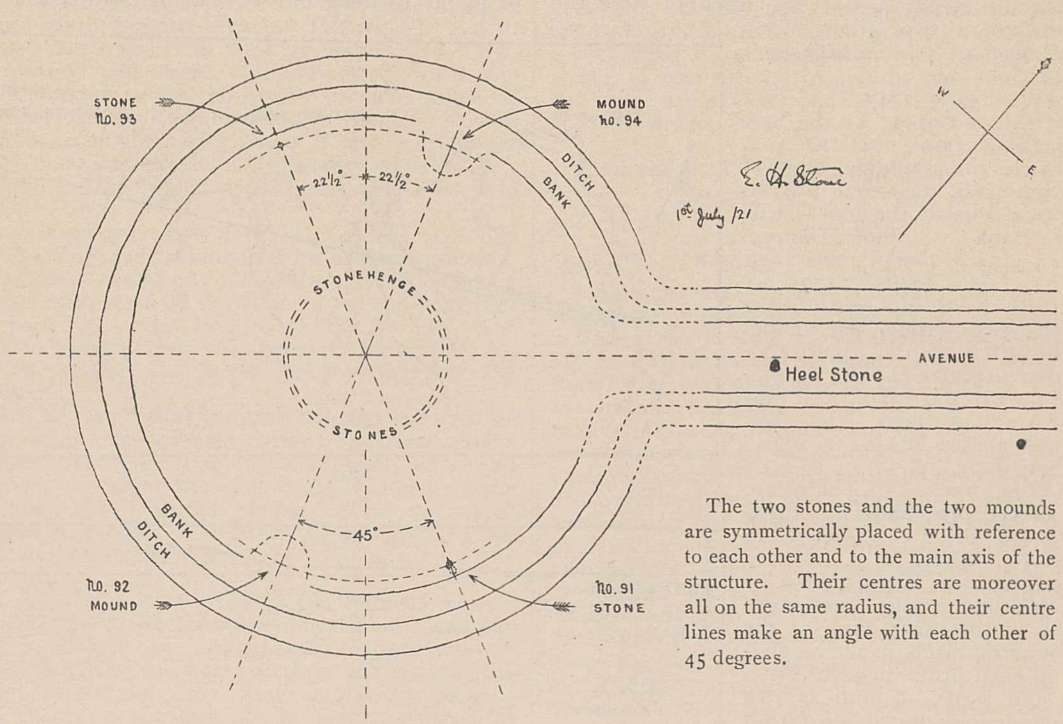

FIG. 1.—Plan of Stonehenge. Scale—120 feet to 1 inch.

That these mounds are really positions which were once occupied by stones has, however, now been placed beyond doubt by the excavations lately carried out by Col. Hawley, in the course of which the crater or hollow in the middle of one of these sites (No. 92) was completely cleared down to the original chalk rock. I inspected the bottom of the hole when it had just been cleared out, and it was evident that it had been dug as the foundation pit for a large stone. There was no indication of any barrow having ever existed on the site.

In his report published in the *Antiquaries Journal* for January 1923 (pp. 15-16), Col. Hawley, in reference to this, remarks:

> "Nearly in the middle of the place [No. 92] was a large hole. Sir Richard Colt Hoare mentions having opened it without result, consequently it was in a very disturbed state and afforded nothing of interest until it had been emptied. It was then seen that it must formerly have contained a large stone, perhaps about the size of the one [No. 91] lying near the rampart a little way to the east,

[1] Dr. Rice Holmes makes a mistake in his reference, which he gives as NATURE, April 29, 1922, p. 563.

and the bottom showed irregularities indicating the pressure upon it of an irregular base of a stone.

"On the north side, forming part of the hole, was an incline in the solid chalk for introducing the stone somewhat similar to those met with in the Stonehenge circle.

"The hole was about 4 feet deep."

It appears probable that most of the material of these so-called mounds is merely the spoil thrown out by Colt Hoare in making his excavations. Before Colt Hoare's time we find these two sites are always referred to as cavities or depressions (not as mounds), and we may infer that these cavities were the hollows left after the removal of the stones. The following extracts are quoted from well-known authorities:

William Stukeley, 1740.—"The two cavities in the circuit of our area, very probably were the places where two great stone vases were set" ("Stonehenge," p. 14).

John Wood, 1747. — "Two stone Pillars appear at the foot of the inner Bank next the Area in which the Building stands; and these are answered by two Spherical Pits at the foot of the same Bank" ("Choir Gaure," pp. 43-44).

Dr. John Smith, 1771. — "Directly north and south of the temple, just within the vallum of the ditch, is the appearance of two circular holes, encompassed with the earth that was thrown out of them. But they are now almost effaced by time" ("Choir Gaur," p. 52).

Waltire, 1792. — "There are two clayed pits, and two stones near the ditch" (Quoted in Britton's "Wilts," ii. p. 122.)

Rev. Richard Warner, 1801.—"Two other smaller stones are found on the inner bank of the surrounding ditch, exactly opposite to each other, in a direction east and west; as well as two circular depressions, about sixteen feet diameter, in the same bank, one lying S.S.E. and the other W.N.W." ("Excursions from Bath," p. 177).

We may conclude therefore:

(*a*) That the sites Nos. 92 and 94 were once occupied by stones corresponding with the now existing stones Nos. 91 and 93.

(*b*) That in the Bronze Age period the stone had already been removed from site No. 94, as a cremated interment was found by Colt Hoare in the foundation pit.

This latter conclusion (*b*) may prove of further interest in connexion with the history of Stonehenge. If supported by other evidence, it may be taken to indicate that in the Bronze Age the dilapidation of Stonehenge had already begun.

E. HERBERT STONE.

The Retreat, Devizes,
January 15.

A Double-Vertical-Reflection Mirage at Cape Wrath.

ON the morning of December 5, 1922, about 10.30 A.M. G.M.T., Mr. John Anderson, lightkeeper at the Cape Wrath Lighthouse, Durness, observed a mirage of an unusual character. Mr. Anderson focussed his telescope on a sheep which was grazing on top of a conical hill (height about 200 feet) about a quarter of a mile away, and immediately noticed an unusual appearance in the atmosphere around. On swinging the telescope slightly upward, he observed that a belt of the atmosphere appeared to be land and sea, giving a perfect representation of the whole of the coast line from Cape Wrath to Dunnet Head.

The appearance in the mirage was an exact replica of what would have been seen from a distance of about 10 miles out at sea. In a direction south

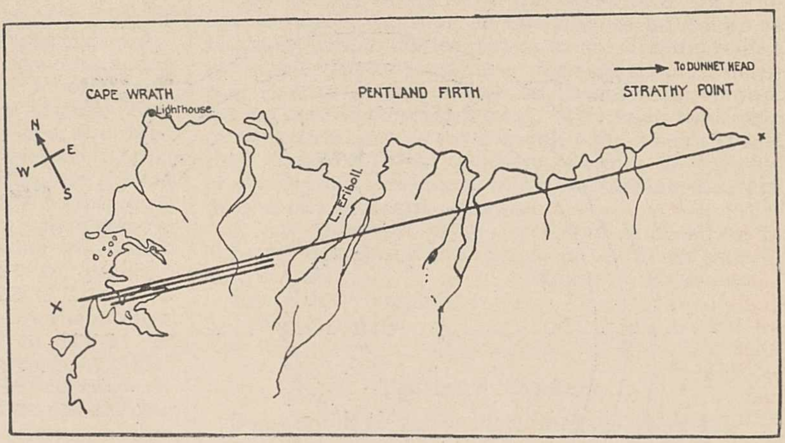

FIG. 1.

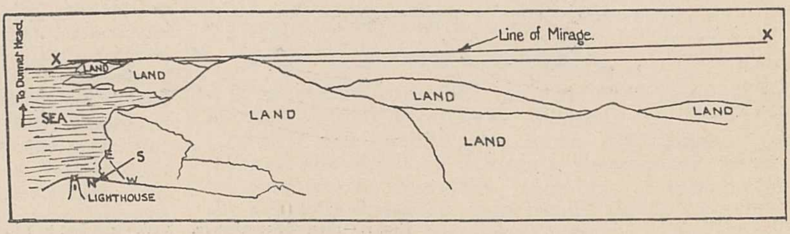

FIG. 2.

of the lighthouse there were three repetitions of the mirage one above the other, with sea separating each pair. The entrance to Loch Eriboll and the other bays could be seen and easily recognised in the main mirage, though Cape Wrath itself was rather indistinct.

The accompanying map (Fig. 1) shows the apparent position of the mirage and the outline of the coast, while the sketch (Fig. 2) gives a rough idea of how the country appeared to the observer. The mirage was hidden at one point by a hill.

The mirage was practically invisible to the naked eye, and was only visible from a very restricted area. Mr. Anderson states that it was not visible at a distance of 20 yards either way from his original position, but was still visible 4 or 5 yards from that point. Mr. Anderson estimates the apparent height of the image above the ground as about 1000 feet, in a southerly direction, while the distance from Cape Wrath of the triple image shown on the map is about 12 miles.

The phenomenon was observed for about thirty minutes, when it was blotted out by heavy, dark clouds from the south-west. Within a short time the sky was darkly overcast and rain began to fall, lightly at first, accompanied by slight fog; later rain fell very heavily, the raingauge giving a total of 1·97 inches for the afternoon.

The mirage was seen by practically all the residents at the station.

The meteorological conditions do not point to anything extraordinary. The synoptic chart for 7 A.M. shows an anticyclone centred westward of the mouth of the English Channel, with a very slight ridge of high pressure extending over Ireland and up the West Coast of Scotland. The temperatures at 7 A.M. were 48° at Wick and Stornoway, 51° at Castlebay, and 55° at Aberdeen. There was therefore a fairly sharp discontinuity of temperature along a line just south of Cape Wrath. The wind at 7 A.M. at Cape Wrath was from west by north. By 1 P.M. a secondary depression had advanced from the Atlantic, and was centred about 50 miles north of Stornoway, giving a south-westerly trend of isobars over the coast line from Cape Wrath to Dunnet Head. The temperature at Stornoway was now 52°, but only 47° at Wick, where the wind was still light.

The mirage was seen at 10.30 A.M., at the time when the wind was backing in front of the depression. The Deerness anemograph shows a slight backing of the wind from west by north at 10.30, and a further slight backing to west by south about 11 A.M. The wind blew steadily from west by south until 3.30 P.M., when it shifted to north in the rear of the secondary.

It will be noted that the phenomenon occurred at a time when the warmer current in front of the secondary depression had not completely displaced the colder air from the immediate vicinity of the coast line. There would remain a cold pocket of air under the cliffs, and other masses of cold air would probably be trapped by the hills near the coast.

The only suggestion which I can offer as a basis of explanation for the phenomenon is that there was a sharp surface of discontinuity—approximately vertical—between the warm air over the sea and the cold air under the cliffs, and that some distance inland there was another nearly vertical surface of discontinuity between the cold air near the coast and warm air which had penetrated inland through a gap in the hills south of Cape Wrath.

Reflection of light at two such surfaces of discontinuity would account for the phenomenon, the effect being that produced by two mirrors, one in front, and one behind, the observer. There should be a small amount of reflection at any sharp surface of discontinuity, perhaps sufficient to account for the phenomenon being visible through a telescope. The extremely small limit of the region from which the phenomenon was visible would place the inland discontinuity near to the observer. The effective surface of the mirror may have been quite small.

Mr. Anderson records that there was a slight fog when the rain came. The fog would be produced by the mixing of the warm humid current with the colder air which had previously remained over the coast.

The phenomenon has been called a mirage, but the mirage as ordinarily understood is either an effect of refraction in air stratified horizontally, or, in the case of inverted mirage, is an effect of reflection at a horizontal surface at which there is a rapid change of density. But the admitted theory of formation of inverted images confirms the claim that there should be reflection at a surface of discontinuity of density. The phenomenon described above might perhaps be named a "vertical-reflection mirage," to distinguish it from the ordinary mirage due to refraction or reflection in air stratified horizontally.

No other records of similar phenomena can be traced, probably on account of the fact that such mirages are never likely to be visible to the naked eye. The telescope is useful in such cases only in so far as it limits the amount of light reaching the observer's eye. A plain tube without lenses would probably have shown the mirage more clearly than a telescope.

Mr. Anderson has been keeping a watch for others, but so far without success. This particular observation has been perhaps due in part to a series of happy accidents, in that the observer happened to be in the best position to note the effect, at the time when a wandering sheep roused his curiosity. Much credit is due to him for the trouble he has taken to draw the map and sketch, and to write a very detailed account of what he saw.

D. BRUNT.

Meteorological Office, Air Ministry,
January 26.

The Sugar-Cane Mealy-Bug.

I HAVE just received a very interesting paper on the sugar-cane mealy-bug (*Pseudococcus sacchari* Ckll.) from Mr. W. J. Hall, of the Ministry of Agriculture, Egypt. He describes the insect as being so injurious that "the whole future of the industry hangs in the balance." When I was recently in Madeira I examined the sugar-canes wherever I went, and found only a sparing and local infestation by *P. sacchari*. I had no microscope with me, but the determination was confirmed by Mr. E. E. Green. The insects may be found on the canes near the cliffs below the new road, a short distance west of Funchal. It is certainly worth while to determine why the pest is so serious in Egypt, and scarcely noticeable in Madeira. It may be that there is more damage in Madeira than I thought, but probably some efficient parasite will be found there. By collecting a quantity of the white material and placing it in a box, the parasites might be bred. That there is a parasite we know for certain, as my first sending from Funchal to Mr. Green could not be positively determined, consisting only of a mass of waxy secretion with fragments of the coccid, along with larvæ and pupæ of a parasitic Dipteron.

It is worth while to record at this time the occurrence of a really dangerous pest in Madeira, the *Aleurothrixus howardi* (Quaintance), on citrus in Dr. Grabham's garden in Funchal. It was determined for me by Dr. A. C. Baker of the U.S. Department of Agriculture. The infestation, while local, was very heavy, and if the insect spreads it may become a serious menace to the cultivation of oranges and related fruits.

Another potential pest found in Madeira is the rose-weevil *Pantomorus fulleri* (Horn). A single specimen was given to me by Mr. A. C. de Noronha, who found it in the vicinity of Funchal. It was identified by Dr. G. A. K. Marshall. As no other specimens have been found, it has perhaps not succeeded in getting established.

T. D. A. COCKERELL.

University of Colorado,
January 2.

Definitions and Laws of Motion in the "Principia."

By Sir GEORGE GREENHILL.

MACH'S "Historical Lectures on Mechanics in its Development" ought to have a great influence on the treatment of the subject, with an English version from the Open Court Company. Mach has many a shrewd deep criticism to make on Newton's "Principia," and the present remarks are intended as an amplification of some of his scientific animadversion. It would have been worth his while to examine the previous state of the theory of dynamics to see what laws were current before the statement as given by Newton. These laws must have been enunciated, not only to give precision to the subject, but at the same time to correct and contradict previous fallacy and error, and it would be valuable to have a record in historical development.

The First Law must have excited incredulity, as contradictory to common observation of a body in motion, soon coming to rest of itself; and when the heavenly bodies were pointed at, a divine Primum Mobile was postulated to keep them going eternally, in the pious reflections of Aristotle, quoted in the former conventional manner at the end of the "Principia," and suggesting Napoleon's criticism of Laplace.

Axiomata sive Leges Motus. Lex I. Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum, nisi quatenus a viribus impressis cogitur statum illum mutare.

Similar statements can be traced in the writings of Aristotle and Plutarch. But it would be more instructive if we were told something of previous ideas contradicted in this Law, such as "A body in motion will come to rest of itself," as in observation of daily life, ignoring the reason and cause.

Lex II. Mutationem motus proportionalem esse vi motrici impressae, et fieri secundum lineam rectam qua vis illa imprimitur.

A vector change of momentum, *motus*, is indicated here; but the Law requires amplification in a commentary-corollary. *Motus* is quantity of motion, called momentum to-day, and *mutationem motus* requires to be qualified as time change, rate of change per time change, per unit of time; not per length or distance, which would imply energy or *vis viva*, an idea not extant in Newton's day.

Translated into our algebraical symbols, quantity of matter, *quantitas materiae*, of Definition I is denoted by W, lb. (in French it would be denoted by P, kg., for *poids, pondus*). Here W, the *Pondus* of our *Corpus*, is measured by weighing it in the scales, corrected for buoyancy of the air, and this is an operation susceptible to the greatest accuracy in physical measurement.

The velocity is v, in f/s (feet per second), so that the quantity of motion is Wv, lb.-ft. per sec., according to Definition II. Velocity v is not so easy to measure to equal accuracy as W.

Then, according to Law II, quantity of motion Wv acquired (from rest) under a force F acting for t seconds, is proportional to Ft (called the impulse), and expressed in a proportion, $Wv \propto Ft$, leaving the unit of force to choice.

The absence of the algebraical sign of equality, =, will be noticed as not employed in the "Principia." But in any numerical calculation, equality must be introduced by the appropriate constant factor.

Working with the practical gravitation Unit of Force, the only one in use up to fifty years ago, and still the only one capable of exact measurement, and taking our unit as the gravitation heft of a pound weight, the sign of variation, $\propto$, is replaced by the sign of equality, =, in the variation above by introducing g in the right place, and writing it in a homogeneous form

$$(1)\ \underset{\text{(lb.)}}{W}\ \underset{\text{(sec.)}}{\frac{v}{g}} = \underset{\text{(lb.)}}{F}\ \underset{\text{(sec.)}}{t}$$

so as to verify when $F=W$, with $v/g=t$, $v=gt$, as in a free vertical fall of the body; $t=v/g$ being the number of seconds of descent to acquire velocity v, ft./sec.; in most practical problems it is near enough to take $g=32$, ft./sec.^{2}, in round numbers.

Then if s feet is the distance required to get up speed v from rest in t seconds, the average velocity

$$(2)\ \frac{s}{t}=\frac{1}{2}v;$$

and multiplying into equation (1)

$$(3)\ \underset{\text{(lb.)}}{W}\ \underset{\text{(ft.)}}{\frac{v^2}{2g}} = \underset{\text{(lb.)}}{F}\ \underset{\text{(ft.)}}{s}$$

and $\frac{v^2}{2g}=s$ in a free fall, where $F=W$.

And in a flying start, from velocity u,

$$(1)^*\ W\frac{v-u}{g}=Ft,\ (2)^*\ \frac{s}{t}=\frac{1}{2}(v+u),\ (3)^*\ W\frac{v^2-u^2}{2g}=Fs.$$

With these three equations, (1), (2), (3), any two of which imply the third, the young engineer may carry on for a long time in the linear dynamics, seen on the road and railway or in the air, up and down hill, getting up speed and checking it again with the breaks.

After that a variable force F may be introduced, as in Hooke's Law of the spring; a vibratory motion investigated, shown off in the pendulum, and seen in reciprocating masses of machinery, or a carriage body on springs. Here is theory enough to keep him going for a year.

Then after linear dynamics comes uniplanar dynamics, and the notion of rotation is introduced. A familiar illustration is always at hand in the door; every room has a door. The muscular sense of starting and stopping the rotation can be exercised; also in brandishing a stick, poker, bat, or club.

Angular inertia then requires measurement, although not mentioned in the "Principia," not even in "De motu corporum pendulorum" in Book II, or "In Horologiis et similibus instrumentis, quae ex rotulis commissis constructa sunt," where the *Corpus* may be the compound pendulum of a clock oscillating about its axle. Then Moment of Inertia requires definition,—the scalar sum of the product of every particle of the body by the square of its distance from an axis.

Thus, in "Matter and Motion," Maxwell reduces the uniplanar motion of any rigid body to an equivalent particle pair, rigidly connected, having the same total weight, the same centre of gravity, and the same moment of inertia about the centre of gravity.

The compound clock pendulum of Huygens is replaced in this way by its equivalent pair of particles, one being placed at O in the axle of suspension, and the other will be at P the centre of oscillation; and then OP is the length of the simple equivalent pendulum, a plumb bob P at the end of a thread OP.

Provided with these additional ideas in dynamics, the young engineer will be able to investigate the motion of the revolving parts of his machinery, such as a flywheel, a revolving shaft, a screw propeller, and the influence of the rotation of the wheels of a carriage.

Whatever the system of units employed, it is essential in the dynamical interpretation for g to be assigned its proper place, here under v. It must not be allowed to straggle and take cover under W, as in the old-fashioned treatise, where the author, to save trouble in writing and printing, adopted the mischievous delusive plan of replacing his W/g by the single letter label M, and then calling it the mass, a quantity *sui generis*, not its *Corpus*. He then wrote, with $v/t=f$, the acceleration, time rate of growth of velocity,

$$(4)\ F=Mf, \text{ with } W=Mg.$$

These relations are not seen in the "Principia-Elements," where g does not occur explicitly but is concealed in the length L of the seconds-pendulum, $g=\pi^2L$. The "Principia" is chiefly kinematics; very little of kinetics until the second book, and then of experiments on fluid resistance, aways expressed in gravitation units.

Lex III. Actioni contrariam semper et aequalem esse reactionem: sive corporum duorum actiones in se mutuo semper esse aequales et in partes contrarias dirigi.

According to Maxwell, this Law—Action and Reaction are equal and opposite—amounts to no more than the definition of a stress, a pull or thrust, tension or pressure.

The sequel of Corollaries of Law III is important in introducing the ideas of vector composition, the conservation of momentum, and immunity of the centre of gravity to the internal actions and stress.

The Law was put forth probably as a contradiction to some accepted law in vogue before Newton, now forgotten. In some recent figurative language of the Press, we read "The pendulum is always swinging. Action, especially if violent, is apt to entail reaction." The former Law can still be traced in the popular idea current that the horse advances by pulling the cart harder than the cart pulls back. I remember a similar question about a double-headed express train; I was asked to explain what would happen if the second engine was going faster than the first: pulling harder I presume was meant.

The definitions come first in the "Principia," but we prefer to discuss them after the Laws, when the ideas they imply have been employed already in some tangible application, and so are capable of a better appreciation, and we can refer to them. Abstract definition requires to settle on some hard base of fact and comes after action in order of thought.

Definitio I. Quantitas Materiae est mensura ejusdem orta ex illius Densitate et Magnitudine conjunctim.

According to Mach, this is really no more than a definition of density, and *quantitas* is used as a synonym for *Corpus, Moles, Massa, Pondus,* five names to one entity. Nomina-Entia non sunt multiplicanda praeter quam necesse est.

Here *Corpus* would connote a body, *Moles* or *Mola* the bulk, *Massa* the aggregation of its stuff, and *Pondus* the quantity of its stuff measured out in a balance against standard lumps of metal called weights; revealed also roughly in the heft required to lift the body off the earth's surface.

The Greek equivalent for *Massa* would be μάγμα, μᾶζα, something kneaded and fashioned into shape; and the distinction in Latin between the words is brought out clearly in Ovid's lines (*A. A.* iii. 219):

"Quae nunc nomen habent operosi signa Myronis,
Pondus iners quondam duraque massa fuit";

assigning the quality of Inertia to *Pondus*.

But because Newton in this definition goes on to say—Innotescit ea (Quantitas) per corporis cujusque Pondus. Nam Ponderi proportionalem esse reperi per experimenta Pendulorum accuratissime instituta, uti posthac docebitur (meaning experiments to prove that the quality of the Matter does not matter)—it is rigidly insisted to-day in elementary instruction that *Pondus* should never be used except in this subsidiary sense of the accident of the gravitation of it, due to its situation on the surface of the earth. Moreover, we find Newton using *Pondus* elsewhere in both of the meanings of ordinary language; as, for example, in his preface—Unde solvitur in omni aptorum instrumentorum genere Problemata. Datum pondus data vi movendi. Sic pondera aequipollent ad movenda brachia Librae, quae oscillante Libra sunt reciproce ut eorum velocitates sursum et deorsum: hoc est, pondera, si recta ascendunt et descendunt, aequipollent, etc.

Definitio II. Quantitas Motus est mensura ejusdem orta ex Velocitate et Quantitate Materiae conjunctim.

This is the quantity called momentum to-day, our Wv, lb.-ft. per sec. And—Motus totius est summa motuum in partibus singulis—requires amplification to-day of "sum" to "vector sum."

Definitio III. Materiae Vis Insita . . . etc., is qualified as undistinguishable from *Inertia massae*, the *pondus iners* of Ovid, so here the two names are convertible, and one of them would serve.

The *Vis Impressa, Vis Centripeta, Vis centripetae Quantitas Absoluta, Acceleratrix, Motrix* (felt forcibly on the top of a motibus), and so on of the subsequent Definitions display a curious profusion of the word *Vis*, as much as in Hooke's vaunted Law: Ut Tensio sic Vis.

Vis, like moment, momentum, moment of momentum, moment of inertia, is a word too hackneyed in dynamics. A. N. Whitehead, in the "Concepts of Nature," uses the word moment to mean "all Nature at any instant." "Two moments of the same family are parallel." "A point flash of Nature is an event particle."

In Definition I, density is taken as the primary property of matter, although left undefined by Newton; while *Quantitas Materiae*, our *W* or *P*, is the product of density and volume.

The *Materiae Vis Insita* of Definition III is described as the same as *Inertia Massae*. This, however, is not the definition of *Massa*, but *Inertia*, although the two are treated as the same thing in modern interpretation.

Newton is not consistent with himself, as asserted, in always using *Pondus* as meaning the attraction of the earth on a body on the surface. As often as not he uses *Pondus* in the popular acceptation, as in the Act of Parliament,and a search in the "Principia" will reveal numerous instances.

This distinction, insisted on so carefully in modern instruction, was ignored in language and thought till about fifty or sixty years ago, when Absolute Measure was first introduced into dynamical teaching.

The artless definition of Mass, as the quantity of matter in the body, is near enough to serve in a dictionary, as a synonym in one line. It is merely the selection of a new name as a label in the long list already in Def. I. But a real definition will give at the same time the best way to measure the quantity. In a recent Royal Society memoir, on "mass determination" as the author is careful to call it, the question of its measurement turned on a "Study of the Balance, in its greatest precision, in a projective series of weighings of small masses," the most accurate of all physical operations we know.

Libra, sign in the Zodiac of the Balance, is an appropriate emblem of justice holding the scales.

It is contrary to the strict legal language of the Act of Parliament on weights and measures to start off with another artless definition—the weight of a body is the force with which it is attracted by the earth. At that rate, what is the weight of the moon, the sun? The definition is not supposed to apply to a body, so long as it is not terrestrial.

The attraction of the earth on the pound weight as the unit of force (gravitation) will never be abandoned by the engineer, as it is susceptible to the same degree of accuracy of measurement as the operation of weighing.

But when Tait took in hand the reform of dynamical teaching, he altered the equations in our form of (1), (2), (3), (4) in a new way, with the view of exterminating *g*. He discarded the old *sui generis* mass, with unit of *g* lb., and taking mass in its new meaning of the invariable quantity of matter in the body, he measured it in terms of the Act of Parliament unit of weight, the pound weight. This involved him in a change in the unit of force, to what was called a poundal, such that the engineer's gravitation unit of force, the pound (force), was equivalent to *g* poundals.

Tait's change merely amounted to labelling *M* the quantity formerly labelled *W*. But he insisted on retaining $W=Mg$, and so measuring what he called weight in poundals, contrary to the strict law of the Act, and rendering himself liable to a fine for every offence. Better if Tait had retained the letter *W* for lb., writing the equation $P=Wf$, and rejecting the useless $W=Mg$, as perpetuating the old *sui generis*, and breaking the law in the Act of Parliament.

This trouble of mere terminology would be exorcised if the habit was inculcated of always stating the unit of a dynamical quantity, as, for example, of a mass *M*, g, a weight *W*, lb. The engineer refuses to accept the poundal or to give a weight *W* in poundals. Scrap the name as useless, except for passing certain examinations.

To the masses in general the word mass implies a combination of bulk and density as in Definition I, as when we speak of mass of stuff, the mass of the earth—"Die Erde und ihre eigene ungeheure Last" (Mach). In ordinary language the mass will mean the multitude, or majority, as in the statement attributed to Herbert Spencer, "The mass of woman is insensible to gravity," which might mean a reminiscence of the ballroom floor; but this was before the women began to take themselves so seriously; and when we read the critic's snarl of the "Vast Mass of his writings consigned to Oblivion," Vast Mass here is forcible-feeble for *Major Pars*.

The word is spelt *Maas* in German; "Mass für Mass" is the title of the German version of Shakespeare's play "Measure for Measure."

Wegener's Hypothesis of Continental Drift.[1]

By PHILIP LAKE.

WEGENER'S hypothesis is based on the idea that the continental masses are patches of lighter rock floating and moving in a layer of denser rock, and this denser rock forms the floor of the oceans. Following, with a slight alteration, the terminology of Suess he calls the lighter material the Sial and the denser layer the Sima. Suess uses the words Sal and Sima, and thinks that the Sal covers the globe completely.

I shall not here discuss the possibility of Wegener's conception. He does not profess to explain completely why the continents should move, but he claims to have proved conclusively that such movement has taken place. It is the evidence on which he relies, and more particularly the geological evidence, that I propose to examine.

[1] Abridged from an address to the Royal Geographical Society on January 22.

One of the arguments on which he lays great stress is derived from the relative frequency of different heights and depths upon the earth. His diagram of frequencies shows two well-marked maxima, one at about 100 metres above sea-level and the other about 4700 metres below it. Wegener concludes that two distinct surfaces standing at these two altitudes must have been involved in the subsequent movements. He assumes that these surfaces were originally level—or, more strictly, equipotential—and that they were the surfaces of the Sal and the Sima respectively. He holds that if originally there were only one such level, the deformation of that level could not produce two maxima and "the frequency must be regulated according to Gauss's law of errors."

In reality, if it is only a single level that has been deformed, it is improbable that the resulting altitudes will conform with the normal law of errors. The crust of the earth is not so constituted that each point can move independently of the rest, and the movements therefore are not analogous to the errors in a series of independent observations. According to the geological evidence the greater movements, which have most influence on the frequencies, are of a widespread character, and their general effect is to throw the surface into broad undulations. Upon these broader movements are superimposed the more intense but more local mountain-building movements.

Mr. G. V. Douglas points out in a paper to appear shortly in the *Geological Magazine* that if we start with a level, or equipotential, surface, and suppose it affected by movements of the types referred to, the resulting altitudes will necessarily give a frequency curve showing two maxima. The actual frequency curve is, in fact, perfectly consistent with ordinary geological conceptions and does not require the original existence of the two distinct surfaces postulated by Wegener.

Wegener imagines that at the close of the Carboniferous period the Sal formed one continuous patch covering about half the globe, and the Sima covered the rest. He professes that he has taken the forms of the existing land-masses, including their continental shelves: he has modified the present forms by unfolding the mountain ranges which have been raised since the Carboniferous period; and he finds that the different patches can then be fitted together into one continuous whole, like the pieces of a puzzle. It is evident, however, that Wegener has given free play to his imagination. In following the edge of the continental shelf he has allowed himself a very considerable amount of latitude, and he has not hesitated to distort the shapes of the masses. Few geologists who are familiar with mountain structures will attach much value to Wegener's estimates of the effect of Post-Carboniferous folding.

It is easy to fit the pieces of a puzzle together if you alter their shapes, but your success is no proof that you have placed them in their original positions. It is not even a proof that the pieces belong to the same puzzle. If Wegener's hypothesis rested solely on the evidence of fitting that he brings forward it might well be ignored. But there is more to be said for it than this.

In the Indian Peninsula the oldest fossiliferous deposits are of terrestrial origin and contain remains of plants and of reptiles. The flora is commonly called the Glossopteris flora and is very distinct from the contemporaneous flora of north-western Europe. There is a similar series of terrestrial deposits in South Africa and another in Brazil, both of which contain the Glossopteris flora and remains of reptiles. The Glossopteris flora occurs, moreover, in Australia, the Falkland Islands, the Antarctic continent, and in other parts of South America besides Brazil. In Wegener's reconstruction all these areas are brought together, and it is easy to understand why they should have a common flora and why that flora should be different from the flora of the distant Europe.

But the Glossopteris flora is found also in Kashmir, north-western Afghanistan and north-eastern Persia, Tonquin, northern Russia and Siberia. In Wegener's reconstruction all these areas lie far from the masses that he has grouped together in the south.

The Russian deposits are especially interesting. Not only do they contain representatives of the Glossopteris flora, but they also include reptiles of the same type as those which are found in South Africa, and several species of freshwater shells which are identical with those in the South African beds. Wegener's explanation has not by any means simplified the problem of the distribution of the Glossopteris flora and of the fauna associated with it.

In India, South Africa, South America, and Australia the system containing the Glossopteris flora begins with a boulder bed, which is universally admitted to be of glacial origin. These glacial deposits are now scattered over a wide extent of the earth's surface. Even if we admit movement of the pole, on the most favourable supposition the ice must have spread much farther towards the equator than the ice-sheets of the Pleistocene Glacial period ever did. Nor is it possible to invoke the aid of icebergs, for the associated deposits, except in the case of Australia, are all of terrestrial origin. With Wegener's reconstruction these difficulties disappear. The areas are grouped together and the pole may be placed conveniently in the middle of the mass.

But the boulder beds of this period are not limited to these areas. There is a boulder bed in the Salt Range which appears to be of the same age as the Talchir boulder bed of the Indian Peninsula. In north-western Afghanistan Griesbach found a boulder bed similar to the Talchir boulder bed, and in the beds overlying it he found several of the characteristic plants of the Glossopteris flora. According to Wegener's maps this boulder bed must have been deposited within 30 degrees of the equator of the period; and it cannot have been laid down at a great elevation, for the beds that conformably follow it include both marine and terrestrial deposits. Wegener's ideas have not very greatly reduced the area that must have been affected by the ice of the Permo-Carboniferous Glacial period.

There is another line of evidence that Wegener puts forward. There are five geological features, according to him, which occur on the two sides of the Atlantic and are re-united when the patches of Sal are fitted together.

The strike of the ancient gneiss of the Hebrides and northern Scotland becomes, he says, continuous with that of the gneiss of Labrador. The former, according to him, now runs from north-east to south-west, the latter from east to west. But according to the Geological Survey of Scotland the prevalent direction in Scotland is W.N.W.–E.S.E. or east to west. If Wegener's direction fits the other side the real direction does not.

The Caledonian folds of Scotland and Ireland, he says, become continuous with those of Newfoundland. But the Newfoundland folds are of considerably later date. If there was actual contact the earlier Scottish folding, in spite of its great intensity, must have ended abruptly at the line where separation was to take place ages afterwards, and on the other side of the line the commencement of the later Newfoundland folds must have been equally abrupt.

Farther south the Armorican folds of Europe, in Wegener's reconstruction, are continued by the Appalachian folds of North America, and no objection can be raised on the score of age. But a single coincidence of this sort has no value, for Wegener has adopted the simple plan of bending North America so that the ends of the two systems meet and the folds fall into line.

In Africa, according to Wegener, the ancient gneiss foundation shows a sudden change of strike at the head of the Gulf of Guinea, and in South America there is a similar sudden change at Cape St. Roque. When the two continents are brought together the two different strikes and the line of separation between them become continuous. But in bringing about this coincidence he gives to the gneiss north of the Gulf of Guinea a north-east to south-west strike, and this is very far from the truth. Over a large part of the area the actual observations indicate that the prevalent direction is from north to south.

In South Africa a folded mountain range runs from east to west. In Buenos Ayres a folded range belonging to the same period has been described. According to Wegener one was the direct continuation of the other. But before they reach the western coast the South African folds, and the range that they have formed, turn to the north and run roughly parallel to the western coast. Wegener's explanation of this deviation is far from convincing.

It will thus be clear that the geological features of the two sides of the Atlantic do not unite in the way that Wegener imagines, and if the continental masses ever were continuous they were not fitted as Wegener has fitted them.

Obituary.

Prof. George Lunge.

On January 3 Prof. Lunge died in his eighty-fourth year. For more than thirty years, from 1876 to 1907, he held the professorship of applied chemistry in the Polytechnic Institute of Zürich, directing the destinies of this department with characteristic energy, and with a success that attracted students from far and near, who sought to equip themselves for a career in industrial chemistry by a training under one who was recognised as the authority, especially in the branch of the manufacture of "heavy chemicals."

Dr. Lunge by his literary activity, as in other ways, contributed greatly to the advancement of chemical technology. His treatise on "Sulphuric Acid and Alkali," which has passed through several editions, is not only indispensable to the technologist, but is also replete with knowledge. As Mr. T. W. Stuart, himself a leader in the alkali industry in this country, and one of the few early contemporaries of Dr. Lunge, recently stated, "When you refer to these books on any obscure subject in the Alkali industry, you never go empty away, but always find in them a wealth of information."[1] A similar statement might justly be made in respect to Lunge's "Coal Tar and Ammonia," his "Technical Chemists' Handbook," and his "Handbook of Methods of Technical Gas Analysis," etc., each and all of which are essential to the equipment of the chemical technologist.

George Lunge was born at Breslau on September 15, 1839; from 1856 to 1859 he studied at the universities of Breslau and Heidelberg, graduating as Ph.D. In 1864 he came to England, with the object of obtaining technical experience. For a part of the twelve years spent in this country he was employed in the tar distillery of Messrs. Major and Co. at Wolverhampton, and in 1868 he was appointed chemist and manager to the Tyneside Alkali Company at South Shields. Dr. Lunge's efforts to obtain a footing in one or other of the twenty-six chemical works on the Tyne were at first far from encouraging, for, as Mr. Stuart tells us, a partner in one of the largest of these works offered Dr. Lunge the post of chemist at 1*l*. per week, which even at that time was but 2*s*. above the wage of a labourer! In the small works at South Shields Dr. Lunge continued until 1876, when he received the call to the chair of applied chemistry at Zürich. It is not without interest to note that his chief publications and researches deal with those phases of chemical industry, with the actual practice of which his sojourn in England had made him familiar.

At the time of his residence on Tyneside the Newcastle Chemical Society was founded, with Mr. Isaac Lowthian Bell (later Sir Lowthian Bell, Bart.) as its first president. Dr. Lunge became a member of this society, taking an active part in its proceedings and was elected president in 1872. In 1883 this society became merged into the Society of Chemical Industry and was formed into a local section of that society. However, Dr. Lunge, until the time of his death, retained his membership of the local section, using its Proceedings as the medium of publication from time to time of important scientific communications, and in many other ways evincing his sustained interest in its welfare.

The first Hurter Memorial Lecture was delivered in 1899 by Dr. Lunge before the Liverpool section of the Society of Chemical Industry, who selected for the subject of the lecture—"Impending changes in the general development of industry, and particularly the Alkali industry."

Drs. Hurter and Lunge, like many German chemists, *e.g.* Caro, Pauly, Otto Witt and others, came to England in the sixties of last century to gain a practical knowledge of British chemical industries. Dr. Hurter remained in this country and became identified with the Lancashire alkali industry, while Dr. Lunge returned to the continent, and based his teachings and writings on experience gained in the rival industry of the Tyne. Dr. Lunge had a complete command of the English language, writing and speaking it with ease and fluency. He married Miss Bowron, the daughter of a member of the firm of the owners of the Tyneside Alkali works at South Shields. P. P. B.

[1] *Chemical Trade Journal and Chemical Engineer*, January 19.

Prof. James Ritchie.

We much regret to record the death of Prof. James Ritchie, Irvine professor of bacteriology in the University of Edinburgh. Up to the end of the summer term of 1922 Prof. Ritchie carried on his work with his customary energy and zest. In the holiday which he took during August in Perthshire, however, the early symptoms of his last illness began to give anxiety, and he died on January 28.

The record of Ritchie's life shows that since he graduated in medicine in Edinburgh in 1888, at twenty-four years of age, there can have been few unoccupied hours. In 1889 a happy chance took him to Oxford to be assistant in general practice to Mr. Horatio Symonds. This post gave him a wide clinical experience, and at the same time he was able to develop his scientific bent in the laboratories of the Oxford Medical School. His mental and physical energy seemed inexhaustible. At first his available time was spent in original research in bacteriology: on the nature of bacterial toxins; the theory of germicidal action; the relation of toxic action to chemical constitution of the toxins; the reaction of immunity, etc. Following this, he undertook to teach the subject in the Medical School at the request of Sir Henry Acland, and while preparing for this he wrote, with Prof. Muir, the "Manual of Bacteriology," which was at once accepted as the standard English text-book in this subject.

After Sir John Burdon Sanderson was appointed to the Regius chair of medicine the teaching expanded into a full three terms course in pathology and bacteriology, and in 1902 Ritchie was appointed professor of pathology. In 1907 he returned to Edinburgh. As a result of his work in Oxford he had risen to the front rank in his subject. In Edinburgh he first carried on with great success the work of Superintendent of the Laboratory of the Royal College of Physicians, and in 1913 he was appointed to the newly established chair of bacteriology in the University. The Royal College, the Infirmary, and the University had endless profit from his labour.

For the interests of his subject in the medical schools of the country generally he did exceptional service as secretary of the Pathological Society, and as one of the editors of the *Journal of Pathology*. He held many offices, and his influence on the progress of medicine extended far, and in all his relations with his fellow-men his idealism and faithfulness called forth deep trust and affection. J. L. S.

MR. W. W. BRYANT.

WALTER WILLIAM BRYANT, whose death on January 31 we much regret to record, was born on January 9, 1865, at Forthampton, near Tewkesbury, where his father was a schoolmaster. He obtained a scholarship to Pembroke College, Cambridge, and secured a first-class in the Mathematical Tripos in 1887, and a second-class in the Natural Science Tripos of 1888. He was for a short time a master at Dulwich College, and in February 1892 obtained a post as assistant at the Royal Observatory, Greenwich. His work was mainly connected with meridian astronomy. He was a most expert observer with the transit circle and was largely responsible for raising the output from 5000 to 10,000 observations. This increase in the annual number of observations remains as a permanent result of Bryant's enthusiasm. His skill and enthusiasm was also shown in observations of double stars made with the 28-inch refractor. He continued to observe regularly with this instrument till the present time.

In the year 1904 Bryant was appointed senior assistant and given the superintendence of the magnetic and meteorological department. He took up magnetic work about the time when the instruments were being set up on a new site in an enclosure in Greenwich Park. He made a large number of absolute observations, and during the war had little, if any, assistance. He took a great interest in meteorology and was for many years on the council of the Royal Meteorological Society, being secretary from 1916 to 1920, and vice-president 1920–1922. His interest in astronomy did not cease when he took up meteorology. He was a regular attendant at the meetings of the Royal Astronomical Society and the British Astronomical Association, and was the author of a "History of Astronomy," published in 1907, and of biographies of Galileo and Kepler in the "Pioneers of Science" series.

Bryant's recreations were music and hockey. He was one of the founders of the hockey club associated with the Observatory and played regularly up to 1914, and from 1919 onwards he acted frequently as referee.

Bryant married in 1894 and had ten children, of whom one died in infancy, and one was killed in Gallipoli. He was at the Observatory until within a few days of his death. His colleagues were greatly shocked by the announcement of his death following an operation. He was conscientious and industrious and a very pleasant man to work with, who will be greatly missed by his astronomical and meteorological colleagues.

MR. T. V. HOLMES.

MR. THOMAS VINCENT HOLMES, whose death at the age of eighty-two occurred on January 24, was for long a familiar figure in the ranks of English amateur geologists. From 1868 to 1879 he held a temporary post on the Geological Survey, when he was occupied about Carlisle and was the author of the Survey's memoir on that district; he also took part in the mapping of the Yorkshire coalfield in collaboration with the late Prof. A. H. Green, and later had similar experience in the south-eastern counties. Though Mr. Holmes so soon relinquished his official duties for a more leisured life, he maintained to the end his keen interest in local geological problems. An acute observer, he did much useful work in recording new exposures in the south-east of England, and was one of the active members of the Geologists' Association and Essex Field Club, being president of the latter in 1886–1888. He was a fellow of the Geological Society and of the Royal Anthropological Institute.

Mr. Holmes contributed a considerable number of short papers to the Association and Essex Field Club; others appear in the Transactions of the Cumberland Association and the *Essex Naturalist*. His last association with the Geological Survey was a large share in the compilation of the memoir "On Thicknesses of Strata," published in 1916.

WE learn from *Science* that Dr. Fritz Wilhelm Woll, professor of animal nutrition in the University of California, died on December 6 at the age of fifty-seven. Dr. Woll was born and educated in Norway; on going to the United States, he became attached to the University of Wisconsin and was appointed assistant chemist in

1887, and later chemist, to the Wisconsin Agricultural Experimental Station. In 1906 he became professor of agricultural chemistry in the University, a post which he held until 1913, when he went to the University of California as professor of animal nutrition. Dr. Woll issued a number of valuable reports and bulletins on dairy matters and stock feeding while he was in charge of the research stations, and wrote, among other works, "A Book on Silage," "Testing Milk and its Products," and "Productive Feeding of Farm Animals," all of which have passed through several editions. According to *Science*, it was due mainly to Dr. Woll's efforts that the cow-testing associations, of so much importance to the dairy industry of California, have been developed and placed on a permanent basis.

MR. F. E. WESTON, the late head of the Chemistry Department of the Regent Street Polytechnic, died on January 4 after a long illness, and some account of his life and work appears in the *Chemical Age* of January 20. His death will be regretted by large numbers of chemists who came under his influence. Mr. Weston was the author of some sound and popular text-books, and in addition to his activities as a teacher he made several original investigations.

WE regret to announce the deaths of: Prof. Wilhelm Konrad von Röntgen, at the age of seventy-seven years; Mr. Bernard Bosanquet, on February 8, in his seventy-fifth year; and Dr. A. H. Fison, lecturer on physics at Guy's Hospital, London, and secretary to the Gilchrist Educational Trust, on February 5, at the age of sixty-five years.

THE *Chemiker Zeitung* of January 18 reports the death on December 6 of Prof. Luigi Marino-Zuco, of the Applied Chemistry Department of the Royal School of Engineers, Pisa.

Current Topics and Events.

THE recent decision of the Commissioners of Customs to enforce payment of the entertainment tax by the Committee of the West Highland Museum at Fort William in respect of an exhibition of local objects meets with some caustic comment in the February number of the *Museums Journal*. It is pointed out that the official regulations contemplate the issue of certificates of exemption for "entertainments" of this nature, and that the Board of Education encourages such temporary local exhibitions as the best means of securing the establishment of permanent provincial museums. Thus does one Government Department hinder the efforts of the other; and thus is constructed another argument for a properly thought-out State policy towards museums.

IN view of the withdrawal of oversea contributions to the Imperial Institute, a committee under the chairmanship of the Hon. W. Ormsby-Gore and including the High Commissioners of Canada, Australia, New Zealand, South Africa, and representatives of the Board of Trade, the Colonial Office, the Treasury, and the Associated Chambers of Commerce, has been appointed to investigate the position of the Institute. Mr. E. B. Boyd of the Colonial Office is acting as secretary to the committee. The terms of reference include a consideration of what functions now carried out by the Institute are considered essential and whether they should be transferred to other research organisations. Further, the committee has to consider to what extent the intentions of the founders of the Institute are being carried out and to suggest improvements which may be financially possible should it be recommended that the Institute continue on its existing basis. To us it seems astonishing that, as the Institute is largely concerned with the scientific study of the natural resources of the Empire, the committee does not include representatives of science, who alone are able to understand the significance and value of research aspects of the Institute's work.

THE General Electric Co. of America has had for several years a testing transformer which can produce a potential difference of a million volts between its terminals. We understand also that Prof. Millikan will be able to experiment with a million volts at his new laboratory at Pasadena. According to *La Nature* of January 20, the Compagnie Générale d'Électro-Céramique has decided to instal a battery of transformers in its test-room at Ivry which will give a pressure of a million volts for measuring the electric strength of insulating materials. With these high pressures it is possible to make commercial tests on insulators when arranged in series, as they are on high voltage transmission lines. The Americans have also used them for testing the efficiency of lightning safety devices, and for studying the phenomena which occur when a very high voltage discharge takes place on a network.

To any one concerned with public health, and more especially to those who have witnessed the ravages of small-pox among natives in our overseas possessions and the benefits conferred by vaccination, the exhibit of pictures and relics connected with Edward Jenner now on view at the Wellcome Historical Medical Museum, 54A Wigmore Street, W., cannot fail to be of interest. Here are shown many mementoes of this illustrious benefactor of mankind; an English country doctor, blessed with unusual powers of observation and animated by a scientific spirit, whose work, despite the efforts of cranks and detractors, will stand for all time. In addition to the large number of interesting objects forming part of the Wellcome Museum, special loan exhibits are displayed. Among them is the original pencil drawing of Jenner from life executed by Thomas Drayton, while there are many rare books and the original water-colour drawings of Kirtland showing the results of vaccination and variolation from day to day. Of the lancets Jenner used there are two with ivory points similar to those on which he sent dried lymph to India. The coloured cartoon by Cruikshank entitled "The Cow-Pox Tragedy" only serves to remind us that the Jennerian method has survived the foolish and often venomous attacks made upon it for a century and more.

SEVERAL important Dinosaurian remains have lately been added to the collection exhibited in the Department of Geology in the British Museum (Natural History). A pelvis and tail of Trachodon, obtained by Mr. C. H. Sternberg from the Upper Cretaceous of Wyoming, U.S.A., have been mounted for direct comparison with the corresponding remains of Iguanodon from the Wealden of Sussex. The snout and jaws of a large Megalosaurian (Gorgosaurus), found by Mr. W. E. Cutler in the Upper Cretaceous of Alberta, Canada, have been placed close to the cast of the skull of Tyrannosaurus. The unique skull of Megalosaurus, discovered some years ago by Mr. F. L. Bradley in the Great Oolite at Minchinhampton, Gloucestershire, has been given by him to the Museum and is also now exhibited. It shows the bony core of a horn on the nose as in the American Jurassic Ceratosaurus. An interesting pelvis and femur of a small Megalosaurian found by Mr. S. L. Wood in the Lower Lias of Barrow-on-Soar, Leicestershire, and given by him, have also been mounted in the same case.

THE Decimal Association directed attention recently to the handicap imposed on foreign trade by the confusion which at present exists owing to the difference—amounting to twenty per cent.—between the Imperial and the American gallons, the former having the capacity of 277·2 cubic inches while the latter is the old wine gallon of 231 cubic inches. The Association therefore suggested that the British and American Governments should abandon their existing gallons and adopt the international litre as the common unit of capacity (100 litres are equal to 22 Imperial gallons). Anglo-American uniformity and a common basis for all international trade in liquids would thus be secured simultaneously. In this connexion it is interesting to note that the American Metric Association at its annual meeting on December 30 passed the following resolution: "Be it resolved that the American Metric Association heartily approves the recommendation for the immediate adoption of the litre as the common unit of capacity, believing that this step will not only facilitate trade between the two countries, but will also constitute a common basis for international trade and good-will; and it respectfully urges the British and American Government Departments, manufacturers, and merchants to effect this desirable reform."

ON February 17 occurs the bicentenary of the birth of the German astronomer Johann Tobias Mayer, who from 1754 to 1762 superintended the observatory at Göttingen. Mayer began life in a cartographer's office in Nuremberg, where he made improvements in map-making. His scientific work led to his appointment first to the chair of mathematics in Göttingen University, and then in 1754 to the charge of the observatory, which had just been furnished by George II. of England with a fine mural quadrant by Bird. Mayer's fame rests mainly on his lunar Tables, which were compared with the Greenwich observations by Bradley and Mason. Mayer died in 1762, and after his death a revised set of tables was sent by his widow to the British Government, who awarded her 3000*l.*, this being a part of the 20,000*l.* offered in 1713 for a method of determining the longitude at sea. His "Theory of the Moon" and his Tables were published in London in 1770 under the editorship of Maskelyne. He also made investigations on eclipses, colours, the motion of the stars, refraction, and terrestrial magnetism. His star catalogue was revised by Baily in 1830 and again by Auvers in 1894, while in 1881 Klinkerfues published a reproduction of Mayer's fine map of the moon which for a century had remained unsurpassed.

A CABLEGRAM from Calcutta to the *Times* announces the return of Mr. Kingdon Ward from a journey of eleven months in south-western China, Chinese Tibet, and northern Burma. Mr. Ward left this country early last year and first visited Mili in western Szechuan, where he found evidence of former glaciation, which he has already described in the *Geographical Journal.* His effort to proceed from Mili directly westward was frustrated by the disturbed condition of the country, and he returned south to Likiang and went north-westward to Atuntze. Thence he crossed passes between mountains, which he reports as ranging from 20,000 to 25,000 feet in height, along the Burmese-Yunnan frontier, between Major Bailey's route into Assam and that of Prince Henri d'Orleans from Tasa on the Salween into Burma. According to suggestions previously made by Mr. Ward the mountains of the Irrawadi-Salween divide are still rising, so that their glaciers are expanding instead of being on the wane as farther to the east. Apparently, however, in this area the glaciers have also decreased in size. Mr. Ward's observations on the structure of these mountains will be of special value. His primary work is botanical, and he has discovered remarkable new species of rhododendron and primula. Mr. Ward passed a little south of the area which, according to Mr. Forrest, was the original centre of distribution of the rhododendron. A fuller account of Mr. Ward's discoveries will be awaited with great interest.

A GREAT submarine earthquake occurred in the Pacific Ocean on February 3. As a first approximation, Prof. Turner locates the epicentre in lat. 50° N., long. 170° W., or about two hundred miles south of the Aleutian Islands. He remarks (*Times*, February 6) that other earthquakes occurred in the neighbourhood of this origin on January 30, 1914, and February 20, 1916. At Washington, D.C., and Fordham University (New York) the recording pointers of seismographs were thrown off the drums, indicating that the earthquake was one of unusual violence. Seismic sea-waves of considerable size swept over the ocean. At Hilo, in the Hawaiian Islands, which is about 2080 miles south of the origin, the waves were reported to be twelve feet in height and to have drowned several fishermen in the harbour. With the above position for the origin, it is difficult to account for the fracture near Hawaii of the cable from Midway Island to Guam, unless, as is sometimes the case, there were two separate earthquakes, one to the south of the Aleutians and the other to the west of Hawaii—a supposition which receives some confirmation from a more recent telegram (*Times*, February 9) that the origin was about 2000 miles from Samoa.

A GERMAN correspondent writes: On February 9 Dr. G. Aufschlaeger, general director of the Dynamit A.G., formerly Alfred Nobel and Co., Hamburg, celebrated his seventieth birthday. Dr. Aufschlaeger was born at Jahnishausen, Saxony, graduated at Heidelberg and then became assistant lecturer at the Technical High School of Dresden. In 1882 he founded the dynamite factory of Muldenhütten, which was combined in 1884 with the dynamite works of Dresden; and in 1889 he became general director of the dynamite factory founded in 1864 by Alfred Nobel in Hamburg. Here he displayed an activity which was of the greatest importance for the whole industry of explosives. He brought about the combination of the principal German dynamite works and their co-operation with the chief foreign representatives of the industry. As the patents of Nobel for the manufacture of gelatin-dynamite from nitroglycerin and nitrocellulose, which belonged to his company, initiated a new epoch in the production of smokeless powder, he also succeeded in forming a syndicate with the manufacturers of gunpowder. This co-operation was of the highest importance technically, as it rendered possible the widespread distribution of new inventions and improvements. For the purpose of testing new inventions the scientific technical central offices in Neubabelsberg near Berlin were founded. In the construction of explosives works Dr. Aufschlaeger directed his attention towards securing the isolation of possible explosions and preventing their spread to other parts of the buildings. At the present time he is endeavouring to utilise the plant of the explosives works for peaceful purposes. "Vistra-wool," a substitute for cotton, produced from wood, is being manufactured by one of the dynamite works, and has been highly praised by experts.

IT is announced in the *Times* that in celebration of the 450th anniversary of the birth of the Polish astronomer Copernicus on February 19, a memorial tablet will be unveiled and a municipal scientific library bearing his name will be opened in his native town of Thorn.

THE new Research Laboratories of the General Electric Co., Ltd., Wembley, will be opened on Tuesday, February 27, at 2.30 P.M., when Lord Robert Cecil and Sir Joseph Thomson will deliver inaugural addresses.

THE annual lecture to the London Graduates' Section of the Institution of Mechanical Engineers will be delivered at 7 o'clock on Monday, February 26, by Prof. E. G. Coker, who will speak on "Photo-elastimetric Researches on Mechanical Engineering Problems."

WE notice in the programme of lectures for 1922–1923 of the Franklin Institute, Philadelphia, Pennsylvania, that Dr. Walter Rosenhain is lecturing to the Institute on the structure and constitution of alloys, and that in April Sir Joseph Thomson is to deliver a course of five lectures at Philadelphia on the electron in chemistry.

MAJ.-GEN. SIR FREDERICK B. MAURICE, Dr. Alexander Scott, and Prof. A. N. Whitehead have been elected members of the Athenæum Club under the provisions of the rule of the Club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

THE following officers and members of council of the Royal Astronomical Society were elected at the anniversary meeting held on February 9:—*President*: Dr. J. L. E. Dreyer. *Vice-Presidents*: Prof. A. S. Eddington, Sir F. W. Dyson, Mr. E. B. Knobel, and Prof. H. F. Newall. *Treasurer*: Lieut.-Col. F. J. M. Stratton. *Secretaries*: Mr. H. Spencer Jones and Rev. T. E. R. Phillips. *Foreign Secretary*: Prof. H. H. Turner. *Council*: Prof. A. E. Conrady, Dr. A. C. D. Crommelin, Mr. C. R. Davidson, Prof. A. Fowler, Dr. J. W. L. Glaisher, Mr. P. H. Hepburn, Mr. J. Jackson, Dr. Harold Jeffreys, Prof. F. A. Lindemann, Mr. E. A. Milne, Dr. J. W. Nicholson, and Mr. J. H. Reynolds.

WE have received an address on advances in the metallurgy of iron and steel, delivered by Sir Robert Hadfield before the Cambridge University Engineering Society on January 25. The address, which was illustrated at the time by means of kinematograph and lantern slides and exhibits, ranges over a wide field, its subject being the importance of metallurgical discoveries to modern engineering. The scientific record of Cambridge and its school of engineering is taken as a text for a discourse on the technical applications of science, with special reference to motor-car engineering. In this connexion many passages are quoted and commented on from the recent autobiography of Mr. Henry Ford. An opportunity is taken to point out the exaggerated impression of German supremacy in chemical science which has been caused by our dependence on German text-books, and to urge that more attention should be given to the production of scientific compendia in the English language, and free from undue national bias. The address, which breathes a spirit of scientific enthusiasm, contains some interesting incidental notes on armour-piercing projectiles and similar subjects on which the author speaks with authority.

ACCORDING to the fourth annual report of the Scientific Instrument Research Association, the period for which Government grants on the present scale were guaranteed expires on June 30, but as there is in the case of the Association an unexpended balance sufficient to maintain the work for a sixth year, the Department of Scientific and Industrial Research has extended the period of the grant to June 30, 1924.

During the year 1921–1922 covered by the report, the Association has been engaged on researches on neutral, optical, and coloured glasses, on abrasives and cements for optical work, on the durability of glass, on phosphorescent material for X-ray use, on greases and wax mixtures, on lacquer, on the best wave for generation of X-rays, on regulation and focussing of X-ray tubes, on insulators, manganin wire, and on galvanometer coils. The work already done by the Association is bearing fruit, and firms engaged in instrument making are finding that the saving in their working costs owing to the adoption of methods suggested by the Association thoroughly justifies their financial support of it. We are glad to be assured that steps are being taken to secure from the industry adequate means to continue the work of the Association after the close of the Government grant period in June 1924.

WE regret that a manuscript note on the corner of the first part of the *Zeitschrift für angewandte Geophysik* led the reviewer in our issue of February 3, p. 145, into stating that the price of the single part was 20s. The publishers, Gebrüder Borntraeger, have pointed out that this sum covers the whole of the first volume, and we hasten to make this correction in the interests of a publication which they have undertaken with their characteristic enterprise.

MESSRS. LONGMANS AND CO. have nearly ready for publication "Synthetic Colouring Matters: Vat Colours," by Prof. J. F. Thorpe and Dr. C. K. Ingold. It will deal with the history of vat dyeing, of synthetic indigo and the various analogues of indigo; the derivatives of anthraquinone, and the preparation of some of the vat colouring matters. Another book to be published soon by the same house is "Printing Telegraph Systems and Mechanisms," by H. H. Harrison, a text-book intended for the use of the designer, the administration official, the technical telegraphist, and the student of telegraph matters.

A NEW departure in the policy of the American Chemical Society is evidenced by the appearance (through The Chemical Catalog Co., Inc., New York), of a number of monographs on various branches of chemical science and the issue of a long list of projected volumes. The series is announced as "a serious attempt to found an American chemical literature without primary regard to commercial considerations." Among the monographs in preparation are: Shale Oil; Coal Carbonisation; Aluminothermic Reduction of Metals; The Chemistry of Leather Manufacture; Liquid Ammonia as a Solvent; Wood Distillation; Thyroxin; Extraction of Gasoline from Natural Gas; Refining Petroleum; The Structure of Crystals; The Properties of Metallic Substances; Solubility; Valence, and the Structure of Atoms and Molecules; Organic Arsenical Compounds; Absorptive Carbon; Chemistry of Cellulose; The Properties of Silica and the Silicates; Piezo-Chemistry; The Animal as a Converter; Cyanamide; The Corrosion of Alloys.

Our Astronomical Column.

THE GREAT RED SPOT ON JUPITER.—Mr. W. F. Denning writes:—The planet Jupiter is now coming well into view and will rise at about midnight at the end of February. The Great Red Spot which has been certainly visible, though under rather different aspects, since 1857, is still to be distinguished.

It should be observed as often as possible during the ensuing spring months, and the times of its transit across the central meridian carefully recorded. Its rate of motion last year indicated a period of rotation equal to $9^h\ 55^m\ 38^s$. During the last few years the spot has exhibited a slackening of velocity. As a guide to telescopic observers the following times are given when this marking will be on or near the central meridian:—

	h.	m.		h.	m.
March 6	14	29	March 16	12	40
,, 8	16	7	,, 18	14	18
,, 10	17	45	,, 28	12	30

At the present time the spot precedes the zero meridian (of System II.) by about $3\frac{1}{2}$ hours, and this is increasing. There is another long, dusky marking in nearly the same latitude of Jupiter which closely follows the eastern end of the Red Spot. This will also well repay observation. It has been visible since 1901.

PERIODIC MOTION IN THE THREE-BODY PROBLEM.—Prof. Strömgren gives in No. 39 of the publications of the Copenhagen observatory a useful summary of the progress attained in recent years in the studies made there both in the restricted and the general problem of 3-bodies. (The former supposes one body infinitesimal, and the motion of the other two bodies circular.) The method used is that of mechanical quadratures, which is tedious and needs many successive approximations before periodic orbits are found, but it has the advantage of avoiding the mathematical difficulties involved in theoretical work.

The pamphlet also summarises the work of Sir G. Darwin and others. The connexions between families of orbits are traced, and it is considered that the treatment of the restricted problem with the selected mass-ratio is approximately complete. The orbits are divided into 16 classes comprising libration orbits about the 5 equilibrium points, 3 of which are in the line joining the finite masses, the other 2 are the equilateral-triangle points, which were at first merely theoretical, but later found exemplification in the Trojan group of minor planets.

The results illustrate various possibilities in the case of planets moving about a pair of suns. Each sun might have some satellites peculiar to itself, their motion, like that of our moon, being somewhat disturbed by the other. A figure-of-eight, encircling each sun in turn, is another possibility, while other orbs might pursue large orbits, in the form of distorted ellipses, outside both suns. But it must be remembered that periodic motion requires an exact adjustment of the initial speed and direction of motion. In most cases the orbits would not be periodic at all, but would undergo changes from one type to another.

A beginning has now been made with the study of the motion with all three masses finite. The case first studied was that of small librations about the 3 equilibrium points in a rotating line. This was subsequently extended to orbits of ejection or collision, in which 2 of the bodies are together at the beginning or end of the time considered. A case of 4-body libration is also sketched. No. 40 of the Copenhagen Publications deals with a special case of the 4-body problem, with 3 equal masses in a line, and the fourth infinitesimal.

Research Items.

The Sikhs of the Punjab.—The present agitation among the Sikhs of the Punjab is critically discussed by a well-informed writer in the February issue of the *Fortnightly Review*. He points out that numerically the Sikhs constitute only 12 per cent. of the population of the Province, as compared with 51 per cent. Muslims and 36 per cent. Hindus, and that the revival of Sikhism in the period before the war was largely due to its encouragement by the British officers in Sikh regiments. The Sikh, by his aptitude for emigration, is much more open to foreign influences than the stay-at-home Hindu, and after the war he has suffered from a "swelled head." The recent agitation has centred round the management of the Gurudwaras or religious foundations, some of which fell into the hands of ill-conducted Mahants or Abbots, and has been favoured by the influence of outside agitation. We cannot enter into a discussion of the proposals the writer suggests for the control of the agitation and the redress of legitimate grievances. But as an episode in the history of one of the leading fighting races of India we may direct attention to this comprehensive review of a situation which, if not dealt with in a statesmanlike way, may have serious consequences.

The Plundering of Royal Egyptian Tombs.—While the recent wonderful discoveries in Egypt are engrossing public attention two writers in the February issue of *Discovery* have thrown welcome light on the subject. In the first article Prof. T. E. Peet tells us the little that is known of the history of King Tutankhamen, really a series of inferences from archæological remains. In the second article Dr. A. M. Blackman tells the strange tale of the plundering of the Royal Tombs at Thebes in the XXth and XXIst dynasties, as recorded in the Abbott Papyrus preserved in the British Museum, with sidelights from two Meyer Papyri, now at Liverpool, recently published with a translation and notes by Prof. Peet. In spite of the tragical course of the inquiry which followed the outrage and the horrible examination of the criminals by torture, the tale of the rivalry of the two Mayors, Peser and Pewer'ō, governors respectively of eastern and western Thebes, is graphic and characteristic: Peser acquired information of the robbery and thought it a good opportunity to pay off old scores against his hated rival, who was responsible for the protection of the royal sepulchres. Pewer'ō ultimately was discharged, but we may reasonably suspect that the charges were anything but groundless, and that the truth of them was being gradually forced on the Vizier Khamwesē who conducted the inquiry. In fact, it would seem that the maladministration of the necropolis had become so notorious that even heavy bribes could no longer make it worth the Vizier's while to continue his policy of hush. The tale, as a whole, shows that human nature in Egypt is now much the same as it was three thousand years ago.

Sarsen Stones.—The origin of the name given to these stones in the central region of the English Chalk seems still in doubt, but Sarsden village, near Andover, has been suggested as a possibility. The grey sandstone of which sarsens are composed is widely known through its use at Stonehenge; but the original bed in the Eocene series seems to have been completely broken up by denudation. The sarsens lie as relics on the surface, with detrital deposits worn from the Eocene strata and the Chalk, and an instructive photograph has now appeared in the Geological Survey Memoir on the country around Beaconsfield (Ordnance Survey, 1922, price 2s.). Here we are shown great blocks lying in the "clay-with-flints" of Buckinghamshire, and we learn that the stones are sought for by boring in the hope that the tool will strike on one. Following prehistoric practice, the builders of Windsor Castle gathered sarsens, and they are still the only useful stone to be found in the Beaconsfield district.

Citrus Fruit from South Africa.—Investigations on waste in export citrus fruit were carried out by Miss Thomson, and Messrs. Putterill and Hobson, during 1920 and were continued during 1921, and the results are embodied in a report, Bull. No. 1, 1922, Union of S. Africa, Dep. of Agriculture, Pretoria, 1922. Care in handling is perhaps the principal factor upon which elimination of waste depends. The slightest damage in packing or in the subsequent handling of the cases tends to induce discoloration and the development of moulds which spoil the fruit. Cargoes can be successfully shipped to this country not only in cold storage, but also in holds without cold storage provided they be properly ventilated and the fruit undamaged. Proper wrapping of the fruit in special wax tissue wrappers reduces wilting considerably. The best cold storage temperature lies between 43° and 50° F. Change in flavour is particularly induced by a temperature below 40° F., probably by killing the cells, thus allowing the acrid-tasting constituents of the skin to penetrate to the juicy part of the fruit.

British Mycology.—Volume 8, Parts I. and II. of the Transactions of the British Mycological Society contains Mr. Carleton Rea's presidential address; the views expressed by Mr. Rea as to the value of certain continental revisions of the systematic arrangement of the larger fungi will carry very great weight and, in the future, the microscope will certainly figure more prominently in the work of British mycologists. J. Line shows good reasons for regarding with suspicion the advent of the well-known "coral spot" fungus, *Nectria cinnabarina*, among a plantation of pruned red currants; the fungus apparently spreads slowly from dead spurs into the healthy tissues with disastrous effects ultimately. The paper by J. Ramsbottom upon orchid mycorhiza is reprinted in full from Messrs. Charlesworth and Co.'s catalogue; it is a scientific contribution of very general interest and at the same time a tribute to the memory of a remarkable orchid grower, the late Mr. Joseph Charlesworth. Among other papers should be noted Dr. M. C. Rayner's critical analysis of the claim recently made by Christoph to have raised healthy Colluna seedlings free from mycorhizal infection. W. B. Crow's account of that curious bacterial organism *Leuconostoc mesenteroides* is an interesting example of the significance that may attach in classification to the chemical constitution of a plant membrane: another step towards the distant day when chemical knowledge may be freely used to underpin the elaborate framework erected by the systematist.

Brown Bast Disease of Rubber Trees.—A. Sharples has recently published (*Malayan Agricultural Journal*, vol. x. No. 6, June 1922) a résumé of recent experimental work in Malaya upon this problem, which is perhaps less urgent for the moment as the industrial depression has decreased the demand for rubber, and the one fact that seems firmly established in connexion with this disease is that its spread coincides with efforts to get more latex from the trees. Sharples chronicles briefly the progress of investigations promoted by a representative Brown Bast Investigation committee formed in Malaya in 1918, but owing to changes of personnel this committee appears to have ceased to function in 1920 although investigations still proceeded. He also passes in critical review a number of papers recently published on the subject which were also noticed in NATURE for March 16, 1922 (vol. 109, p. 357). One general result of the investigations under the auspices of the committee is to strengthen the conclusion, also reached by Rands in Java, that while various organisms may be casually connected with the disease, none can be considered causal and the disease must apparently be definitely added to the list of pathological physiological conditions of obscure origin. In view of confident assertions by Keuchenius in Sumatra that bacterial inoculations produced a similar disease, this conclusion was very critically re-examined and comparative inoculations made with the organism used in Sumatra; the evidence against bacterial causation thus accumulated is very convincing. On the other hand, the Malayan experiments supply further experimental evidence that increased tapping of the latex, either by more frequent incision or by a wider cut, greatly increases the percentage of trees attacked by brown bast. Sharples reviews recent suggestions that various anatomical peculiarities may throw light upon the pathology of the disease. He regards the pockets of laticiferous tissues enclosed within wound cork, recorded by Sanderson and Sutcliffe, as after-effects of little value in elucidating the causes of the disease, and he points out that lignification and necrosis of sieve-tubes, such as is recorded by Farmer and Horne, may frequently be seen in perfectly healthy plants.

RAINFALL IN 1922.—The British Rainfall Organization, which now forms a part of the Meteorological Office, Air Ministry, has made a hurried scrutiny of the rainfall records for 1922 in time for insertion in the *Meteorological Magazine* for January, which is published in the middle of the month. Several thousand returns are said to have been already received and a selection has been made of those for which average returns exist; 280 such records have been examined and they afford sufficient data for the construction of a rainfall map. The rainfall for the individual months shows that the rain over the country as a whole was close to or above the average except in the autumn. The total was excessive over England in July, yielding locally more than double the average. October was exceptionally dry, the rainfall being in England and Wales 33 per cent. of the normal, in Scotland 59, and in Ireland 37 per cent. In England and Wales the only months with a deficiency of rain were May, June, October, and November. In Scotland there were six months with an excess and six months with a deficiency, the first seven months being wet with the exception of March. In Ireland there were only five months with a deficiency of rain; these were March, May, June, October, and November. The country as a whole had practically the normal fall for the year. The *Times* for January 29 had a detailed article on the rainfall of the past year, in agreement with its practice followed for many years past. It shows that 1922 was almost entirely devoid of remarkable features. Among the selection of records available the variations of rainfall registered in 1922 ranged from 115·25 in. at Seathwaite to 18·66 in. at Shoeburyness. The map giving the rainfall over the British Isles shows that there was a general deficiency of rain in Scotland and Ireland and a general excess over England, although in the extreme south-east, where the drought of 1921 reached its climax, the rainfall of 1922 was again below the average; but the deficiency apparently nowhere exceeded 10 per cent. The date given at head of Table II. for all columns except the average should be 1922 and not 1921.

RECENT VOLCANIC ACTIVITY IN S. AFRICA.—Dr. P. A. Wagner has written a very thorough and interesting memoir on "The Pretoria Salt-pan, a soda caldera," for the Geological Survey of S. Africa (Mem. No. 20, 1922, price 7*s*. 6*d*.). A saline lake some 25 miles north-west of Pretoria has long been used by natives as a source of common salt, and in recent years it has been worked on a commercial scale on account of the sodium carbonate in its waters. Excellent photographs are given of this *zoutpan* in its primitive and its industrialised conditions; but the most interesting of the numerous illustrations are those showing the form and the walls of the depression in which it lies. The author proves clearly that we are here dealing with a true caldera of explosion. If at any time a layer of volcanic scoriæ covered the broad cone of eruption, all traces have disappeared through denudation. It is far more probable that the walls were built up entirely of fragments exploded from the granite and dolomite that underlie the area. Their structure is seen in a number of cliff-sections, and the freshness of the whole ring suggests a Quaternary age for the paroxysm that actually domed up the granite cover and flung the fragments for 1700 feet on all sides from the central pipe. The perimeter of the caldera measures 11,100 feet. The saline layers from which the soda is mainly derived are a trona bed above and a bed of the rarer carbonate, gaylussite, in the muds below. There is a remarkable absence of sodium sulphate. Dr. Wagner gives good reasons for regarding the salts as of magmatic origin. Now that a kimberlite pipe in the Cape Province has been proved to be of post-Neocomian age (see NATURE, vol. 110, August 19, 1922, p. 262), evidence of volcanic outbreaks linking the southern region with the still active areas near the great lakes will be sought for with a lively interest. Folding sections and a map on a large scale accompany this comprehensive memoir.

PALÆOBOTANY AND THE GONDWANA CONTINENT.—Recent contributions to palæobotany will be found in the Quarterly Journal of the Geological Society, vol. 78, Part 3, where Prof. A. C. Seward describes carboniferous plants from Peru (pp. 278-83), and Seward and R. E. Holttum report upon Jurassic plants from Ceylon (pp. 271-77); and in the *Geological Magazine* (vol. 59, pp. 385-92, September 1922) Prof. Seward has a note upon fossil plants from the Tanganyika Territory. Dr. A. B. Walkom (Queensland Geological Survey Publication, No. 270) has recently commenced the publication of a monograph upon the Palæozoic Flora of Queensland, while the general issues and problems of distribution and of plant migration across regions of the globe that at the present day provide impassable oceanic or climatic barriers is raised by Prof. Seward in the Hooker lecture published in the Linnean Society's Journal for October 1922. These new palæobotanical data recorded above supply more facts for land areas that presumably were organically linked in Mesozoic times through the great Gondwana continent of which India now remains one of our most authentic relics. It is therefore interesting to note, from the address of Prof. B. Sahni delivered at the Indian Science Congress in 1921 (Journal and Proceedings of the Asiatic Society of Bengal, vol. 17, No. 4, pp. 152-75), that Indian botanists are taking an interest in the Indian fossil flora, as yet but little explored since the earlier work of Feistmantel, embodied in the "Fossil Flora of the Gondwana System." Prof. Sahni points out that so far Indian strata have given little but plant impressions, but with the recent microchemical methods for the microscopic study of such impressions, developed in the Cambridge laboratories and demonstrated by Mr. J. Walton at the British Association Meetings at Hull, fossil impressions may become as valuable and as definite in the results they yield as the plant petrifactions permitting anatomical study.

MEASUREMENT OF VERTICAL DIMENSIONS WITH MICROSCOPE.—In the Journal of the Quekett Microscopical Club (Ser. 2, vol. 14, No. 88, November 1922) Mr. F. Addey gives a note on the measurement of the vertical dimensions of objects by the use of the graduated fine adjustment, in which he shows from mathematical considerations that the true thickness of the object is its apparent thickness multiplied by the refractive index of the mounting medium, the cover glass making no difference. This result has been confirmed by actual measurements.

FOCUS APERTURE RATIOS OF MICROSCOPE OBJECTIVES.—In the Journal of the Quekett Microscopical Club (Ser. 2, vol. 14, No. 88, November 1922) Mr. E. M. Nelson discusses the focus aperture ratios of microscope objectives. If the values of the numerical apertures of objectives now available be plotted against the magnifying powers the resulting graph reveals several inconsistencies. In the present paper a new set of power aperture curves drawn up on a definite plan are given for the construction of objectives. The ideal value for the power aperture ratio, obtained from a consideration of the resolving power of the eye, cannot always be realised in practice. This ideal ratio expressed as an "optical index" (that is 1000 times the N.A. divided by the initial magnifying power) is shown to be 25, and in the proposed curve for achromats the low powers up to $\frac{1}{10}$ in. have an optical index of 20, after which the optical index is reduced and the curve becomes steeper, rising to a $\frac{1}{8}$ in. with N.A. 0·9. In the apochromats the optical index in the curve is maintained at 20 up to a N.A. of 0·8. For oil immersion lenses the optical indexes have to be reduced, and the proposed curve begins with a $\frac{1}{7}$ in. of N.A. 1·0 (optical index 14·3) and ends with a $\frac{1}{12}$ in. of N.A. 1·4 (optical index 11·7). If such schemes of ratios of aperture to power were adopted the initial magnifying power and the numerical aperture would become practically synonymous terms and a lens could then be accurately designated by its numerical aperture instead of by the focus, thus avoiding ambiguity where different tube lengths are used.

CONTACT CATALYSIS.—No. 30 of the Reprint and Circular Series of the National Research Council contains the first report of the committee on Contact Catalysis. The report, which has been drawn up by Prof. Bancroft, gives a summary of recent work and suggests that the two fundamental things to be done in the study of contact catalysis are: (1) To determine in what cases definite intermediate compounds are formed and what they are; (2) To determine what bonds and contravalences are opened when adsorption takes place, and to show that the opening of these bonds and contravalences accounts for the formation of the reaction products.

BACTERIA AND CONDENSER CORROSION.—An investigation on the influence of the fermentation products of bacteria on corrosion in engine condensers, conducted by Messrs R. Grant, E. Bate, and W. H. Myers, originated during the systematic examination of possible factors in the causation of corrosion, particularly pit-hole corrosion, in condensers of two power-houses of the Government Railways and Tramways, Sydney, N.S.W. (Rep. of the Director-General of Public Health, N.S.W., for the year 1920, Sydney, 1922, p. 171). It had been noticed that tube failures often occur after a long period of shut-down, even when a condenser has previously been immune from trouble. The authors point out that condensers generally retain a considerable quantity of water, complete drainage never being obtained with the usual horizontal setting. This stagnant water always contains a very high proportion of free and albumenoid ammonia and nitrates. Various micro-organisms of ammonia-producing types were isolated from the circulating and stagnant waters of condensers. Plates of copper, brass, and zinc introduced into cultivations of these organisms underwent corrosion and pitting, photographs of which are reproduced. It is concluded, therefore, that the activity of micro-organisms as a factor in starting or causing corrosion must be seriously considered. If corrosion were a purely thermal or chemical effect, the pitting might be expected to increase steadily with temperature; actually, it is found to be more in evidence in low temperature condensers, which supports the micro-organismal theory.

FRENCH STREAM GAUGING APPARATUS.—In a notice recently issued from the gauging station of the University of Toulouse at Ponts-Jumeaux, a description is given of the log used by the French Service des Forces hydrauliques and the method of calibration adopted. The log is essentially a screw of a special form, attached to a revolving axis mounted on ball-bearings in the body of the log. The apparatus is designed in such a way that the axis lies in the direction of the current, and the screw encounters the liquid filaments in front. The relationship between the rotations n of the screw and the velocity v of the water is in the following form: $v=a+bn$. The determination of the speed of the screw in revolutions per second is carried out as follows. The axis of the screw engages by a worm in a cogged wheel, designed so that the screw makes N revolutions for a single revolution of the cogged wheel. This number, N, is fixed for any particular log and is generally equal to 25 or 50. A cam carried by the cogged wheel comes in contact at a fixed point of each turn with a spring plate connected with an insulated electric terminal on the body of the apparatus and thus closes an electric circuit actuating a bell. By measuring the time T, which passes between two consecutive signals, there is deduced therefrom the number of revolutions of the screw per second ($n=N/T$) and the movement of the water can be calculated. The coefficients a and b are determined in the process of calibration. For the purpose of calibrating the apparatus, a carriage with a platform is propelled at a certain speed while the instrument it supports is drawn through still water. During a sufficiently long series of runs, the speed of the carriage is related to the number of revolutions of the screw, and a curve, which is generally a straight line, can be drawn. A cement-lined channel 75 metres long, 2 metres wide, and 1 metre deep is used for calibration.

The Conduction of Excitation in Mimosa.

THE problem of the conduction of excitation in organisms is one that concerns both plant and animal physiologists, and any advances in our understanding of conduction in either kingdom should be of common interest to all. Yet certain recent discoveries concerning excitatory conduction in plants have so far not become very widely known.

The problem comprises essentially two questions: first, what is the nature of the excitation itself? and secondly, how is excitation at one point in an organ able to lead in turn to excitation at a neighbouring point? As to the first, there may perhaps be indications that excitation is something fundamentally similar in all protoplasm; but as to the second, it may well be that the link connecting the excitation of one point with that of the next is quite different in the case of different organs. In one case the nature of the link seems now to be well established—namely, in the case of species of the "sensitive" genus Mimosa, on which Dr. U. Ricca [1] has carried out a remarkable series of experiments.

As is well known, the spread of excitation in these plants is revealed mainly by the fall of the main petiole of the doubly compound leaf, the forward movements of the secondary petioles, and the folding together upwards in pairs of the leaflets. These movements can be brought about by injuring a leaflet, and also by inflicting cuts or burns on the main stem of the plant, which may lead to the spread of excitation along the stem and out over several leaves. It is principally on this conduction in the stem that Ricca has experimented.

The starting-point of his work is the proof that, as maintained long ago by Dutrochet, the path of conduction is the wood and not the phloem or cortex. To establish this he has made use, not of the well-known *Mimosa pudica*, but of *Mimosa Sepzazzinii*, in which it is possible to remove completely, in a ring round the stem, the tissues external to the cambium, thus laying bare the wood.

Such ringing does not prevent the excitation from passing, as is shown by the closure of the leaflets in the leaves above the ringed zone, after a part of the stem below the ring has been stimulated by cauterisation. Conduction can therefore take place without cortex. Further, by removing one longitudinal half of the stem and then, in the remaining half, prising off the extra-cambial tissues from the wood, he has been able to investigate the effects of stimulating the two separately. Stimulation of the strip of wood leads to movements in the leaves above, even after the pith has been scraped away, whereas stimulation of the strip of phloem and cortex does not. Since the latter are known not to be insensitive to stimulus, it follows that they must be unable alone to conduct the excitation effectively.

Next Ricca confirms the fact, already known, that conduction can pass through a zone of the stem that has been completely killed by heat, and he also shows that even when a zone of 4-5 cm. is maintained at a temperature above 150° F. this does not prevent the supply of water to the leaves above, nor the conduction of excitation. Going further, he divides the stem transversely and inserts the cut ends into the expanded ends of a narrow glass tube 8 cm. long and 1 mm. in diameter. An earlier experiment with a wider tube (1916, "a," p. 94) is less convincing. Cauterisation of the stem below the tube was followed by closure of the leaflets above it; and if the stimulus was strong, a greenish substance was seen to issue from the lower cut end, and slowly to spread up the tube. The time taken by the coloration to spread agreed roughly with the time apparently taken by the excitation to pass the tube (see schedules, *loc. cit.*, p. 119 *sq.*).

Already these results suggested that conduction takes place by the transference of a soluble stimulating substance excreted by the stimulated cells; for increase of permeability and excretion of liquid is known to accompany excitation in Mimosa and other plants. The final experiment in confirmation of this was the extraction of the substance by preparing in a small quantity of water a large number of transverse sections of stem. Other cut branches were then placed with their cut ends in the liquid thus obtained, and thereby excitation was found to be set up in them and to spread gradually up from the cut end towards the apex, as shown by the successive movements of their leaves.

It seems clear then that conduction both in the glass tube and in the wood of the plant must be brought about by the movement of a stimulating substance with the water current. It cannot be due to pressure changes; first, because it is too slow (in one case 55 cm. in 1¼ hours: average values for *M. pudica* are 8-15 mm. per sec. in the petiole and 2-3 mm. per sec. in the stem); and secondly, artificial changes in pressure of the water-supply to cut branches were not found to result in stimulation.

In agreement with this, factors increasing transpiration and so accelerating the ascent of water in the stem were found to increase the rate of conduction. Still, it may remain uncertain whether movements of the water current alone can account for all cases of conduction in these plants, particularly for basipetal conduction in the leaves. In *Mimosa Spezazzinii* this takes place only with difficulty, and Ricca considers it due to the excretion of liquid from the stimulated region, which is then sucked away in both directions by neighbouring unstimulated tissues. In *Mimosa pudica* basipetal conduction takes place rapidly and easily. Possibly the activity of other living tissues along the conducting zone may in some cases be involved, even if it is not necessary for conduction in the stem. It is also desirable that the results should be confirmed by other workers in warm countries.

Comparison may be made with the conduction of excitation in the cotyledon of a grass seedling, which also seems to involve a stimulating substance. In this organ, various stimuli, striking on the tip alone, bring about a responsive curvature in the elongating region below. The excitation conducted from tip to responding region can pass through a layer of gelatin, after the tip has been cut off and stuck on again.[2] It appears that Stark (*loc. cit.*) has extracted the stimulating substance concerned. An excitatory process capable of passing through gelatin has also been found by the present writer in roots.

But in these cases the mechanism of conduction in the tissues is still obscure, and probably different from that found in Mimosa. It appears that conduction may here take place in parenchymatous tissues, and it is checked by local application of anæsthetics and other physiological agents.

R. SNOW.

[1] Ricca, U., "Soluzione d' un problema di fisiologia," *Nuovo Giorn. Bot. Ital.* 23, 1916, "a."
"Solution d'un problème de physiologie," *Archives italiennes de Biologie*, 65, 1916, "b."

[2] Boysen-Jensen. Ber. d. D. Bot. Ges., 31, p. 559. 1913. Páal, *Jahrb. f. wiss. Bot.* 58, 1918. Stark, *Jahrb. f. wiss. Bot.* 60, 1921.

The Third Air Conference.

By Prof. L. BAIRSTOW, F.R.S.

THE Air Conference at the Guildhall, London, occupied four sessions — the mornings and afternoons of February 6 and 7—the first day being devoted to the reading of papers, and the second to their discussion. Of the papers read, that of greatest interest to men of science was by Sir Geoffrey Salmond, the Air Member for Supply and Research on the Air Council, on "The Progress of Research and Experiment." Before referring to this paper and the subsequent discussion, it is desirable to note some of the points made by Sir Samuel Hoare, the Secretary of State for Air, who spoke immediately after the opening ceremony by the Lord Mayor of London.

It was pointed out that the new Air Ministry had only been in office for three months and that the time had been all too short for the determination of a fixed policy. Later speakers emphasised the importance of the earliest possible declaration of policy, and were not wholly inclined to agree that, so long as the world is in a state of confusion and uncertainty, military aviation must have the first and principal call on the nation's purse. It was argued that civil aviation will have the same relation to the Air Force as the mercantile marine has to the Navy, and that the most economical expenditure of money would lead to a rearrangement of the vote so as to give a greater share to the commercial aspect.

It was argued by one speaker that private enterprise would be ready to find the capital for aerial transport when once it felt certain of a continuous and sympathetic policy on the part of the Air Ministry. The Secretary of State for Air had previously said that he was trying to develop a consistent civil aviation policy, and for weeks past had been considering schemes for its organic development.

The Conference was assured that the Air Ministry fully realised the importance of research and was anxious to foster it within the limitations imposed by finance. It is necessary to bear in mind the fact that the word "research" does not mean the same thing to all men, but in the sense in which that word is understood by men of science, there is a marked improvement in policy. It may be some time before the effects of the change are evident in results, for we have fallen on evil days, but it is to the good that the tide has ceased to ebb.

The Air Ministry organisation was described by the Air Member for Supply and Research in his opening paragraphs. He said: "Perhaps I may be forgiven if I describe to you our organisation for research, as I fear it is sometimes misunderstood. In the first place, there is the Air Ministry charged with the general direction of research. The Air Ministry is advised by the Aeronautical Research Committee, either on the initiative of the Air Ministry or on the initiative of the Aeronautical Research Committee, as to the problems to be solved, or as to the methods by which they should be solved. A representative of the Aeronautical Research Committee works in the Air Ministry and has direct access to me on all questions.

"The Aeronautical Research Committee does invaluable work in investigating all sorts of problems, and is wonderfully assisted in its work by the National Physical Laboratory and a whole body of scientists who give their services free to the nation, as well as by the great universities and consulting engineers.

"These organisations deal with the theoretical solution of air problems in the domain of pure research. But research cannot stop here; its practical application has to be considered, and this portion of the work is carried out by the Royal Aircraft Establishment at Farnborough and various experimental stations such as the Aircraft Experimental Establishment at Martlesham, and the Marine and Armament Experimental Establishment, Isle of Grain.

"A third organisation also exists, and that is the Aircraft and Aero-engine Constructors, who maintain most capable designing staffs who constantly bring forward solutions of problems, which enable us to step forward. I would be failing in my duty if I did not here acknowledge the debt this country owes to all these organisations, the joint efforts of which have undoubtedly brought our world position as regards research to a position second to none."

This constitutes the clearest statement of the organisation yet given, and it will be obvious to readers of NATURE that research as defined by the Air Member for Supply and Research has a much wider range than research as understood by men of science. In his interpretation, all technical development and experiment is included, and there is an absence of recognition of the usual criterion as to the fundamental or specific nature of the inquiry. It is in conformity with this definition that the Director of Research in the Air Ministry has wholly different functions from the Director of Scientific Research in the Admiralty. With adequate subdivision of funds and duties the matter of definition is unimportant, although the effect is the nominal allocation of a large sum for research, while in fact only a small fraction is devoted to scientific operations. There are marked indications of a welcome change, and that the advice of the Aeronautical Research Committee as to need for greater attention to fundamental inquiries is being acted on.

Sir Richard Glazebrook, chairman of the Aeronautical Research Committee, made during the Conference a special appeal for fundamental research, giving as subjects the study of the motion of viscous fluids from first principles, the provision for full scale research on airships should these again come into operation, and the study of the motion of aeroplanes in flight. All these forms of inquiry are greatly assisted by laboratory experiments and wind channel tests on models of aircraft.

The mathematical treatment of viscous fluid motion has not hitherto received any direct recognition by the Air Ministry, although the programme of the Aeronautical Research Committee leaves an opening for the staff of the National Physical Laboratory. The inquiry is, however, being fostered by the Department of Scientific and Industrial Research, and by the governors of the Imperial College of Science and Technology. Sir Richard Glazebrook asked for favourable consideration of such research by the Air Ministry.

The position of airship research was shown by the inquiry into the disaster to R38, but, in pursuance of instructions from the Air Ministry, the Aeronautical Research Committee has been unable to carry out its programme. A paper by Commander C. C. Burney on "The Establishment of a Self-Supporting Airship Service" has led to a reopening of the subject and to a divergence of opinion between the Air Ministry and Admiralty which is generally regretted. It appears that the Admiralty needs airships and is prepared to pay for them, but that the Air Ministry considers itself to be the proper body for supervising their construction. While it is hoped that the latter body will prevail, it would appear to require a change of policy and a real desire to retrace its disastrous past. Sir Alan Anderson expressed the point briefly when he asked whether it was really necessary to build airships at considerable cost in order to put them into sheds and let them decay. Probably this action, typical of late policy, had much to do with the objections voiced by representatives at the Air Conference to the predominance of a military policy.

For heavier-than-air craft the feeling of the Conference appeared to be that the tide was turning, notably in the case of fundamental research. Sir Geoffrey Salmond mentioned many specific experiments and a few fundamental inquiries. Those relating to safety and trustworthiness received most attention in the discussion; but one item can be dealt with here. The dangers of flying are few so long as the engine is running perfectly, a state which cannot be relied on to persist for many consecutive hours. Failure of the power plant brings about a forced landing, and where the ground is unsuitable an accident follows. The dangers are increased by a peculiarity of an aeroplane when its wings are inclined to the wind at more than twenty degrees, for it then becomes uncontrollable. During the past year the trained and skilled experimental pilots of the Royal Aircraft Establishment, working in co-operation with a panel of the Aeronautical Research Committee, have modified an aeroplane and flown it at an angle of forty degrees. This is a momentous advance, for it leads to the hope that the danger arising from lack of control may be greatly reduced by further knowledge. It is therefore gratifying to find that the Air Ministry is ready to provide special aeroplanes solely for research by the Aeronautical Research Committee. It will be necessary to develop instruments for the inquiry, for we are still without adequate means of observation in flight except for the simplest types of motion, but again the Air Ministry is ready to give assistance.

Our lead in aeronautical research has been greatly reduced by America, but we appear to be regaining our power for progress, and a continuation of present policy may be expected to lead to that progress in aviation which is so clearly required for projected developments in civil aviation and for the defence of the realm.

Industrial Applications of the Microscope.

A MEETING of the Royal Microscopical Society was held on January 24, for the purpose of inaugurating an important departure in the history and attitude of the society towards national industry by the formation of a special section to deal with the industrial applications of the microscope.

Prof. F. J. Cheshire, president of the society, in his opening address, said that many years ago it had been seriously contended by some pessimistic fellows of the Society that its principal work of usefulness was done. Events of late years, however, had refuted that contention. Why, it was asked, have we a Royal Microscopical Society and not a Royal Telescopical Society? The answer was obvious. In the case of the telescope, practically any tyro could take out an instrument, of which he knew nothing or very little, direct it to the moon or any other object, and could, with a little practice, obtain the very best image which that telescope was capable of giving. The microscope could not be used in that simple way. It was the most complicated of all the optical instruments in common use, and it demanded, in its user, a considerable amount of optical knowledge and manipulative skill before it could be used efficiently and satisfactorily. The use of the microscope as a tool was extending day by day, advancing step by step with the recognition of the great importance of the study of micro-organisms and micro-structures. The Royal Microscopical Society had already carried out certain work in connexion with the industrial applications of the microscope. Sections, dealing with metallurgy, the manufacture of leather and of paper, had been in existence for a short time, but it was recognised that these specific sections made it difficult for the society to deal, as it ought to do, with the practical applications to new industrial work. In these circumstances it had been decided to form a large general section dealing with industrial applications of the microscope. The work of the section would be to encourage, in every possible way, the use of the microscope in industry and, at the same time, to give the most generous assistance to workers in the new fields of endeavour. Any one interested, whether a fellow of the Society or not, would be cordially invited to attend the meetings of the section.

A communication by Dr. F. J. Brislee dealt with the necessity of providing facilities for more definite instruction and training in the practical use and manipulation of the modern microscope, and outlined the manner in which the Royal Microscopical Society could be of assistance to those who had to use the microscope in industrial processes. Dr. Brislee further indicated the lines on which this practical training should proceed, starting with low-power work, the preparation, mounting, and examination of specimens, and proceeding gradually to the more difficult problems.

Dr. J. S. Owens (Superintendent to the Advisory Committee on Atmospheric Pollution) read a communication on atmospheric pollution. The importance of this subject to those working in large factories and to the general health of the community was insisted upon, and many interesting exhibits and lantern slides illustrated the means by which samples of polluted air were collected and examined. The method adopted is one in which a given volume of air is collected and then deprived of suspended matter by causing it to issue from the container as a jet and impinge against a prepared glass surface. Many unsolved problems were submitted to the meeting and suggestions invited as to the best methods of determining the actual nature of the particles of dust, oil, micro-organisms and other foreign matter collected.

In connexion with the leather-making industry, Dr. Browning suggested the more general use of the microscope in the control of the various processes. He showed sections of skin before and after puering, and stated that *if* it was necessary to remove the elastic tissue by puering, then this could be controlled only by the use of the microscope. Samples examined from several sources showed that different manufacturers were content with more or less removal of the elastic tissue. They could not all be right. Every detail in the preparation of specimens and the cutting of sections of leather was practically demonstrated by Miss Scott, and finished slides were exhibited.

Apparatus specially constructed for research work in many industries was demonstrated and described by Messrs. J. W. Atha and Co., R. and J. Beck, Ltd., The Cambridge and Paul Instrument Co., Ltd., Ogilvy and Co., J. Swift and Son, and W. Watson and Sons, Ltd.

Prof. Michelson's Work in Astronomical Interferometry.

MR. POST-WHEELER, who is on the staff of the American Embassy, attended at the annual general meeting of the Royal Astronomical Society on February 9 to receive the gold medal on behalf of Prof. A. A. Michelson, who was unable to be present himself.

Prof. Eddington gave a most illuminating address on the reasons of the award, explaining that the necessity for the great separation of the mirrors receiving the pencils of light from the stars was to give sufficient difference of length of path to enable the rays from the two extremities of a diameter of the star to be in opposite phase, so that the bright regions of the image from one extremity should fall on the dark regions of the other and so cause the fringes to vanish. It was mentioned that the method had been successfully applied to the measurement of the diameters of Jupiter's satellites, but the stars seem to have been considered hopeless, till recent physical work on the distribution of energy in the spectrum led to the conclusion that the red stars have such dull surfaces that the brighter ones must have appreciable discs in order to give so much light.

The actual figure had been calculated for Betelgeuse, and the observed diameter afterwards proved to be very close to it.

Some letters from Mr. Pease were read, in which he described the great practical difficulties that were incurred in applying the method of diffraction fringes, and the long-continued trials that were finally crowned with success. One of the earliest successes was the determination of the orbit of Capella. This gave, for the first time, a really accurate value of the mass and absolute magnitude of a giant star, which had already proved of use in the physical studies that were being made on these bodies.

A recent interesting development of the Betelgeuse measures was that the diameter came out different at different times, to an extent much beyond the probable errors of the measures. Attempts were being made to correlate these changes with the variable brightness and variable radial velocity of the star, but it will be necessary to carry on these measurements for some time before a definite conclusion could be reached.

Prof. Eddington went on to point out that the famous Michelson-Morley experiment, for which the Copley medal of the Royal Society was awarded in 1907, though not specially contemplated in the present award, might be considered as coming within its terms; for the measures were made by interference methods, and the question whether the movement of the earth through the ether could be detected was one of the highest astronomical interest. He knew that their medallist was disappointed at the negative result, but the whole of the system of relativity had been founded upon it, so that in his (Prof. Eddington's) opinion it was more fruitful than a positive result would have been.

In handing the medal to Mr. Post-Wheeler he asked him to transmit to Prof. Michelson their congratulations on his success and their good wishes for the long continuance of his fruitful labours. Mr. Post-Wheeler replied in a few suitable words expressing his sense of the pleasure it gave him to be there as the representative of America, and thanking the Society for the honour they had conferred upon his country in the person of Prof. Michelson.

University and Educational Intelligence.

BIRMINGHAM.—The Mitsui family of Japan has made a gift of 5000*l*. to the faculty of commerce. The Council has decided to apply the gift to the foundation of a chair of finance which, in view of the personal connexion of the Mitsui family with the university and of their generous contribution to its funds, is to be designated the Mitsui professorship of finance.

Mr. F. W. M. Lamb has been appointed assistant lecturer in pathology.

At the annual meeting of the Court of Governors, the principal appealed for more assistance from the districts surrounding the city. These districts at present contribute only 3500*l*. per annum to the university as against 15,000*l*. given by the city, although half the students come from outside the city.

CAMBRIDGE.—Mr. J. B. S. Haldane, New College, Oxford, and Trinity College, has been appointed Sir William Dunn's reader in biochemistry. Mr. A. Hutchinson, Pembroke College, has been appointed University lecturer in crystallography. Dr. C. Shearer, Clare College, has been appointed University lecturer in embryology.

MANCHESTER.—The following lecturers have been appointed: physics, Dr. J. C. M. Brentano; engineering, Mr. H. W. Baker; biological chemistry, Mr. A. D. Ritchie.

OXFORD.—The vice-chancellor has appointed Sir Archibald E. Garrod, Regius professor of medicine and student of Christ Church, to act as deputy for the current term to Dr. Rudolph A. Peters, fellow of Gonville and Caius College, Cambridge, who has recently been elected Whitley professor of biochemistry in succession to the late Prof. Benjamin Moore.

The Weldon memorial prize, which was founded in 1907 by friends of the late Prof. Weldon, to perpetuate his memory and to encourage biometric science, has been awarded to Dr. Johannes Schmidt, director of the Carlsberg Laboratory, Copenhagen. This prize is awarded every three years, without regard to nationality, sex, or membership of any university, to the person who, in the judgment of the electors, has, in the six years next preceding the date of the award, published the most noteworthy contribution to biometric science. Previous recipients of the prize have belonged to St. Andrews, London, and Washington University, St. Louis. On one occasion it was awarded to a lady, Miss Ethel M. Elderton, fellow of University College, London.

SHEFFIELD.—Mr. W. Vickers has been appointed lecturer in education and master of method.

PROF. R. V. WHEELER, professor of fuel technology in the University of Sheffield, has been awarded the Greenwell medal of the North of England Institution of Mining and Mechanical Engineers, for his researches on coal.

THE first of a special series of lectures on "Master Minds and their Work," arranged in connexion with the London County Council's scheme of lectures for teachers, was delivered at King's College on February 14 by Dr. Charles Singer, whose subject was Leonardo da Vinci (1452–1519). The object of the series is to illustrate, by the history of the work and influence of a few great men of various nationalities, the truth that in the study of the history of science is to be found a strong appeal to the spirit of community among men. It is suggested that this line of study will show that all nations have borne their share in building up the structure of knowledge according to the opportunities and civilisation of the times. Succeeding lectures are as follows:—February 21, Descartes (1596–1650), Prof. H. Wildon Carr; February 28, Newton (1642–1727), Prof. A. R. Forsyth; March 7, Pasteur (1822–1895), Sir D'Arcy Power; March 14, Helmholtz (1821–1893), Sir W. M. Bayliss; March 21 (at University College, Gower Street, W.C.1.), Darwin (1809–1882), Prof. Karl Pearson.

THE annual prize distribution was held at the Sir John Cass Technical Institute on Wednesday, January 31, and the awards were distributed by Sir Thomas Holland. The chairman of the governing body, the Rev. J. F. Marr, in giving a summary of the work of the Institute during the past session, stated that during this period a total of 1073 students had been in attendance—the highest figure yet attained. The year had not been an easy one, for financial considerations were and still are conspicuously in the foreground. The needs of technical education cannot be satisfactorily met without mutual trust and confidence between the public authorities and those administering the funds placed at their disposal, and without a full belief in the national value of technical education. Despite the restricted accommodation in the science departments, 31 students had been engaged in research work and five papers had been published, bringing the total number of original investigations issued from the Institute to 120. For the second year in succession a student of the metallurgy department had been awarded the first prize (Silver Medal) in the City and Guilds of London Institute examination in non-ferrous metallurgy.

THE Attorney-General, Sir Douglas McGarel Hogg, distributed the prizes at the Borough Polytechnic on Friday, February 2. Mr. J. Leonard Spicer, chairman of the governors, referred to the fact that Sir Douglas Hogg's father, Mr. Quintin Hogg, was the founder of the great Polytechnic in Regent Street, and Sir Douglas himself had throughout his life been associated with that Institute. Sir Douglas Hogg, in his address, said with regard to the work of the Institute, that it was not their desire to turn out a number of half-fledged amateurs to compete with the men in the workshops, but by technical instruction to enable those in the workshops to make themselves more efficient and to make greater progress in the industry to which they belonged. The policy of the governors in supplementing the experience of the workshop by trade instruction, and of selecting teachers who themselves had worked in the trades, is undoubtedly sound. The women's side of the Polytechnic is strong, and some of the activities of the Borough Polytechnic are unique in the south-eastern counties of England; the School of Bakery and Confectionery has no parallel, and the Department of Painters' Oils, Colours and Varnishes represents highly specialised and valuable technological departments. The Polytechnic has received valuable assistance from expert trade committees, trades unions, and associations of employers, in order to keep its work closely related to the current needs of industry. Principal Bispham, in his report, stated that both in quality and bulk the work of the past session was a record one and altogether a worthy tribute to the former principal, Mr. C. T. Millis, who has recently retired.

Societies and Academies.

LONDON.

Royal Society, February 8.—L. **Bairstow**, Miss B. M. **Cave**, and Miss E. D. **Lang**: The resistance of a cylinder moving in a viscous fluid. The equations of motion of a viscous fluid in the approximate form proposed by Oseen are taken as a basis for calculations of the resistance of a circular cylinder and the surface friction along a plane. In the case of the circular cylinder experimental information obtained at the N.P.L. is wholly suitable for the purposes of comparison with the present calculations. A resistance coefficient is found which is about 30 per cent. greater than that observed at the limit of the range of observation. Calculations for the plane show singularities at the edges, but lead to a resistance which is in rough agreement with experiment.—G. I. **Taylor**: The motion of ellipsoidal particles in a viscous fluid. According to Dr. G. B. Jeffery ellipsoidal particles immersed in a moving viscous fluid assume certain definite orientations in relation to the motion of the fluid. Ellipsoidal particles of aluminium and immersed in water glass take up such positions, but they take a long time to get to those positions. In the meanwhile they oscillate in the way indicated in Dr. Jeffery's analysis.—W. E. **Dalby**: Further researches on the strength of materials. In a new apparatus, an alternating load, push and pull, can be applied to a test piece in such a way that the curves of load and elastic extension are recorded photographically. The yield in tension and compression is found to be substantially the same, and the modulus of elasticity is the same, but alternating load is met by alternating response. When a load of either sign is removed the response is elastic, but imperfectly so. When a load is re-applied, but of opposite sign to the load removed, the response is mainly plastic. By means of a new instrument an alternating torque can be applied to a test piece in such a way that the curves of torque and elastic twist are recorded photographically. This shows that alternating torque is met by an alternating response in shear. It is possible to predict a practical fatigue limit from these diagrams.—Lewis F. **Richardson**: Theory of the measurement of wind by shooting spheres upward. A steel sphere, about the size of a pea or a cherry, is shot upwards from a gun, which is not rifled. The gun is inclined from the vertical towards the advancing air, and the tilt adjusted by trial until the returning sphere falls very close to the gun. The tilt is then some measure of a weighted average of the wind, in the region extending from the ground up to the maximum height attained. This height is found from the time of absence of the sphere. The observation of the tilt and time is repeated for greater and greater heights in succession. Mathematically speaking, the problem involves a "linear integral equation of the first kind," which is solved approximately by transforming it into a moderate number of algebraic simultaneous equations. In the general part of the theory an approximation which fails at the vertex of the trajectory is made. A special and sufficiently correct theory or a correction to the general theory meets this difficulty.—Ernest **Wilson**: On the susceptibility of feebly magnetic bodies as affected by tension. When magnetite is subjected to tensile stress of 50-130 kgrm. per sq. cm. as a maximum, the susceptibility for a given value of the magnetic force at first increases and then decreases as the specific load continuously increases, and exhibits a reversal point as in iron. The magnetic force at which the percentage increase in permeability has a maximum value is less than the magnetic force at which maximum susceptibility occurs.—L. C. **Jackson** and H. Kamerlingh **Onnes**: (1) Investigations on the paramagnetic sulphates at low temperatures; (2) Investigations on the paramagnetism of crystals at low temperatures.—W. D. **Womersley**: The specific heats of air, steam, and carbon dioxide.—D. W. **Dye**: The valve-maintained tuning fork as a precision time standard. The valve-maintained fork is steady in frequency to a degree beyond that required for most purposes. The most serious cause of variation of frequency is that due to temperature. The temperature must be kept constant to 0·1° C. if accuracy to one part in a hundred thousand is required. By the use of a special steel ("elinvar") having a very small temperature coefficient of elasticity, it is probable that the variation of frequency with temperature could be reduced to one-tenth that of ordinary steel forks. The other factors causing variation of frequency are not themselves variable without attention to an extent which would cause a variation of more than a very few parts in a hundred thousand. By suitably choosing the capacities and the anode voltage, a variation of voltage of ±10 per cent. will cause a change of only about one part in a million in frequency.

Geological Society, January 24.—Prof. A. C. Seward, president, in the chair.—S. H. **Haughton**: On reptilian remains from the Karroo beds of East Africa. Three specimens of a small fossil from black shale from the middle of the Karroo formation, near Tanga, on the coast of Tanganyika Territory, represent a new genus and species of aquatic reptile resembling Mesosaurus. It may be regarded as an aquatic adaptation of Youngina. If so, the shale at Tanga is approximately of the same age as the Middle Beaufort beds of South Africa.—Rev. C. **Overy**: Glacial succession in the Thames catchment-basin. A definitive succession-grouping for high-level gravels of the Thames catchment-basin is established. A norm series with effective nomenclature for the Berkshire-Oxfordshire area is suggested, namely, P_{350}, P_{300}, P_{265}, P_{230}, P_{210}, P_{160}, P_{135}. Grading and analysis in the Hampshire and London areas result in the establishment of the norm series for the whole river-system. In this way light is thrown on the age of the Goring Gap, the mode of deposition of the plateau-gravels, glacial succession in the Thames basin, and the bearing of the distribution of drift constituents on the history of the Thames river-system. Evidence is given for the course of the pre-Pleistocene Thames, for the continuity of the Evenlode, Goring Gap, Henley Gorge, Colne-Lea divide, and Essex-coast system.

Physical Society, January 26.—Dr. Alexander Russell in the chair.—C. **Chree**: A supposed relationship between sunspot frequency and the potential gradient of atmospheric electricity. Dr. L. A. Bauer has concluded that both the range of the diurnal inequality of atmospheric electricity potential gradient and the mean value of the element for the year increase and diminish with sunspot frequency. The conclusion was based on observational data from the Ebro Observatory, Tortosa, Spain, between 1910 and 1920. Kew electrical data from two periods of years, the Ebro data utilised by Dr. Bauer, and magnetic data from Kew Observatory were treated mathematically. The results indicate that if a relationship of the kind exists, the sunspot influence must be very much less in the case of atmospheric electricity than in that of terrestrial magnetism.—J. J. **Manley**: A further improvement in the Sprengel pump. The pump was described in Proc. Phys. Soc., vol. 34, p. 86. The present improvement provides a mercury seal during periods when the pump is out of use, whereby the formation of fresh-air skins is prevented.—D. **Owen**: Null methods of measurement of power factor and effective resistance in alternate current circuits by the quadrant electrometer. The methods are extended to high-tension circuits. The usual formula for the quadrant electrometer is applicable only when the needle is maintained at its mechanical and electrical zero.—C. E. **Prince**: An electro-capillary relay for wired wireless. The relay is intended for use with a calling device in connexion with high-frequency currents acting as carrier waves for telephony over power-mains. The high-frequency current is rectified and passed through a thread of mercury which is contained in a capillary tube, and is in contact at each end with some acid containing platinum leads. The passage of the current causes the mercury thread to move. The capillary tube is arranged horizontally on a beam which, as soon as the mercury moves, overbalances in consequence of the weight of the latter and closes the circuit of a call bell or lamp. In series with the thread and with a rectifier is arranged a condenser in which the charge that has passed round the circuit is stored, and after the call this charge is sent through the mercury and acid in the reverse direction; this restores the mercury to its original position. If the call be unanswered the same result is produced more slowly by a high-resistance leak. The instrument responds to currents of 4 or 5 or even 2 microamperes. The total movement appears to be proportional to the coulombs which pass.

Linnean Society, February 1.—Dr. A. Smith Woodward, president, in the chair.—Sir Sidney F. **Harmer**: On Cellularine and other Polyzoa.—Sir Nicholas **Yermoloff**: Notes on Chætoceros and allied genera, living and fossil. Chætoceros is highly differentiated for pelagic life; it occurs in the planktons of the colder seas, sometimes, especially in spring, in colossal numbers. Some 100 living species have been described, but only 6 or 7 are common in the planktons. The parent cells, each consisting of two valves with a hoop between them, form colonies, holding together by means of long setæ; they have thus great floating capacity. Several species develop internal organs, covered with a thick siliceous wall, called statospores, inside the mother-cells. Their function is not known. The mother-cells, or colonies, as such, never appear in any fossil marine deposits, though the spores appear fairly often. The spores of Chætoceros have been taken in the past as separate Diatom genera, and classified and named as such. Fossil spores of Chætoceros are frequent in Miocene diatomaceous earths. The most common form is Syndendrium Ehr., the spore of *Chætoceros diadema* Gran, which is very common in the planktons.—H. L. **Clark**: Some echinoderms from West Australia.

CAMBRIDGE.

Philosophical Society, January 22.—Mr. C. T. Heycock, president, in the chair.—Sir Joseph **Larmor**: (1) The stellate appendages of telescopic and entoptic diffraction. (2) Can gravitation really be absorbed into the frame of space and time? (*see* NATURE, February 10, p. 200).—H. F. **Baker**: The representation of a cubic surface upon a quadric surface.—H. **Hartridge** and F. J. W. **Roughton**: Measurements of the rate of oxidation and reduction of hæmoglobin. Methods were devised for estimating instantaneously the percentage saturation of hæmoglobin with oxygen, for mixing instantaneously either reduced hæmoglobin with an oxidising agent or oxyhæmoglobin with a reducing agent, and for preparing rapidly the reduced hæmoglobin solution in large quantities. Oxidation takes place exceedingly rapidly, in approximately one-hundredth part of a second at 10° C., whereas reduction takes approximately one second. The rate of reduction agrees with the formula deduced on the assumption that the reaction is mono molecular, and the ratio of the rates of the two reactions was of the same order as the value of the equilibrium constant. In the body both changes take place at temperatures considerably higher than those used. They would be expected therefore to be even faster (some ten or twenty times) in the body than in these experiments. —J. T. **Saunders**: A method of measuring the carbon dioxide output of aquatic animals. The method is based on the fact that, from measurements of the hydrogen ion concentration of solutions of bicarbonates of known concentration in equilibrium with carbon dioxide, the tension, and so the amount dissolved, of carbon dioxide can be calculated.—Miss D. **Eyden**: Changes in the specific gravity of *Daphnia pulex* L. *Daphnia pulex* increases in specific gravity immediately after feeding and diminishes after starvation. These changes may account for the vertical movements of forms living in the plankton.

DUBLIN.

Royal Irish Academy, January 22.—Prof. Sydney Young, president, in the chair.—A. K. **Macbeth**: The action of sulphur chloride on ammonia and on organic bases. The action of sulphur chloride on ammonia was examined quantitatively. No sulphur nitride hitherto unknown was isolated, but a new derivative containing sulphur, nitrogen, and hydrogen was described. This compound, which it is proposed to call hexasulphamide, appears to have the composition S_6NH_2. The action of sulphur chloride on the aromatic amines was examined qualitatively, and the course of the reaction at low temperatures was studied with *o*-toluidine, N-dithiotoluidine being isolated.—T. P. C. **Kirkpatrick**: Charles Willoughby, fellow of the King and Queen's College of Physicians. In 1690 Dr. Charles Willoughby wrote a paper dealing with the political economy and vital statistics of Ireland which he sent to William King, then Bishop of Derry. It was published in full in the Proceedings of the Royal Irish Academy in 1857. Recently a letter from King has come to light in which he gives information about the condition of the people in the country, and the difficulties in collecting statistical information. Some letters from Willoughby to King throw an interesting light on medical practice in Dublin at the end of the seventeenth century. While studying medicine in Padua, where he graduated M.D. in March 1663/4, Willoughby made a collection of botanical specimens, which he afterwards presented to Merton College. Willoughby was one of the founders, and was the first director of the Dublin Philosophical Society, and in 1675 he was elected president of the College of Physicians. He died in 1694.

PARIS.

Academy of Sciences, January 22.—M. Albin Haller.—G. **Bigourdan**: The co-ordinates of the Observatories of Muette and Passy.—L. **Lecornu**: The orbit of Mercury. A development of a suggestion of M. Haag in a recent note, showing that the displacement of the perihelion of Mercury can be explained by adding to the Newtonian attraction a small tangential force and a small force directed towards the sun.—L. **Maquenne**: Remarks on a recent communication of MM. P. A. Dangeard and Pierre Dangeard. A discussion of some consequences of the observation that leaves of *Aucuba japonica* suffer no loss of vitality over a period of several months if preserved in a vacuum and exposed to light.—E. **Leclainche** and H. **Vallée**: Vaccination against symptomatic anthrax by toxins. A discussion of the difficulties and limitations attending vaccination by toxins derived from *B. Chauvoei*.—A. **Blondel**: The determination as a function of the initial conditions of the free oscillations of alternators working in parallel and connected individually with motors with theoretical regulation, instantaneous and fixed. Application to synchronous motors.—A. **de Gramont**: Observations on the structure of the chromium spectrum. Directing attention to the recent experimental confirmation by M. Catalan of the theoretical views propounded by the author in November 1922.—C. **Guichard**: Polar figures reciprocal with respect to a sphere.—A. **Guntz** and **Benoit**: The heat of oxidation of the metals of the alkaline earths. A repetition of earlier work with purer material. The heats of oxidation of calcium, strontium, and barium were found to be 152·7, 141·8, and 134·04 calories respectively.—A. **Bigot** and Mme. E. **Jérémine**: New observations on the geology of the Hague (Manche). M. Philippe Glangeaud was elected corresponding member for the section of mineralogy in the place of the late Otto Lehmann.—Erwand **Kogbetliantz**: The double means of Cesàro.—S. **Stoïlow**: Continued functions and their derivatives. —C. **Kuratowki**: The effective existence of functions representable analytically every Baire class.—M. **Alliaume**: The nomographic resolution of systems of equations.—H. C. **Levinson**: The Einstein gravitation of systems.—Emile **Picard**: Remarks on the preceding communication.—G. **Poivilliers**: A method of stereoscopic representation of topographical surfaces.—Paul **Dienes**: The relativist electromagnetic theory.—G. **Gire**: The dissociation of potassium chloro-iridate.—Pierre **Steiner**: The ultraviolet absorption spectra of the alkaloids of the isoquinoline group. Narcotine, hydrastine, and hydrocotarnine. The ultraviolet absorption spectrum of narcotine is determined by the benzene ring of its molecule; the isoquinoline nucleus only displaces the absorption towards the red end. For papaverine, on the contrary, it is the isoquinoline and not the benzene ring which is the determining factor.—A. **Catalan**: The structure of the arc spectra of molybdenum, selenium, and chromium.—F. W. **Klingstedt**: The ultraviolet spectra of aniline and the toluidines. The results are given in diagram form, and differ considerably from the data obtained by earlier workers in the same field. —Mlle. **Chamié**: The ionisation produced by the hydration of quinine sulphate. A direct connexion between ionisation and the amount of water taken up is proved.—A. **Bouzat**: A class of unstable hydrates known as hydrates of gases. Confirmation of M. Villard's hypothesis. Many gases form hydrates possessing the following properties: their formula is $M . 6H_2O$, they are unstable, formed with a small heat evolution starting with the constituents in the solid state, and on dissociation lose all the six molecules of water at once.—L. **Franchet**: A new industrial material of the neolithic age. An account of the discovery of neolithic agricultural implements made of polished sandstone, at Piscop.—Pierre **Lesage**: The persistence of the characters produced in plants by salt.—Antonin **Němec** and Kvapil **Karel**: The biochemical study of forest soils.—V. **Crémieu**: The growth of plants and the principles of physics.—L. M. **Betancès**: The ageing of the hæmatic cell.—G. **Ramon**: Dissociation of the diphtheria toxin-antitoxin complex and the recuperation of the antitoxin.—**F. Heim, E. Agasse-Lafont,** and **A. Feil**: The rôles of lead and turpentine in the professional pathology of painters. From a comparative study of painters divided into two groups, one using paints containing lead and the other working with lead-free paints, the authors conclude definitely that it is not turpentine but lead and its compounds which are the cause of renal lesions and hypertension in painters.

Official Publications Received.

Abstract-Bulletin of the Nela Research Laboratory, National Lamp Works of General Electric Company, Cleveland, Ohio. Vol. 1, No. 3, October. Pp. ix+303-521. (Cleveland.)

Summary of the Annual Report of the Naval Observatory for the Fiscal Year 1921. (Appendix No. 2 to the Annual Report of the Chief of the Bureau of Navigation.) Pp. 53. (Washington: Government Printing Office.)

Nauka Polska: jej Potrzeby, Organizacja i Rozwój. (Polish Science: its Needs, Organisation and Progress.) III. (Year-Book of the Mianowskie Institution for the Promotion of Scientific Research Work.) Pp. vi+280. (Warszawa.) 150 marks.

Report of the Department of Mines for the Fiscal Year ending March 31, 1922. (Sessional Paper No. 15.) Pp. iii+48. (Ottawa.) 5 cents.

Department of the Interior: United States Geological Survey. Mineral Resources of the United States in 1921 (Preliminary Summary). Pp. iv+102A. (Washington: Government Printing Office.)

Crichton Royal Institution, Dumfries. Eighty-third Annual Report, for the Year 1922. Pp. 49. (Dumfries.)

National Museum of Wales. Fifteenth Annual Report (1921–22) presented by the Council to the Court of Governors at a Meeting held in Cardiff on the 27th October 1922. Pp. 35+6 plates. (Cardiff.)

Diary of Societies.

SATURDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (1).

MONDAY, FEBRUARY 19.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Dr. R. L. Sherlock: The Influence of Man as an Agent in Geographical Change.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. P. Sexton and others: Discussion on Esprit de Corps.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. V. Lanchester: Architecture and Architects in India.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—C. E. M. Joad: The Problem of Freewill in the Light of Recent Developments in Philosophy.

FARADAY SOCIETY (at Chemical Society), at 8.—Prof. A. W. Porter and J. J. Hedges: The Law of Distribution of Particles in Colloidal Suspensions with Special Reference to Perrin's Investigations, Part II.—D. B. McLeod: A Relation between the Viscosity of a Liquid and its Coefficient of Expansion; The Viscosity of Liquid Mixtures showing Maxima; A Relation between Surface Tension and Density.—M. Cook: Crystal Growth in Cadmium.—F. H. Jeffery: Electrolysis with an Aluminium Anode, the Anolyte being (1) Solutions of Sodium Nitrite, (2) Solutions of Potassium Oxalite.—S. D. Muzaffer: Electric Potential of Antimony-Lead Alloys.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. P. Stevens: The Vulcanisation of Rubber (Cantor Lectures) (3).

TUESDAY, FEBRUARY 20.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—J. Hilton: Statistics of Unemployment derived from the Working of the Unemployment Insurance Acts.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30.—F. Bushrod and J. F. S. Tyler: Modernisation of Passenger Railway Stations.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the Month of January 1923.—Prof. H. M. Lefroy: Exhibition of Cinematograph Films of the House-fly.—Dr. N. S. Lucas: Reports on the Deaths which have occurred in the Society's Gardens during 1922.—Prof. E. Lönnberg: Remarks on some Palearctic Bears.—E. W. Shann: The Embryonic Development of the Porbeagle-Shark, *Lamna cornubica*.—R. Gurney: Some Notes on *Leander longirostris*, M.-Edwards, and other British Prawns.

INSTITUTION OF CIVIL ENGINEERS, at 6.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. S. Newman: The Causes of Static Trouble in the Kinematograph, and Means for its Elimination.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—W. J. Jones, E. A. Marx, Jr., and others: Discussion on the Projection of Light.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—P. E. Newberry: The Beb Sed Festival of Ancient Egypt.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—Prof. J. A. Thomson: Biological Contributions to Sociology.

WEDNESDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Pearson: Greek Civilisation and To-day (2), Progress in the Arts.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—R. L. Braithwaite: The Flow of Lymph from the Ileo-Cæcal Angle and its possible bearing on (1) the formation of Gastric and Duodenal Ulcer, and (2) the cause of other types of Indigestion.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—Informal Meeting.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Col. E. Gold and others: Discussion on Reform of the Calendar, by C. F. Marvin.—Dr. S. Fujiwhara: The Growth and Decay of Vortical Systems.—Dr. S. Fujiwhara: The Mechanism of Extratropical Cyclones (Third memoir on Vortical Phenomena).

ROYAL SOCIETY OF ARTS, at 8.—C. Ainsworth Mitchell: Handwriting and its Value as Evidence.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Sir William Maddock Bayliss: Microscopical Staining and Colloids.—A. Mallock: Note on the Resolving Power and Definition of Optical Instruments.

THURSDAY, FEBRUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. B. Melvill Jones: Recent Experiments in Aerial Surveying (2).

ROYAL SOCIETY, at 4.30.—G. I. Taylor and C. F. Elam: The Distortion of an Aluminium Crystal during a Tensile Test (Bakerian Lecture).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. W. G. Savage: Canned Foods in Relation to Health (Milroy Lectures) (1).

INSTITUTION OF STRUCTURAL ENGINEERS, at 7.30.—E. Godfrey: Shear Resistance.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Principal J. C. Irvine: Some Constitutional Problems of Carbo-hydrate Chemistry.

CAMERA CLUB, at 8.15.—E. R. Ashton: Picturesque India.

FRIDAY, FEBRUARY 23.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Theatre, Imperial College of Science and Technology), at 2.30.—Sir John Russell, H. G. Thornton, and others: Discussion on Partial Sterilisation of Soil: Present Views as to its Effects and their Causes.

PHYSICAL SOCIETY OF LONDON, AND RÖNTGEN SOCIETY (at Imperial College of Science and Technology), at 3.—Demonstrations: Major C. E. S. Phillips: A Method of Measuring X-ray Intensity.—E. J. Evans: Intermittent Discharge from Sectorless Wimshurst Machine.—L. H. Clark: An X-ray Balance.—H. B. Gough: Ionometer.—W. E. Schall: Spectrometer for Measuring End-radiation.—Dr. F. L. Hopwood: The Ondoscope.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 5.—Dr. L. Hogben: Intersexuality and Sex Reversal.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—E. R. Flint: Abnormalities of the Hepatic and Cystic Arteries and Bile Ducts.

PHYSICAL SOCIETY OF LONDON, AND RÖNTGEN SOCIETY (at Imperial College of Science and Technology), at 5.—Discussion on The Measurement of X-rays.—Sir William H. Bragg: Introductory Address.—Prof. S. Russ: The Measurement of X-ray Intensity and the Necessity for an International Method.—F. T. Harlow and E. J. Evans: The Quality of X-rays produced by Various Types of High-tension Generators and an Incandescent X-ray Bulb.—Dr. M. Berry: Practical Measurements for Medical Purposes.—Dr. G. W. C. Kaye and Dr. E. A. Owen: X-ray Protective Materials.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. J. Tracey: Characteristics, Operation, and Maintenance of Underground Cables.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. S. Eddington: The Interior of a Star.

SATURDAY, FEBRUARY 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (2).

BRITISH PSYCHOLOGICAL SOCIETY (at Bedford College), at 3.—Prof. T. H. Pear: An Examination of some Current Beliefs concerning Muscular Skill.—Miss M. MacFarlane: The Use of Mental Tests in American Schools and Clinics.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. F. A. Bather: A Limestone Cliff and the Animals that built it.

MONDAY, FEBRUARY 19.

KING'S COLLEGE, at 5.30.—Dr. W. Brown: Psychology and Psychotherapy (1). (Succeeding Lectures on February 26 and March 5.)

TUESDAY, FEBRUARY 20.

LONDON SCHOOL OF ECONOMICS, at 5.—S. P. Vivian: Statistics, before, during, and after the War: Population.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. T. G. Bailey: The Sansis, or Thieves of India; their Language, History, and Customs.

KING'S COLLEGE, at 5.15.—Dr. J. H. Orton: The Bionomics of Marine Animals (1). (Succeeding Lectures on February 22 and February 23).—At 5.30.—Prof. H. Wildon Carr: Physical Causality and Modern Science (1). (Succeeding Lectures on February 27, March 6, 13, 20, and 27).—Prof. A. J. Toynbee: The Expansion of Europe Overland (1). (Succeeding Lectures on February 27, March 6, 13, 20, and 27.)

WEDNESDAY, FEBRUARY 21.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.15.—Prof. Miles Walker: The Control of the Speed and Power Factor of Induction Motors (1). (Succeeding Lectures on February 26, March 14 and 21.)

KING'S COLLEGE, at 5.30.—Prof. F. Soddy: A Physico-Chemical Theory of the Instability of Western Civilisation.

SATURDAY, FEBRUARY 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30—S. H. Warren: The Interplay of Land and Sea.