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CONTENTS.

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Science and Labour.[1]

BOTH science and labour owe a sincere debt of gratitude to the British Science Guild for its efforts, through the Conference held at Wembley at the end of last May, in establishing contact between two movements so clearly destined to change the nature of society. If nothing more has been accomplished than to establish a precedent for a periodical scrutiny of our social and industrial relations in the scientific spirit, the British Science Guild will have erected a monument to itself.

The avowed object of the conference was, to quote Lord Askwith, "to consider the lines upon which science could be directed and applied more widely and effectively to increase human health, happiness and efficiency, to reduce human toil, and to develop human personality."

Considering the scope of such an inquiry, and it embraces within its ambit the whole field of sociology, it would be amazing if any definite or concrete conclusions emerged; but while no attempt was made to collate the ideas expressed by the large number of speakers in any concise form, certain common lines of thought are easily discernible. In particular, the belief was constantly reiterated that the industrial problem must yield to scientific solution. "The scientific method," asserted Sir Thomas Holland, "is just as necessary in industrial affairs as in matters of less immediate economic importance." "It is vital," said another, "that established systems and practices should be re-examined from a scientific standpoint"; and Sir Richard Gregory: "The new conditions of industry demand a new system of industrial management." At any rate, on the part of the scientific man uncontaminated by industrial conflict, there is a real desire to approach this question in the true spirit of inquiry.

While, however, this is undoubtedly true, there is a danger against which he must be guarded. It is natural that scientific men immersed in the study of questions bearing directly or indirectly on the problem of material efficiency should regard the industrial system as centring mainly around the question of production, and it is significant that throughout the whole of this inquiry each speaker on the scientific side, almost without exception, made his contribution to this question as if it were the whole problem. Sir Hugh Bell, taking heart from his numerous supporters in this respect, was perfectly frank about it. "The one thing towards which we should struggle is . . . to aim at larger productivity," he asserts with emphasis.

[1] "Science and Labour: being the Principal Addresses at the Conference on Science and Labour held in London on 30th and 31st May 1924." Edited by Thomas Lloyd Humberstone. Pp. 120. (London: Ernest Benn, Ltd., 1924.) Paper, 6*s*. net; cloth, 7*s*. 6*d*. net.

It is equally natural that labour, with its memory ever fresh of bitter struggles against long hours and low wages, should stress much more acutely the complementary problem of distribution of the products of its toil, remaining largely apathetic to talk of more efficient production. Mr. Cramp puts it quite bluntly when in his address he says that labour in the past has had reason to regard every labour-saving device as a wage-saving device. The labour leader will find it difficult to wax enthusiastic about science, except as a pure matter of intellectual interest, so long as scientific workers remain indifferent to the ultimate division of the wealth in the creation of which they so ardently desire to assist, ignoring the distinction between those who create wealth and those who acquire it. With all the goodwill in the world, an infinity of round-table conferences will not destroy that barrier until men of science are prepared to examine the question of distribution in the same spirit and with the same energy as they are doing in the case of production.

It is mainly for this reason that, on a study of the addresses delivered and the discussions that ensued, it is clear that, practically with one exception to which we shall presently return, the battle was not waged by the scientific men in the field of labour or by labour in the sphere of science, but by science in the realms of applied science. For that reason the employer of labour, ignoring the problem of distribution, had his full say, and science found little to urge in criticism, while labour itself was absent from the discussion. When Sir Hugh Bell ventured the above-quoted plea for more and more intensive production, there is no evidence that a single voice, scientific or labour, was raised to question the dictum or to suggest the necessity for the scientific statement of other essential conditions.

If science is to raise production to such a pitch of efficiency that everything essential to the community can be produced in sufficient quantity by a limited group of workers, it is clear that the remainder must starve unless means are adopted for placing purchasing power in their hands; that is to say, for effecting some form of distribution. The present stage of society, which utilises the wage system as a means of effecting distribution, with its million unemployed, is obviously chaotic in this respect, and from the scientific point of view utterly indefensible. It is apparent that so long as the sale of labour power by the individual worker, and thereby the receipt of a wage, is the procedure that is to be adopted for effecting distribution, so long will labour as a whole remain apathetic—if not antipathetic—to scientific schemes of production that may decrease his opportunities for such sale.

Science must face this question squarely. It is contended by Lord Ashfield, in his intensely interesting address describing the historical and scientific development of the London omnibus service, that the introduction of scientific improvements into the system, while it may have led temporarily to the employment of fewer workers in the industry, ultimately swelled their numbers. This provision of employment, he asserts, was therefore something which redounded to the benefit of labour. Apart from the fact that the sudden cessation of employment among the men initially displaced laid the brunt of an unsound distributive system immediately upon a group scarcely fitted to withstand it, it is not clear that anything more was finally achieved in this respect than that men were merely transferred to more productive employment; and, as we have already indicated, mere productiveness is not sufficient in itself. If Lord Ashfield's contention were valid, one would anticipate that since the industrial revolution the percentage of unemployed would have decreased continuously. We doubt if this would be borne out by the facts.

Even on the productive side there are questions which, merely from lack of examination, we are prone to prejudge. We have become accustomed to the constant repetition of the phrase "speeding up," and in the mind of labour it is associated with much of the valuable work done on industrial psychology. But suppose the individual workman be urged to work at his maximum capacity, will his output be increased 20 per cent.? Now suppose the employer be urged to introduce the maximum of science and scientific method into his factory, by how much will the output ultimately be increased? We would suggest that the history of the cotton industry, where the output since the age of scientific invention has increased something like fifty-fold, is illuminating. How futile when viewed in this light does the grudging attitude of many captains of industry to science and labour become. How inefficient also are the means adopted for bringing the perfected article to the consumer is apparent when we recollect that for most proprietary articles, out of every three produced approximately two are absorbed in providing the third with what the economists would term "utility of place."

The single field upon which all groups appear to have met was that set for "The Place of Science in Government," and here a discussion arose of intense moment to all scientific workers whose interests extend beyond the mere confines of their laboratory. The gauntlet was thrown by Mr. Sidney Webb, who, in the course of his address on "Knowledge and Control," asserted that concentration on scientific work frequently gave rise to a narrowness of outlook and that this inevitably implied that the scientific expert, while he had a place, and a distinct place, would not find it as an adminis-

trative or as a governmental head even, it is presumed, when the subject of administration was scientific. The function of the politician, he contended, was to interpret the will of the people, and on the expert guidance afforded him by the man of science, to express this will as a detailed practical policy. On this challenge there were, of course, not lacking protagonists with a memory of past or present lay control of their scientific work to attack various aspects of this point of view. If only for this part of the discussion, the report of the Conference is well worth study.

It is a strange doctrine that because a cramped outlook is sometimes associated with extreme concentration on scientific work—and we venture to suggest that this is not confined to scientific work—there must be a definite limitation of the administrative scope even of those who have avoided this narrowness. This dictum can have any validity at all only if it can be demonstrated that a true scientific training is inferior in general as an educational influence to that of any other, and that the scientific method is of little moment in government and administration. Unfortunately, any attempt to discuss this question with those who themselves have escaped a scientific training immediately reveals a fundamental confusion between what is meant by the scientific method and what is a mere jumble of chemical or physical facts and propositions in Euclid. To some extent our school and university teaching, where it ignores the broad underlying principles of scientific knowledge and inquiry, and harps too insistently on the mere technical facts, is partly to blame for this false conception of the true educational value of science. But in any event Mr. Webb's attitude on this matter would appear to run directly counter to the spirit of the whole Conference, that the scientific method is essential to the solution of industrial problems.

If we are to re-examine old-established systems and practices from the scientific point of view, we must join issue with Mr. Webb at even an earlier point than this. He is satisfied apparently that, all things considered, we are happy in the possession of a democratic system in which the considered will of the electorate as interpreted by the politician is put into effect by him with the guidance of the expert where the politician deems it necessary. Can it be contended in all seriousness that the present conditions under which electoral decisions are registered are even an approximation to the type of democracy Mr. Webb has in mind, or from the point of view of the scientific man, even a remote approach to an efficient instrument for deciding matters of fundamental communal importance? If it is desirable that even on matters of minor scientific consequence an unfettered unbiassed judgment should be exercised, and that at moments of such decision external distractions and emotional factors should be absent, how much more important is it that on matters of national consequence, involving the welfare of millions for years, at least similar conditions should apply? Is it necessary to point out that, with a press for which liberty is licence and prejudged issues are truth, it is impossible at a general election to attain the requisite calm for the exercise of a considered judgment by a democracy ill-equipped to rise above the passionate clamour of parties? It may be necessary to tolerate this at present as the only instrument to hand, but let us not at least be blind to its inherent weaknesses, so that in establishing an administrative and governmental machine upon it, none of the more grotesque results of democracy as practised at present should be exaggerated.

We have not done justice to this record of a notable occasion. It abounds in material of fundamental importance to the scientific and labour movements, and we can only hope that the British Science Guild, taking heart again from its experience this year, will place one more stone next year upon this worthy structure.

H. LEVY.

Activity of Vesuvius, 1903-1921.

The Vesuvius Eruption of 1906: Study of a Volcanic Cycle. By Frank A. Perret. (Publication 339.) Pp. 151 + 24 plates. (Washington: Carnegie Institution, 1924.) 4 dollars.

THIS valuable monograph gives the results of the author's investigations on the state of Vesuvius from the end of 1903 to 1921, and more especially his observations on the mountain during the height of the eruption of 1906, which culminated in the stupendous outbreak on the night of April 7-8. The volume is divided into five sections. The first deals with the events of 1904–5, the second with the eruption period in April 1906, the third with the post-eruptive period of repose, and the fourth with the seven following years of present activity. The fifth contains descriptions of apparatus invented or modified by the author for better determinations of temperature and the perception of subterranean sounds, etc., and also of diagrams for recording the phenomena concisely. A postscript by Mr. H. S. Washington deals with the analyses of lavas which have flown from the crater at different periods and gives some useful notes. There are 24 full-page plates and 98 text-figures, which are mainly reproductions of excellent photographs made by the author.

The volcano's activity began at the end of 1903, and during the next two years good opportunities of

investigating the phenomena were afforded. The cone was steadily rising in height until in May 1905 its top was nearly 4400 feet above sea-level. The vent was small, and the lava reached nearly, if not quite, to the top, whence it was ejected several hundreds of feet from time to time. Such portions as fell on the outside were still hot and plastic, and helped to consolidate the cone. On May 27, the author saw a white cloud shoot from the side of the cone at a short distance below the top, and this was quickly followed by a flow of lava. Soon there were three streams flowing from fractures at points near one another, but at different levels below the top. These relieved the extreme pressure on the cone, and the great outbreak was postponed.

As depicted by the author, the mountain differed widely from its state in 1902, when the crater was wide and deep with a small vent near its middle, from which stones were occasionally thrown up a few feet. During the summer of 1905 the author had an experience of the way in which the cone was being corroded by the hot fumes and lava within. Standing with some students on the side of the cone, they noticed that the ground began to get hot, and it soon became unbearable. Soon after they had moved off, a patch about 2 yards across became red-hot, fused, and gave rise to a small lava flow.

The main eruptive period may be said to have begun in February 1906, when there was an abundant flow of lava with loud explosions, and clouds of ash were thrown out. This state continued with some abatement until the equinox, when jets of lava were thrown out, some horizontally, so that the cone was filled to the brim. The final stage began at midnight, April 4-5, when lava poured out of a new opening on the south side at a height of 2600 feet above sea-level. On April 6 the lowest vent opened about 5 furlongs east of the last, and about 600 feet lower; from this and an adjoining vent poured out the mass of lava which reached and blocked the railway at Bosco Tre Case. The eruption culminated about 3.30 A.M. on April 8, with a great outburst of hot ash, lava, and debris, some of which caused the serious catastrophes at Ottajano and S. Giuseppe, where they were deposited to a depth of nearly 3 feet. The next extraordinary event was the great uprush of gas about 4 A.M. This is represented by a drawing and not a photograph; it is made to ascend to a height of about 8 miles, and marked, according to the author, the *intermediate gas phase*, the gas coming from great depths and being comparatively free from ash. It was followed on April 8 and subsequent days by the dark-ash phase, the columns and billows of which probably attained a height of 3 miles above the crater. The mountain and country round were covered with a great depth of ash, which on the steep slopes gave rise to dangerous hot avalanches, and at a later period to mud avalanches, from which the towns have to be protected by strong walls. The loss of material caused two subsidences near the top of the mountain, and reduced its heights by 350 feet on the N.W. side and 700 feet on the opposite side, the crater becoming a wide-throated funnel some 770 yards across at the top and sloping down at an angle of nearly 45°. Estimates of the quantities thrown and poured out differ widely, but the flow of lava on the southern flank covers about 3,000,000 square metres, and its volume is about 10,500,000 cubic metres.

The author discusses at some length the possibility of a luni-solar influence on eruptions, but leaves the question open. Now the difference of attraction on so small a volume must be inappreciable in its effect on so viscous a substance as liquid lava, and independently of this, the active stages in February and April preceded the full moon by seven and five days respectively. Palmieri, in his account of the 1872 eruption, seems to favour the view, for he says: "in the month of March, with the full moon, the cone opened"; and later, "on the 23rd April (another full moon) . . . splendid lavas descended." Earlier, however, he states that on November 3 and 4 "copious and splendid lava streams coursed down," the moon being full on October 28 and November 27.

The seismic disturbances and subterranean noises were very considerable and were powerfully felt at Pompeii, and probably at greater distances. With the friction of the matter ejected great electrical energy was developed, and manifested itself in short lightning flashes over a considerable portion of the sky.

The narrative portion of the book is extremely interesting, and the discussion of the phenomena is full of suggestion and shows good discrimination.

W. J. L.

Lime and Magnesia.

Lime and Magnesia: the Chemistry, Manufacture, and Uses of the Oxides, Hydroxides, and Carbonates of Calcium and Magnesium. By N. V. S. Knibbs. Pp. 306. (London: Ernest Benn, Ltd., 1924.) 30*s*. net.

THE work under notice is the first book or collection of classified information on the manufacture and properties of lime and magnesia which makes any pretence to be a comprehensive survey of the situation. As such, the author is to be complimented on the result of what must have been to him a long and painstaking piece of work. The volume is divided into three parts: Part I., occurrence and classification of limestone and magnesite, and the chemical and physical properties of

lime and magnesia; Part II., quarrying and manufacture of lime and magnesia products, and Part III., their use in commerce and industry. Of the three, the first may be said to be satisfactory, the second to be less so, and the third to be a rough attempt to outline the very varied uses to which lime and magnesia products are put. It is questionable whether it would not have been advisable to publish the three parts in separate volumes, and make those on manufacture and usage very much more exhaustive. This would, it is true, be even more laborious, but the ultimate value of the work would have been greatly enhanced. Moreover, had the author followed this course, he need have had no fear of being forestalled in the field.

In dealing with each section separately, the following points seem to be of interest. The classification of various limestones is good, and an admirable feature of the book is the bibliography and references at the end of each chapter. There is a fairly ample discussion on the work of Johnston on the thermal dissociation of limestone. It seems to be the only really first-class research which has been done in this field. The method detailed for measurement of the apparent density of lime seems somewhat crude, and it is unfortunate that no better method has been described for measuring this property, from which most of the other physical properties of the sample can be determined. The remainder is fairly exhaustive, but it would be interesting had the author expressed his own opinion on the relative merits of some of the diverse facts and theories which he has collected. On the whole, this section is very capable, though it seems a matter of conjecture whether the English lime burner, practical man as he loves to style himself, will take much account of it.

Of the remainder of the book there is not so much to be said. Part II. contains a long harangue on the ancient kilns which are so much in favour in Great Britain. There seems little to recommend them, save that they have been in use for generations. Rotary kilns are scarcely mentioned, though they are a standard part of the equipment of most American lime works. Little as one likes to admit it, the English lime-burning industry is a very poor second to American practice and output, even though we are far ahead of them in respect of our quarry resources. Hydration is far too scantily treated, though, of course, the English output is quite insignificant and the product high in price. Quarrying is very lightly passed over, and only a very general survey of accepted methods is undertaken.

The section on the uses of lime and magnesia products is as good as it can be in the space devoted to the subject, which is very small compared with its importance.

As a whole, the book appears to be a fairly comprehensive survey of the lime and limestone industry, but not so much so in the case of magnesia. As an incentive to research it would seem invaluable. The author has, so to speak, broken the ice, and accomplished his primary object successfully. It would have been more satisfactory, however, had he been far more critical in his handling of the subject, the lime industry being somewhat in need of it. F. A. FREETH.

Antarctic Meteorology.

British Antarctic Expedition, 1910–1913. Meteorology. Vol. 3: Tables. By Dr. G. C. Simpson. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. xi+835. (London: Harrison and Sons, Ltd., 1923.) 60*s*.

THE physical researches of the *Terra Nova* expedition are now complete in 13 volumes, including one of miscellaneous data still in the press. Dr. Simpson published the first two volumes of the meteorology of Scott's last expedition in 1919, the first containing the discussion of the data and setting forth his conclusions, the second reproducing the weather maps and traces of recording instruments. Volume 3 now supplies the data on which the earlier volumes were based, including hourly readings of all the instruments at the main base, Cape Evans, and the meteorological logs kept at the various subsidiary bases and on journeys. It is a massive monument of the rare devotion with which Dr. Simpson and his many helpers worked in circumstances of the greatest difficulty, and the survivors of them are to be congratulated on its completion. Dr. Simpson must be thanked also for not delaying by five years the publication of his epoch-making general conclusions, to wait for the end of the labour of seeing this huge volume through the press.

In the preface it is pointed out how greatly the value of the meteorological work was enhanced by the concurrence of the Norwegian expedition in the journeys to the South Pole, a subsidiary part of Scott's expedition although the main aim of Amundsen's. Through the unexpected advent of the *Fram*, Scott's eastern party was diverted northward to Cape Adare while the meteorological work at Framheim gave a third series of highly accurate synchronous observations for very nearly a whole year. As Cape Adare is 400 miles north and Framheim 400 miles east of Cape Evans, the three stations enabled synoptic maps to be constructed of the whole Ross Sea area. It is to be regretted that the meteorological data of the Australian Antarctic expedition, which was simultaneous with the second year of Scott's expedition, could not have been dealt with also in these volumes.

In addition to the records at the fixed stations (those at Framheim being given in the British units) the volume includes the meteorological logs of all the sledge journeys and of the voyages of the *Terra Nova* from and to New Zealand. The utmost care was taken in all these observations to define the time-standard used and the true direction in the case of wind and of cloud movements; both these items present difficulties peculiar to very high latitudes, and carelessness in regard to them has deprived some past records (made otherwise with the greatest care) of all their value.

This volume has its sole use as a work of reference, and it ought to prove invaluable when the time comes for a critical discussion of Antarctic meteorology in the light of all records, including those of expeditions the detailed work of which is still unpublished.

Vol. 1 of the meteorology, which was printed in India, is provided with a running title greatly facilitating reference and permitting of the workmanlike numbering of the pages in the outer upper corner; Vol. 3, printed in London, conforms in this respect not to Vol. 1 of the meteorology set, but to the volumes dealing with the other departments of science, which unfortunately have no page-headings. This is neutralised in the case of tables printed across the breadth of the page and only causes delay in referring to the tables which are printed across the length of the page. A more serious defect is that the volume under notice (like most of the others) is numbered awkwardly in the middle of the page at the bottom, so that it is necessary to make a complete opening in order to see the number, instead of merely flicking the top outer corner.

H. R. M.

Our Bookshelf.

A Survey of the Fauna of Iraq: Mammals, Birds, Reptiles, etc. Made by Members of the Mesopotamia Expeditionary Force "D," 1915–1919. Pp. xx+404+20 plates. (Bombay: Bombay Natural History Society; Basra and Baghdad: *The Times* Printing and Publishing Co., Ltd.; London: Dulau and Co., Ltd., n.d.) 10*s*. net.

THE study of the survey of the fauna of Iraq is a convincing proof that the interest in systematic zoology is still well maintained in Great Britain. It is really very remarkable that notwithstanding the hardships and discomforts of the campaign in Mesopotamia, no less than eighty-four of the members of the British Expeditionary Force "D" were keen enough to collect and observe the animals of the country through which they passed or in which they fought.

The papers which constitute this volume were first published in the Journal of the Natural History Society of Bombay, and are now reprinted and published with the authority of the Iraq Government. They deal with the mammalia, birds, reptiles, insects, myriapoda, and crustacea that were collected during the years 1915–1919. The only large groups of terrestrial or freshwater animals that are not included in the volume are the mollusca, arachnida, and fishes. It would be interesting to know if material belonging to these groups were also collected and will be described in later papers.

With a book of such great value and varied interest it is impossible, in a short notice, to convey a just appreciation of its manifold merits. To some naturalists the papers on the birds by Buxton and Ticehurst will appeal most strongly. Dr. Buxton's notes on the avi-fauna of Northern and Western Persia are particularly interesting and well written, giving a very vivid impression of the birds that may be seen in a journey through the country by any traveller who possesses the keen sight and knowledge of a trained and gifted ornithologist. Dr. Ticehurst's contribution on the birds of Mesopotamia, with its more detailed account of the species, including most interesting notes on their habits, nests, and eggs, is rendered more fascinating by some remarkably good photographs of the nesting places of many of the birds.

To others the more attractive papers will be those of Col. Piele on the butterflies. Here, again, the author is not content to give a simple list of species in the collection, but adds many valuable notes on variation and habits. The naturalist who is not a professed entomologist will read with much interest, for example, the three pages of notes on the well-known swallow-tail *Papilio machaon*.

In selecting these two series of papers for special mention, we have no wish to underrate the value and importance of the others in this volume. Every paper has been written by a well-known authority in his group, and, so far as we can judge, it has been treated with the greatest possible accuracy and care.

We can only congratulate the many authors and collectors on the production of such a remarkable and valuable work.

Leaves from the Golden Bough. Culled by Lady Frazer. Pp. xii+249+16 plates. (London: Macmillan and Co., Ltd., 1924.) 10*s*. 6*d*. net.

IT was a happy idea of Lady Frazer's to transform by a few magical touches the learned treatise of anthropology into a fascinating book of stories for children. It is remarkable how readily young folk will respond to good literature, to true talent and to real wisdom. Any one who wishes can convince himself by experiment of this fact by observing how children of four years onwards will listen with delight to properly chosen passages from Homer, Shakespeare, and Cervantes. Frazer's "Golden Bough" contains the most universal and catholic collection of stories, customs, and practices, and these in illustration of some of the most dramatic and mysterious aspects of human nature; and it is told with a unique charm and power by the illustrious author. From this masterpiece of literature and science, Lady Frazer has judiciously selected a number of appropriate incidents which will impress once for all on the young mind the most important facts of anthropology. The child will be keenly interested to hear what the mistletoe bough really means in the Christmas festivities and what it meant to our ancestors. He will follow eagerly

the strange adventures of ancient heroes of Greece, of the semi-animal gods of Egypt, the sagas of Teutons and the folk-tales from five continents and numberless islands.

The wide range, the extreme variety of local colour, the flavour of the distant, of the primeval and of the exotic, so wonderfully preserved by Sir James Frazer, will be a delight to every young reader who, as we know, is so susceptible to the lure of the remote and fantastic. What makes this book unique, however, is not its harvest of folk-lore, but the accounts of belief and custom which form the bulk of the selected passages. The child finds himself in real intimacy with Red Indians and their hunting expeditions and lodge festivals, with South Sea Islanders in their fishing and floral dances, with the hairy Ainu of Japan worshipping the bear. Moving through the wonderful landscapes of the world, tasting of genuine savage life, sharing the beliefs of all ages and all races, the child will receive at the same time an excellent foundation for his future humanism. The pleasing illustrations by Mr. H. M. Brock add another touch of life to these entrancing pages.

The Mortality of Annuitants, 1900–1920: Investigation and Tables. By W. Palin Elderton and H. J. P. Oakley. (Published on behalf of the Institute of Actuaries and the Faculty of Actuaries in Scotland.) Pp. iv+207. (London: C. and E. Layton, 1924.) 42*s.* net.

MESSRS. Elderton and Oakley have given an account of their investigation into the mortality of annuitants as ascertained from data supplied by the leading Life Offices in Great Britain. The investigation covers the period 1900–1920, whereas the tables previously in use related to the years 1863–1893. A striking decrease is shown in the rates of mortality of both men and women, and this fall in the rate of mortality has led the authors to propose a method of forecasting the mortality likely to prevail in the future. For this purpose they assume that the rate of mortality applicable to a given age-group can be expressed in the form $A+Bc^x$, where x is the calendar year in which the annuity is purchased.

The constant A for any age-group thus represents the figure to which the rate of mortality will ultimately fall. This is taken arbitrarily at 63 per cent. of the 1900–1920 rate, and the required value of the forecasted rate of mortality is then found by logarithmic exterpolation from the values given by the 1863–1893, and the 1900–1920 data, the assumed year of purchase being calculated for each age-group from the average duration of contracts in force. For example, in the age-group 80-84, where the average duration is 16 years, the forecasted rate of mortality for those ages, in respect of an annuity purchased in the year 1925, is that applicable to the year 1941, and this average rate is apparently taken whether the annuity be purchased at the age of 40 or at 80. In the result it would seem that the method must tend to overstate somewhat the projected annuity values at the older ages.

The book concludes with the usual adjusted life tables and monetary tables for single and joint lives. It will be of the greatest value to all who require an up-to-date mortality experience of a sheltered class.

A Treatise on Light. By Dr. R. A. Houstoun. New edition. Pp. xi+486+3 plates. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

DR. HOUSTOUN'S text-book, which was first published in 1915, has achieved a wide and well-deserved popularity, and the present edition is supplemented by a short additional chapter on "Recent Advances." Frankly, it is a disappointing chapter. First, the interferometric determination of the angular diameters of stars is briefly treated from an elementary point of view, then half a page is rather unnecessarily expended on descriptions of half-watt and neon lamps. There follows an account of the verification of Einstein's predicted gravitational deflexion of light, but no mention is made of the application of the theory in connexion with the fine structure of spectral lines. The quantum theory is next discussed. This is admittedly a difficult matter to expound in the space of a page, but even so Dr. Houstoun might have given us a more inspiring survey of this fascinating subject. Even the most impenitent classicist should be capable of appreciating the remarkable achievements of the quantum theory, and one cannot help feeling that the bald and unilluminating account here presented is unworthy of the rest of the book. Further, in the final section, which is entitled "Moseley's Work on X-ray Spectra," a statement occurs which can scarcely pass unchallenged. It is that "the examination of spectra in the visible region and near ultra-violet, while affording many interesting results, has not been fruitful as regards the structure of the atom or the mechanism of the production of spectra itself." After this, it is not so surprising to find no mention of Bohr anywhere.

It is greatly to be hoped that in a future edition a more adequate treatment of these matters will be attempted. At the same time, Dr. Houstoun should take the opportunity of rewriting the account of spectral series on pp. 271-275, which is now completely out-of-date.

Cancer: its Causation, Prevention and Cure. By Dr. John Harger. Pp. xv+139. (Liverpool: C. Tinling and Co., Ltd., 1924.) 5*s.*

UNTIL the cause of cancer is discovered, it will remain common ground for ill-informed persons to express their views. The most recent amateur recruit to the cancer problem is Dr. John Harger—apparently a chemist—who considers that as such he has had a "precious legacy," handed to him by Pasteur, namely, "the *right* to interfere in matters of logic, especially when applied to subjects treating of disease." In spite of the statement (p. 132) that "This legacy we must guard and use with discretion, lest it be besmirched by our blundering," his book might be described as a compendium of erroneous and useless elementary anatomical, physiological, and pathological data. In an amusing glossary we find "Atrium (the open court).—The auricular parts of the heart." "Cervix" is said to be the "neck of an organ, etc." "Fibrin" is defined as the "protein in the fibrous parts of the body and in the membranes, cell walls, etc." The suprarenal capsule is a "small attachment to and above each kidney." We are also told that,

in cancer patients, "the red blood corpuscles possess nuclei, which is not the case in normal health."

It is difficult to make out the author's real viewpoint on cancer, but apparently it has something to do with diet. He extols the virtues of Dr. R. Bell, Mr. Forbes Ross, and Dr. John Shaw; and accepts in part their very diverse theories. Incidentally, he is critical of Mr. Ellis Barker and surgeons.

Ore Dressing: Principles and Practice. By Prof. Theodore Simons. Pp. xviii + 292. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

TEXT-BOOKS of ore dressing are frequently little more than extracts from makers' catalogues. The volume by Prof. Simons is of a different character. It gives the usual descriptions of plant, but enters more fully into the principles of the processes of separation and deals quantitatively with the theoretical and practical limits of concentration, and with the theory of grinding. It is readable and should be found exceedingly useful by metallurgists in general. The subject of flotation is rather briefly treated, and the theory, of such remarkable scientific interest, is only alluded to, the reason being given that several important works devoted entirely to flotation have been published recently. Magnetic separation might with advantage have been treated more fully. It is extremely important, and the apparatus figured and described is only one of many efficient types. It is unfortunate that this subject should not have been treated with the same fulness as the mechanical processes, as the applications of magnetic separation are continually increasing. Should a further edition of the book be required, several sections might be expanded with advantage without altering the general character of the work or injuring its readable quality.

C. H. D.

The Structure of Matter. By Dr. J. A. Cranston. (Manuals of Pure and Applied Chemistry.) Pp. xvi + 196. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 12*s.* 6*d.* net.

MOST of the books dealing with the structure of matter have been written rather for the physicist than for the chemist, and there was room for a simple yet sufficiently detailed account of the subject treated from the chemical point of view. Dr. Cranston would seem to have filled this gap very successfully. He gives a preliminary account of the determination of the mass and charge of the electron, of radioactivity, atomic numbers, isotopes, and crystal structure, in all cases giving adequate descriptions of the experimental methods, and then proceeds to discuss the various atom models, and the valency theory of Langmuir. The space devoted to the Bohr atom may seem inadequate, but it must be confessed that its chemical applications are still vague and that Langmuir's ideas, although probably less physically sound, seem to afford greater assistance in this field. This part of the subject is well explained. The book is attractively illustrated, and references for further reading are given. Both teachers and students of chemistry will welcome Dr. Cranston's quietly written book as the best for their purpose which has yet appeared.

Practical Calculus for Home Study. By Prof. C. I. Palmer. Pp. xx+443. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 15*s.* net.

THIS book is professedly written for the practical man who, having already a considerable knowledge of subjects that lend themselves to mathematical formulation and discussion, has yet a very indifferent mathematical equipment. For success in its purpose such a book must satisfy two requirements. It must, in the first place, continuously correlate each complete step in the analysis with concrete problems of practical significance, so that the reader may feel at no stage that he has lost touch with his solid ground. In the second place, the development of the subject must fit into a general scheme in order that the existence of wider fields of inquiry may not be obscured. The present volume, with effectively the same range as most elementary text-books on calculus, fulfils the first of these requirements with a considerable measure of success, practical examples being taken from almost all branches of physics and engineering, besides those of a purely mathematical nature. To satisfy the second requirement is much more difficult in the circumstances, and the author has at any rate made it apparent that he is alive to its importance.

(1) *Technique of Tissue Culture "in Vitro."* By T. S. P. Strangeways. Pp. xii+80. (Cambridge: W. Heffer and Sons, Ltd., 1924.) 7*s.* 6*d.* net.

(2) *Tissue Culture in Relation to Growth and Differentiation.* By T. S. P. Strangeways. Pp. x+50+4 plates. (Cambridge: W. Heffer and Sons, Ltd., 1924.) 5*s.* net.

(1) FOR some time the author has been known as a most successful cultivator of living tissues *in vitro*. His small book describes in the minutest details his technique, and is a notable contribution to the subject; it is invaluable to those who wish to follow this promising line of work.

(2) It is not quite easy to understand why this booklet was separated as a fragment from the author's other work described above, and why its dimensions should be different. It deals with observations of tissue cultures and their possible significance in relation to growth and differentiation. The author's meaning is not always apparent, and in some places the writing is involved, but the book must be ranked as an important if short contribution to a fundamental subject of biology.

Problems of Belief. By Dr. F. C. S. Schiller. (Library of Philosophy and Religion.) Pp. 194. (London: Hodder and Stoughton, Ltd., n.d.) 3*s.* 6*d.* net.

DR. SCHILLER'S little book is a serious contribution to a large philosophical problem. The author's irrepressible humour enlivens the subject and prevents it being for a moment dull. Some years ago, Dr. Schiller sent out a *questionnaire* with the view of discovering how far the desire for a future life is general, and how far, in those who acknowledge it, it is modified by the conditions they attach to it. Many of the answers were surprising and not a few entertaining. An appendix inserted in the middle of the book gives an account of this interesting experiment.

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.*]

The Influence of the Degree of Instability on the Phenomena of Round Liquid Columns.[1]

THE instability of round liquid jets was noticed and described by Savart,[2] Magnus,[3] Plateau,[4] and others. The criterion of instability was given by Plateau as

$$\frac{\lambda}{d} > \pi, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where λ is the "wave-length," measured along a portion of the jet where the diameter is d. Or, in words, the jet is unstable when the wave-length is greater than the circumference.

This criterion depends only upon the tension of the surface and applies to any round column of fluid bounded by such a surface. Thus Boys[5] demonstrated this instability by a purely static experiment, in which a soap film was stretched between the circumferences of two equal and coaxial rings, and these were drawn apart along their common axis. The film collapsed when the distance between the rings was equal to the circumference of either.

The late Lord Rayleigh recognised that the question whether or not an actual jet breaks up in the allotted time, depends also on the *time rate* of its collapse, and thus on physical and geometrical properties of the jet other than its surface tension. This fact seems, however, to have been overlooked by many others. It seems worth while, therefore, to emphasise its significance by a few illustrations of phenomena that depend on this consideration for their explanation. The purpose of the present communication is to furnish these illustrations and to put the factors on which this rate depends, deduced by Rayleigh, into more convenient form for study.

In Rayleigh's treatment[6] external forces were neglected, as was any uniform forward motion common to all parts of the jet. The jet was thus treated as an infinitely long cylinder of liquid initially in equilibrium under the action of the tension of its envelope. The disturbances by which this equilibrium was upset were assumed to act independently of one another. The change in potential energy, caused by a given disturbance, was computed from geometrical considerations, while the kinetic energy, due to the motion of the liquid caused by the disturbance, was evaluated on the assumption that a velocity potential existed. Application of Lagrange's generalised equations of motion then gave the differential equation stating the time rate of variation of a, the "amplitude" of the disturbance. The solution of the equation was found to be

$$a = a_0 e^{qt}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where e is the Naperian base,

and

$$q^2 = \frac{8T}{\rho} \frac{[F(z)]^2}{d^3}, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In (3) T, ρ, d denote surface tension, density, and diameter, respectively;

and

$$[F(z)]^2 \equiv \frac{z}{J_0(iz)} \cdot \frac{\partial}{\partial z} J_0(iz) \cdot (1 - z^2) \quad . \quad . \quad (4)$$

Here

$$z \equiv \pi d/\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and

$$J_0(iz) = 1 + \left(\frac{z}{2}\right)^2 + \frac{1}{(2!)^2}\left(\frac{z}{2}\right)^4 + \frac{1}{(3!)^2}\left(\frac{z}{2}\right)^6 + \ldots \text{ etc.} \quad (6)$$

Aside from the factor $(1 - z^2)$, the rest of the second member of (4) is real and positive; hence q is real if $\lambda > \pi d$ and imaginary if $\lambda < \pi d$. Imaginary values of q correspond to stable oscillations of cross section, but when $\lambda > \pi d$ so that q is real, the amplitude a increases continually,[7] until, when $a = d/2$ the jet breaks up into drops, the rapidity of this collapse increasing with q.

FIG. 1.—The collapse of a round falling liquid jet.

Now it is seen from (3) that the value of q, for a given liquid, is determined by two factors: (*a*) it increases as d decreases; (*b*) it increases as $F(z)$ increases. A necessary accompaniment to the study of the phenomena of any jet is, therefore, a study of these two factors.

As to (*a*), the increase in q, being 50 per cent. greater than the decrease in d which causes it, can be readily computed once the change in d is known. Unfortunately this latter is often difficult to determine in the case of a jet; but it is often possible to get an approximate idea of this change, and even this should be considered in any attempted explanation of given jet phenomena.

Fig. 1 is a typical spark photograph of a round jet of water, falling vertically. The orifice chamber was influenced by an electrically driven tuning-fork, the energy of which was propagated in a direction parallel to the axis of the jet. The fork frequency (n), head causing *efflux* (h), and *jet* diameter (d) were mutually adjusted to satisfy the inequality

$$\frac{\sqrt{2gh}}{n} > \pi d \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Therefore, since the vibrations served merely to regularise the disintegration process, and since this photograph is typical of the form of the jet at any instant, it may be taken as picturing, *at intervals of* λ, the progress of a disintegrating disturbance impressed at the root of the jet.

We note the formation of an indentation in the surface, due to the vibration. This soon grows into a ligament separating the swellings of the main jet. This ligament, having a λ/d ratio greater than π, is unstable, and collapses in the manner indicated above. But its degree of instability is very high, on account of its small diameter. Further, since the ligament is getting progressively finer, its degree of instability is at the same time increasing. q is, therefore, an *implicit increasing* function of t. The ligament thus collapses in a shorter time than would be required for a to equal the jet radius if q were determined only by the initial dimensions of the jet, and a small drop is formed between each pair of larger drops.

Now Rayleigh, in discussing[8] the cause of the reflections of the small drops between the large drops, which is made evident by stroboscopic examination,

[1] Published by permission of the Director of the Bureau of Standards of the U.S. Department of Commerce.

[2] Savart, *Ann. de Chim.*, 53, 337, 1833.

[3] Magnus, *Phil. Mag.*, 18, 161, 1859.

[4] Plateau, "Statique experimentale et theorique des liquides soumis aux seules forces moleculaires," Paris 1873. (Access to Plateau's original memoir has not been obtained. References and quotations are taken from Lord Rayleigh's papers.)

[5] Boys, "Soap Bubbles," p. 79, 1902.

[6] Rayleigh, Proc. Lon. Math. Soc., 10, 4, 1879; Proc. Roy. Soc., 29, 71, 1879.

[7] q can only be positive if real, since such displacements cause a decrease of surface.

[8] Rayleigh, Enc. Brit., 11th Ed., 5, 271, Art. on "Capillary Action."

and by the fact that, in a horizontal jet, the small drops are thrown out of the vertical plane containing the main jet, says that this is caused by the ligament being in a more advanced stage of its development at its front end than at its rear, thus causing an initial collision between each small drop and the large drop following. Considering the facts just mentioned, this explanation seems quite plausible.

Another related phenomenon is that recorded by Ollivier.[9] He observed that, when a drop of water fell upon a smoked surface, a fine ligament was formed at rebound, causing a small drop to be projected in a direction normal to the surface. This phenomenon was ascribed by Ollivier to the fact that the length of this ligament was greater than its circumference, and it was therefore unstable. It is not evident, however, until we consider Rayleigh's work on the variation of the rate of collapse with the diameter of the liquid column, why this ligament collapsed before the liquid at its end could be drawn back into the main drop.

We must now consider the variation of q with λ/d. From (4) Rayleigh computed enough values of $F(z)$ to show the existence of a maximum, of value 0·343, at $\lambda/d = 4{\cdot}5$ (approximately). These computations have been slightly extended by the writer, and the results are shown in convenient graphical form in Fig. 2, where $F(z)$ is plotted as a function of λ/d. It should be remembered that q, which measures the degree of instability, is directly proportional to $F(z)$ for a given liquid and jet diameter.

$F(z)$ is zero for $\lambda/d \leqq \pi$. After this instability point is passed, the value of $F(z)$ increases very abruptly. This accounts for the possibility of quantitatively recognising the instability point, as in an experiment described by the writer.[10] In this connexion it should be noted that since the experimental recognition of the instability point depends on the particular form of the function $F(z)$, the practical application of Plateau's criterion is due to Rayleigh's work.

A somewhat similar experiment has been described by Lord Rayleigh.[11] He observed the following: When the orifice from which a rising jet issued was influenced by a tuning-fork of proper frequency, the jet broke on its upward path. As the vibrations of the fork died down, and the initial amplitude a_0 consequently decreased, the point at which the jet broke rose, but could not be made to pass a certain point, which Rayleigh assumed to be the instability point. Unfortunately, he records no quantitative data, so that one cannot say *from these observations* whether the (length/diameter) ratio for this point was π or some slightly greater number.

The maximum of the curve is not at all sharp. Now in some of Savart's experiments the fall of the drops formed from a jet influenced the orifice chamber, and thus determined the further rupture of the jet. Under such conditions, after the lapse of a short time, the jet collapses in a regular manner, quite similar to Fig. 1. But such a jet should pick out a value of λ/d corresponding to the maximum of Fig. 2. Now Plateau, reasoning from Savart's results, found 4·38 as the λ/d ratio for this point. Consulting Fig. 2, it is seen that the ordinate value at this point is insignificantly different from that at $\lambda/d = 4{\cdot}5$. Hence it is evident that this is a contradiction neither of the accuracy of Savart's experimental work nor of Rayleigh's theoretical work.

For values of λ/d greater than that corresponding to the maximum of $F(z)$ the curve slopes down very gently. Now it is an experimental fact that gravity has but slight effect on the phenomena in a falling jet, when λ/d is initially greater than 4·5. In such a jet, gravity causes an increase in the λ/d ratio of a ligament and a corresponding decrease in d. These have opposing effects on q. The increase in q due to decrease in d slightly exceeds the decrease in q due to increase in λ/d ratio, and the jet breaks sooner than it would according to Rayleigh's treatment, which neglects gravity.

The above quotations could be multiplied almost indefinitely, as will be evident to those familiar with the literature on the subject. It is thought that they furnish the illustrations desired.

It should be noted that we have here one example of

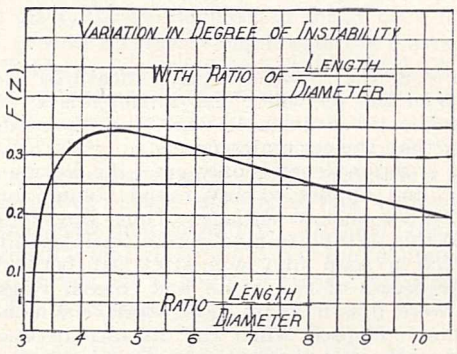

FIG. 2.

a useful principle, which, while quite obvious, does not seem always to receive the attention it merits. It is this:

Static criteria of stability, such as Plateau's criterion mentioned above, are sufficient only in purely static phenomena, where ample time is available for the instability to predominate. In dynamic cases, at least three things must be considered: (1) the static criterion of stability; (2) the degree of instability, as determined by (*a*) the disturbances by which equilibrium is upset; (*b*) the changes through which the system under investigation will pass while the instability is acting; (3) other forces that may act simultaneously. All of which is summarised in the question: Has the instability a chance to produce its effect before something else happens?

R. A. CASTLEMAN, jun.

Bureau of Standards,
Washington,
October 28.

Electronic States of the CN Molecule.

COMPARATIVELY little attention has been paid as yet to the electronic changes involved in the emission of band spectra. In line spectra the study of resonance potentials, of absorption spectra, and of thermal excitation, have all been fruitful in the determination of electron levels. Low-temperature absorption spectra obviously involve as their less excited electronic state the normal state of the absorbing atom, or molecule. Lines, or bands, thermally excited at moderate temperatures, necessarily involve transitions from moderately excited states, very often *to the normal* state of the emitter. Familiar examples of band spectra so excited are the flame spectra of the alkaline earth and copper halides, and of boric oxide; probably many, perhaps all, these involve as an end state the normal state of the emitting molecule; the fact that these bands have not been observed in absorption may be ascribed to the impossibility of

[9] Ollivier, *Ann. de Chim. et de Phys.*, 10, 313, 1907.
[10] Castleman, *Phys. Rev.*, 21, 709, 1923.
[11] Rayleigh, Proc. Roy. Soc., 34, 130, 1882.

obtaining the emitting molecules in sufficient concentration in the vapour state at ordinary temperature.

An examination of the CN bands with these points in mind gives interesting results. The long dispute[1] as to whether carbon in addition to nitrogen is required for the emission of these bands seems now to have been decided in the affirmative.[2, 4] Without attempting to review the evidence, the following important points may be noted: (1) The supposed relation between the constants of the red CN bands and of the first positive nitrogen bands has recently been disproved[2] by Birge; (2) the (red and violet) CN bands appear in active nitrogen when, and only when, carbon compounds are admitted[3]; (3) according to Freundlich and Hochheim,[4] when nitrogen is heated to 2100°-2200° C. in a graphite tube, the violet CN bands are emitted in great intensity (according to A. S. King[5] they also appear in absorption at slightly higher temperatures—about 2500° C.), but are completely absent when nitrogen is heated to the same temperature in a tungsten furnace; in this work the red CN bands were not looked for. Evidently in the presence of nitrogen and carbon above 2000° C., some compound is present which can be excited thermally to the emission of the bands. Since the band structure is that of a diatomic emitter, this compound must be CN.[6]

The red and violet CN bands, as was shown by Heurlinger, have a common final electronic state. The latter, it can now be stated, is in all probability the normal state of the CN molecule. The thermal excitation of the violet CN bands at the moderate temperature of 2100° C., in spite of the undoubtedly very small concentration (see below) of CN molecules, is satisfactory evidence of this. The red and violet bands, respectively, correspond then to electronic resonance potentials of 1·78 and 3·18 volts. The sudden appearance of the bands in emission and absorption above 2000°, however, requires explanation. One would expect CN to be formed by the dissociation of $(CN)_2$ at high temperatures. This does not occur appreciably, however, at or below about 800° C.[7] The matter cannot be investigated experimentally above this temperature, since $(CN)_2$ begins to decompose into carbon and nitrogen.[7]

The concentration of $(CN)_2$ *in equilibrium* with carbon and nitrogen must, in fact, from thermodynamic calculations, be excessively small at all low and moderate, and perhaps even at the highest, temperatures.[8] The equilibrium concentration of CN at low temperatures must be very much smaller still,[9] but may be expected to increase with temperature, probably more rapidly than that of $(CN)_2$. Apparently above 2100° it becomes sufficient for appreciable absorption and emission of the violet CN bands. Presumably it continues to increase with the temperature, perhaps until CN becomes a relatively abundant molecular species. The great intensity of the CN bands in the carbon arc (temperature about 4000° C.) is well known.[10] The bands also appear in absorption in the sun and some of the stars.[10] The low resonance potentials of CN indicate, however, a low ionisation potential, so that it is likely that CN is largely ionised at the higher stellar temperatures.[11]

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[1] This is summarised in Kayser's "Handbuch der Spektroscopie," Vols. 5, 7.
[2] R. T. Birge, paper before Am. Phys. Soc.: abstr., *Phys. Rev.*, 23, 294 (1924).
[3] Cf. Lord Rayleigh and Prof. A. Fowler, Proc. Roy. Soc., 86A, 113 (1912); Lord Rayleigh, *ibid.*, 102A, 453 (1923).
[4] E. Freundlich and E. Hochheim, *Zeit. f. Phys.*, 26, 102 (1924).
[5] A. S. King, *Astrophys. Jour.*, 53, 161 (1921); R. T. Birge, *Astrophys. Jour.*, 55, 273 (1922).
[6] The fact that neither $(CN)_2$ nor HCN absorbs these bands—both are colourless—may also be noted in favour of CN. Also, the presence of H_2 in the arc, causing HCN formation, *diminishes* the intensity of the CN bands.
[7] Cf. refs. in Abegg, "Handbuch der anorg. Chemie."
[8] Lewis and Randall, "Thermodynamics" (McGraw-Hill Co., 1923), pp. 592-4. The existence of $(CN)_2$ at low temperatures must evidently be ascribed to a negligible decomposition rate.
[9] This is shown by the non-dissociation of $(CN)_2$ below 800° C., supported by the non-appearance of CN as a chemical entity at ordinary temperatures.
[10] Cf. A. Fowler and H. Shaw, Proc. Roy. Soc., 86A, 118 (1912). The appearance of the CN bands in comets, presumably at low temperatures (as in active nitrogen), may reasonably be attributed to the action of electron bombardment or high-frequency radiation on C- and N-containing compounds which may be present.
[11] There is considerable evidence of an analogy between CN and BO, both chemically unsaturated "odd molecules," and the Na atom. This will be discussed elsewhere. It may be noted here, however, that in all three cases there are nine electrons in addition to the nuclei and K electrons, and in all the resonance potentials are low.

Spectral Theory and the Origin of the Nebulium Lines.

THE fact that the so-called nebulium lines are found to be associated with hydrogen and helium lines only, has frequently been taken as an indication that these lines are somehow emitted by hydrogen or helium, although it has been a great difficulty for this hypothesis that terrestrial experiments always have failed to reveal the lines. The physical conditions prevailing in nebulæ are very probably characterised by exceedingly low density combined with the absence of nearly all possible sorts of disturbing influences, apart from a field of radiation which, however, in only a few cases can be comparable in intensity to that of faint moonlight. Similar conditions of low density may also be essential characteristics of the outer atmospheres of long period variables, of the solar chromosphere, and the upper atmosphere of the earth, in all places of which there appear spectral lines of unknown origin or under anomalous conditions of excitation.

If the suggestion is true that the appearance of the nebulium lines, etc., is due to absence of disturbing influences, atomic theory would suggest that these lines were connected with a faint metastability of certain possible quantum states of the atoms which, under ordinary experimental conditions, is so small that it is broken down by interaction between the molecules in the gas or by the electric current applied. As to *hydrogen* in an atomic state, there appears to be no possibility left open for emission of lines which do not fit into the ordinary Balmer formula. It is, however, of great interest in this connexion that the 2_1 state of the hydrogen atom is exceptional as regards stability, as the transition $2_1 \rightarrow 1_1$ to the normal state is excluded by the selection principle. The stability of this state depends upon the fact that the relativity modifications in the motion of the electron are equivalent to the existence of a small additional central field necessitating the introduction of the azimuthal quantum number k and restricting transitions to such where k changes by $+1$ or -1. If the 2_1 state really possesses some metastability in hydrogen it must be the case to an enhanced degree for helium atoms with one electron only; and similar cases are to be found for the $2S$ term of the parhelium spectrum as well as for other spectra. (Cf. the calcium spark spectrum.)

Ordinarily, we expect that, in any recombination process between a positive ion and a free electron, the ion will in the overwhelming number of cases be in a normal stable state, while the outer electron occupies successive quantum states of the atom. For the special case in which the ion possesses metastable states, as is expectedly the case in helium, the binding process may perhaps take place to a large extent while the

atom, apart from the outer electron, still persists in a higher quantum state. In the special case of helium, we should thus expect that a free electron might be bound while the inner electron resides in a 2_1 quantum state. The spectral lines emitted in such a hypothetical binding process would be different from any lines or combinations in the ordinary helium spectrum and would just constitute a characteristic spectrum emitted by helium under conditions of a strong ionisation and excessively low density.

It would thus appear that the theoretical possibilities of the nebulium spectrum being due to helium are not yet exhausted. The possible existence of a metastable state of hydrogen would further help materially in understanding how hydrogen can show a marked degree of ionisation under the very feeble conditions of excitation in nebulæ, a fact which is evidenced by a marked emission of continuous radiation at the head of the Balmer series observed in several planetaries. This fact and the concordant complete absence of any trace of the hydrogen many line spectrum seem also to offer difficulties to all theories ascribing the nebular lines to molecular compounds of hydrogen and helium, an idea which otherwise would be in harmony with the above trend of thoughts. (Cf. H. H. Plaskett, NATURE, Sept. 15, 1923, p. 392.)

S. ROSSELAND.

Mount Wilson Observatory,
November 8.

Polarisation of the Light of Rainbows.

IT is quite well known that the failure of Brewster's law in the case of several substances is due to unavoidable imperfections in the polish of the surfaces. Several years ago the late Lord Rayleigh showed, by mechanical separation of surface impurities of water kept in a long metal trough, that Brewster's law did hold good in the case of water treated in this way.

On the morning of August 29, 1924, at about 6.15 A.M., when the sun was about 5° above the horizon, a strong primary bow attended by its strong secondary with the usual colour sequence was thrown on the westward sky. Just before the appearance of these bows, there had been one or two heavy showers, and during the interval the bows were visible it was almost incessantly drizzling. When examined by a nicol, light from the bow appeared almost completely plane polarised. Assuming, then, Brewster's law, and taking 1·33 as the refractive index of water for the mean ray, we find the angle of incidence is 53° 4′ and angle of refraction into the raindrop is 36° 56′ approximately. For one internal reflection, *i.e.*, in the case of a primary bow, we can calculate the total amount of deviation which the incident ray suffers. It is 138° 24′, which is about the same as that calculated in the usual manner. Now the raindrops taking part in the production of bows are for obvious reasons free from surface contaminations, and thus the above observations appear to confirm in a novel way the late Lord Rayleigh's suggestion that in the case of ordinary water, the failure of Brewster's law is due to the attendant surface impurities.

While the above observations were being made, a fresh bow parallel and close to the primary was suddenly developed. This had the same colour sequence as the primary but differed from the latter in intensity of colour and radius. The colour intensity, as judged visually, was slightly less, and the radius slightly greater, than that of the primary bow. But the most noteworthy phase of this phenomenon was that the new bow gradually approached the primary and ultimately merged into it. The whole phenomenon took about two minutes for its completion. The light from the new bow as well showed almost complete polarisation.

So far as I am aware there is no previous record of such a phenomenon, and consequently it is likely to excite much interest and explanatory speculation. So far as I know, the two primary bows may be explained by imagining two parallel rain showers from two gradually approaching clouds until one disappears into the other. A simple qualitative laboratory experiment with glass spheres filled with water, and a strong and steady source of white light, appears to lend support to such an explanation.

I should be much obliged if any reader of NATURE would kindly communicate to me any observations he may possess regarding the phenomena described above.

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An Endotropic Fungus in the Coniferæ.

DURING an investigation on the anatomy of the buds of the Coniferæ in 1923, certain features met with suggested the possible presence of an endotropic fungus in the living tissues, but the feature seemed so unlikely that the matter was not then further pursued. Researches on the distribution of potassium in the tissues of *Picea Canadensis* last year, by Miss E. S. Dowding in this laboratory, again brought to light features suggesting the presence of fungal hyphæ in the bud, and showed with certainty the presence of an endotropic mycorhiza in the deeper living tissues of the root. The inquiry was taken up again in the latter part of October, and since then I have found a fungus present in the living cells of the root, stem and bud in the following tissues: phelloderm, cortex, medullary rays, pith and cortical tissues of the bud.

The mycelium may be present as an exceedingly fine system of threads which are seen to penetrate the cell walls and may be massed in convolutions round the nucleus of the cell; they may be present as short jointed threads nearly filling the cells of the young root, and in certain tissues of the bud the hyphæ may assume the condition of large coiled threads frequently applied to the nucleus of the cell. Many of the stages in different tissues strongly resemble the various conditions of the mycorhiza of *Thismia Aseroe* described by Groom (*Annals of Botany*, 1895). An endotropic fungus penetrating the living cells of the root, stem and bud has been found during the last few days not only in *Picea Canadensis* but also in *Larix Laricina*, and I have good reason to suppose that a similar condition also occurs in Pseudotsuga and Abies. That such a condition of symbiosis, possibly obligate, should be present in some and probably a large number of genera of Coniferæ on this continent is surprising and opens up an extensive field of extremely interesting investigation.

During the last few days an examination of the root and stem of *Ledum palustre* and *Vaccinium Vitis-idæa* from this district has been made, and an endotropic fungus has been found similar to that described by Rayner (*Annals of Botany*, 1915) in European material. An account of the leading features of the coniferous material will be published immediately, and a more detailed paper dealing with the possible infection of the seed and other matters will be published later.

FRANCIS J. LEWIS.

Botanical Laboratories,
University of Alberta, Edmonton, Canada,
November 12.

Molecular Dimensions of Celluloid.[1]

RECENTLY we have had occasion to make thin films of celluloid by the previously known method of dissolving the celluloid in amyl acetate and allowing a single drop of the solution to fall on a clean water surface. With solutions sufficiently dilute, as the amyl acetate evaporates interference colours appear in practically uniform sheets of colour over the entire surface which change from red to violet and then the film becomes colourless. Some of these films were deposited on optically flat glass and their thickness determined by an interferometer method by C. G. Peters, of the Bureau of Standards' staff.

In this manner films so thin as 30 angstroms were measured. The solution from which these were deposited contained one gram of celluloid dissolved in four hundred grams of amyl acetate. Thinner films than these could not be measured directly, but those made from a solution containing one gram of celluloid in eight hundred grams of amyl acetate were sufficiently tenacious to hold together and adhere to the finger. With still further dilution—one gram of celluloid in twelve hundred grams of amyl acetate—as the last traces of the amyl acetate evaporated, a vibration or quiver was seen to pass over the surface of the water and the film simultaneously broke into minute particles of celluloid.

Assuming that the films decreased in thickness in proportion to the dilution of the solutions, since their area remained practically constant, this means that the films which were just too thin to hold together were approximately 10 angstroms thick. This value agrees with that calculated directly from the density of celluloid, the concentration of the celluloid solution and the area of the film on the water surface. Since the thinnest stable films must have been at least one molecule thick, these experiments indicate that the molecular complex of celluloid is not more than 10 angstroms in diameter. This value is in accord with similar results obtained on oil films[2] and other organic substances.[3]

VOLA P. BARTON, Research Associate.
FRANKLIN L. HUNT, Physicist.
Bureau of Standards, Washington, D.C.
November 4.

Mercury and Helium.

IT is known that under some conditions not clearly defined or understood, mercury and helium may become so intimately associated that the separation of the one from the other is difficult. According to prevalent views, helium is a highly inert gas, and is therefore incapable of combining with other elements; hence it appears that helium can in some way not known act as a "carrier" of mercury.

For some years past I have been experimenting with mercury and various gases, including hydrogen and nitrogen. The results obtained led me to try similar experiments with mercury and helium; these last are now almost concluded. Briefly, the findings are as follows. Under certain conditions and in the presence of an electric glow discharge, mercury and helium combine to form mercury helide. The helide is a stable compound, and is not readily decomposed except at or above a bright red heat. As the formation of the helide progresses, a corresponding decrease in the volume of the helium employed takes place. On heating the mixed gases (helium and helide) to the required temperature, the original volume of the helium is restored. The helide is but slightly absorbed by charcoal cooled in liquid air. The refractive index of the mixture of helium and helide, as observed by a Jamin interferometer, increases continuously during the formation of the compound. When used in a vacuum tube of the form employed for spectrum analysis, mercury helide is gradually resolved into its elements. At the moment of activating the coil, the mercury green line (W.L. 5460·7) is invisible; then as the coil is worked, the line, at first faint, steadily increases in strength, and in some cases ultimately becomes quite bright.

Judging from these results, it appears almost certain that the associated mercury detected by earlier observers, has been present as helide, the conditions having been those under which that compound could be formed.

I have not yet carried out a quantitative analysis of the mercury helide, but a plan for doing so has been made, and is now being perfected. I hope shortly to give a detailed account of my work and conclusions.

J. J. MANLEY.
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November 19.

Optical Separations and Atomic Numbers.

IT has been recently shown (Millikan and Bowen, *Phys. Rev.*, 24, 1924) that in optical spectra due to atoms having similar electronic configurations, the doublet and triplet separations vary according to the relativity X-ray formula:

$$d\nu = K(Z-s)^4$$

where $d\nu$ is the doublet (or triplet) separation, K is $(0{\cdot}365 \times 2^3)/n^3$, n being the total quantum number appropriate to the orbits giving rise to the separation, Z the atomic number, and s the screening constant, which varies, becoming smaller, for example, in passing through Li I, BeII, BIII, CIV.

This formula has been applied to doublets and triplets generally, and the values of s obtained tabulated. On plotting curves it is found that the values of s within the same group are directly proportional to the atomic number, this proportionality holding also for the ionised elements. Moreover, the slopes of the graphs are very nearly the same for all groups. So far, straight lines have been obtained for groups I*a*, II*a*, II*b*, III*b*, II*a* spark, II*b* spark; others are being investigated. This linear relationship should be of importance in assigning spectral series; and it is being applied in this way. The matter will appear shortly in more detail.

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November 19.

Eolithic Ornament and Art.

IN the English translation of Prof. Hugo Obermaier's book "Fossil Man in Spain" (Yale University Press), just published, there appears, on page 9, the following statement. "But some—among them Boucher de Perthes, Dharvent, . . . and J. R. Moir, went further, and proclaimed the existence of Eolithic ornament, and art."

This, so far as I am concerned, is entirely incorrect. I have never "proclaimed" a belief in the existence, in any form, of Eolithic ornament and art, nor do I believe that evidence which would make such a belief inevitable has, as yet, been discovered.

As Prof. Obermaier's book will, in all probability, be widely read by English readers, I regard it as necessary to make the above correction.

J. REID MOIR.

[1] Published by permission of the Director of the Bureau of Standards of the U.S. Department of Commerce.
[2] Lord Rayleigh, *Phil. Mag.*, 48, 331 (1899).
[3] Langmuir, Irving, Journ., Am. Chem. Soc. vol. 39, p. 1858 (1917).

The Carbon Atom in Crystalline Structure.[1]

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

IT is one of the great purposes of research to be able to explain the properties of materials in terms of the properties of their parts. The division into parts may be carried to various degrees of fineness; and the nature of the research, its methods and difficulties, and the expectations of success will depend on the division that is attempted. The properties of a piece of steel may to some extent be explained in terms of the small visible particles, crystalline or not, of which it is composed; the degree of division is determined by the power of the microscope, and results of great value are obtained within this range. But we may have, as a higher ideal, the hope of explaining the qualities of steel in terms of the properties of the atoms of iron and carbon and other constituent elements. This division is far finer than the other; but obviously far more complete and satisfying. The difficulties are great, but so also will be, we may be sure, the ultimate success. Generally it must be our aim to explain the properties of all materials in terms of the atoms, remarkably limited in kind, of which the world is made.

Some progress towards the ideal has been made in the case of the gas and the liquid states; the great effort is yet to be made in the case of the solid. The moving particles of a gas are free from each other's influence for the most part of their time; they can be treated as projectiles the rare encounters of which are but slightly affected by the special and peculiar attractions which they exert on each other when very close together. The properties of gases are to a certain extent explainable in terms of a pure kinetic theory. Complications arise when from any cause the times during which the atoms or molecules are under each other's influence become relatively important, and the consequences depend on the individual peculiarities.

So also in the case of liquids much can be explained on a purely hydrodynamical theory, especially when the ties between atoms and molecules can be dissolved and re-formed continually without waste of energy in the form of heat, that is to say, when there are no viscosity effects. But when viscosity is to be taken account of, then the peculiar and individual actions of the atoms and molecules must be treated as effective. Still more, the phenomena of surface tension are direct manifestations of the forces that the atoms exert on their neighbours; and so in general are all the effects studied by the physical chemist. We are yet very far from being able to unravel them.

It is true that the associations and dissolutions of chemical action are due directly to the characteristic forces exerted by the atoms; and that chemical studies afford a most important means of examining them. Nevertheless, we want more than chemistry gives us if we are to reach our object. For example, we are far from linking up the properties of quartz with the known chemistry of silicon and oxygen.

In general, we know very little of the relation between the properties of the solid material and of the atoms of which it is built. Of the relation between the molecule and its constituent atoms we do know something, thanks to chemical study. But the wide field of solid structure is in this respect almost unexplored. The reason for this is very simple. The properties of the solid depend upon the structural arrangement of its component atoms, and the arrangement is, at the first attempt, as we may say, crystalline. When groups of atoms or molecules associate and form a solid, they arrange themselves in a regular pattern; the unit of pattern containing only a few groups, usually two, three, four, six or other small numbers. The arrangement is so uniform and so exact as to imply that the group has a definite and characteristic shape, or, in other words, that the forces which one group, atom or molecule exerts on its neighbours are such as to place them at proper distances from itself, and in proper orientations. The crystal is the direct expression of this tendency and is a far more prevalent form of matter than we had thought. The large crystals that we see with our naked eye, and even the small crystals which the microscope reveals to us, are only the favourable cases. Below all that we can see in any way is a universal tendency to crystallisation which the methods of X-ray analysis are now showing to us. The solid which appears to us to possess none of the properties of the crystal is usually a very viscous fluid, or a disordered mass of minute crystals. The crystal is the simple body, the so-called isotropic body is the complex. Consequently, it is the crystal that must first be mastered.

It is only within the last ten years that the direct study of crystal structure has been possible, and the way to this huge field of inquiry been thrown open. The X-rays, to put it simply, if somewhat crudely, are a form of light ten thousand times finer than visible light, and we are now able to see, indirectly it may be, the actual arrangement of the atoms. Here is our chance of making this supreme analysis. We have before us a widespread research, in the course of which we must examine crystal after crystal, learning its structure, that is to say, the pattern according to which its constituent atoms are arranged, and examining the way in which the properties of the individuals determine that pattern; and in turn the pattern determines the elasticities, rigidities, conductivities, dielectric capacities and every other characteristic which the crystal possesses. After that, follows in its turn the crystal conglomerate, the isotropic solid.

An especial interest is attached to all that we can discover by the new methods of crystal analysis concerning the nature and properties of the carbon atom. It is not one of the more common elements. While oxygen is calculated to form half the materials of the earth's crust, silicon a quarter, and aluminum about a sixteenth, only about a thousandth is composed of carbon. But it is the carbon atom which more than any other impresses its character on the materials of which living bodies are composed. The very term, organic chemistry, which is given to the subject that is largely occupied with the study of the carbon compounds, is an expression of the importance of the carbon atom in the living organism. Not only is the carbon

[1] Address delivered at the University of Pennsylvania, on September 18, on the occasion of the celebration of the centenary of the Franklin Institute. Reprinted, with slight modifications, from the Journal of the Institute for November 1924.

atom of supreme importance in the constitution of our bodies and of their unconscious actions, but also in a great proportion of the external activities in which we are engaged. We must be especially eager to know what we may learn of the behaviour of the carbon atom when it takes part in the constitution of the solid body, and in the first place of the crystal which is the simplest form of the solid. The only fact which makes us hesitate is the vastness of the number of known crystalline compounds, giving us a bewildering choice of material on which to work.

We come to this study with certain expectations founded on the large labours of the organic chemist and their rich harvest of results. We expect the carbon atom to display, for example, a definite tetravalency, a power of attracting to itself under certain circumstances, at least four other atoms and no more, all bound in a similar way to the central carbon; as, for example, when the carbon atom draws to itself four atoms of hydrogen and the methane molecule is formed. Yet, in other circumstances, the carbon atom seems fairly content with a smaller number, as when in the benzene ring each carbon is attached to two other carbons and only one hydrogen, and the benzene molecule has very little general attraction for another benzene molecule. Again in the carbon dioxide molecule, the carbon atom is satisfied by the companionship of two other atoms only, and we should like to know what rearrangement has been made of its activities to permit the formation of this self-contained molecule, so independent that it forms a gas. Also, what further change has been made when the molecule of carbon monoxide is constituted? In other words, what is the explanation of the single, double, and triple bonds known to the chemist? We hope to be able to throw light on all these conditions, and the questions to which they give rise, by the study of the carbon atom as it is built into the crystal, where we can examine the exact nature of its environment and can relate thereto the properties of the crystal.

There are two crystalline forms composed of carbon alone, diamond and graphite, and we naturally turn to their examination first. The diamond structure was, in fact, one of the first to be examined by the new methods. Its structure is very simple and symmetrical, and answers at once our expectation that we should find in some circumstances a perfectly tetravalent behaviour. Each carbon atom is surrounded by four others, which are grouped about it in perfect symmetry; the atom shows no attraction for more than four. A sphere can, of course, be surrounded by twelve other similar spheres, and if the attraction between any two atoms could be represented merely by a central force, we should expect the close packing which gives the full quota of neighbours. Since there are only four, the force exerted by one carbon atom on another cannot be represented by central forces only. Further, the hardness and rigidity of the diamond show us that the forces are mutually oriented; that they are primarily exerted along four lines drawn from the centre of a tetrahedron to its corners and that there is a strong resistance to any relative change in those directions. All these new points are in excellent agreement with known chemical facts. The carbon atom is to be represented by a tetrahedron rather than a sphere.

The disposition of the atoms in the diamond shows that they may be divided into two classes, any member of one class being the reflection of the other—with appropriate shift—in any one of three planes which are the cube faces of the crystal. To put this in another form, each diagonal of the cube crystal passes through the vertex and the middle of the base of each class of atom, but members of the two classes face opposite ways. The X-rays detect the difference between the two kinds, from which we conclude that the scatterers of the X-rays participate in the tetrahedral grouping. Yet the difference is only slight, so that if it is the electrons that scatter, they are close to the centre, which seems unlikely; or else they have an extended movement about their average positions at the corners, so that their diffracting effect is small; their action is like that of broad faint rulings on a diffraction grating.

The other crystal of pure carbon is graphite. There is no clear evidence at present of the existence of any other form, although certain curious carbon materials have not been fully examined. The structure of graphite has recently been re-examined by Bernal, who was able to obtain single crystals of sufficiently perfect form. The results of his work show that graphite is a hexagonal crystal, as Hull had supposed from an examination by the Lowder method. It consists of layers of carbon atoms, each layer separated from the next by 3·40 Å.U., as has long been known. In each layer, the carbon atoms are arranged in a hexagonal network; the long uncertain point as to whether the atoms of one sheet are all exactly in one plane or are in two planes making a puckered network, seems now to be decided in favour of the former alternative, as Debye has suggested. In this case, each carbon atom is very strongly tied to three neighbours, all in one plane; the distance between the centres is 1·44 Å.U. as against 1·54 Å.U. in the diamond. The distance between a carbon atom in one layer and its nearest neighbour in the next is more than twice as great.[2] The curious properties of graphite show that the forces between atoms in the same sheet are exceedingly strong, while the forces between sheet and sheet are very small. It is clear that the carbon atom is now exerting its attraction on other atoms in quite a different manner from that which was followed in the diamond. If the electrons are in some way responsible for these forces, their arrangement must have been altered. The atom is no longer tetrahedral.

The extraordinary success of Bohr's theory in regard to radiation is a constant inducement to attempt a correlation between his arrangement of electron orbits with the display of the atomic forces, although it does not seem possible at present to make more than vague and preliminary attempts in this direction. According to Bohr, there are four electron orbits which we may naturally associate with the tetravalency of the atom; but the four are not all alike, being different, two and two. Thus the tetravalency is not fully symmetrical. The radiating carbon atom which is the subject of the theory is not, however, attached to other atoms, but is free; and we may well suppose that the internal

[2] Since this was written, a paper by Hassel and Mark has appeared in the *Zeitschrift für Physik*, describing experiments which lead to exactly the same result as that of Bernal. The latter's paper appears in the Proceedings of the Royal Society.

arrangements are modified by structural requirements. There may be a real difference, implying perhaps a different energy content between the free atom with its two pairs of outer orbits, the atom in graphite with three like orbits and one odd, and the atom in diamond with all four alike. The electron of the odd orbit in graphite would naturally travel far and be loosely attached to the nucleus; and in this, as has been suggested by Shearer and Bernal, we may find the explanation of the colour, the opacity, and the conductivity of graphite.

We now come to cases in which other atoms beside the carbon enter into the structure; and first to calcite. The X-ray analysis shows that the carbon atom is now surrounded symmetrically by three atoms of oxygen, all alike.

The compact group of one carbon and three oxygens possesses a double negative charge; the calcium atom possessing the corresponding amount of positive electricity. It has been suggested by Kossel that the arrangement is governed by the tendency for the oxygen atoms to surround themselves in each case by the full complement of eight electrons, and that this is effected by stripping the calcium atom of two electrons and the carbon atom of four. On this theory, there is no parallelism with the graphite structure, though in both cases the carbon atom is surrounded by three other coplanar atoms, similarly situated. The carbon atom has now lost all four of the electrons that were moving in outer orbits and is reduced, in external appearance, to helium. It is to be treated as exerting a central electrostatic force due to a positive charge of four units.

It is well known that a vast number of organic substances are based on a substructure consisting of a ring of six carbon atoms, or a chain of carbon atoms of any length. The simplest ring compound is the famous benzene molecule; benzene does not, however, lend itself very readily to analysis because benzene is liquid at ordinary temperature and when frozen does not form good crystals. But there are the two substances, naphthalene and anthracene, of which the former has been imagined by the organic chemist to consist of a double ring, represented by two hexagons in the same plane, having one side and two corners in common. The latter consists of three hexagons in a line, the naphthalene model extended by one more hexagon. Both these substances crystallise well, a very marked characteristic of each being the tendency to split into thin flakes. All these molecules are bounded by hydrogens. They must be considered as simple subjects for attack, because the ring is so common a feature of organic substances, and the single, double and triple rings form a series of comparable members. A curious point of obvious interest is the connexion of each carbon atom with three, and only three, other atoms. Why has the fourth bond apparently disappeared?

The X-ray analysis shows that the unit of pattern of both naphthalene and anthracene contains two molecules arranged so that their long axes are parallel to one another and that they are the reflection of each other in the single plane of symmetry which the crystal possesses. In fact, the crystal can be considered as a set of parallel flakes, like the monomolecular layers of Langmuir. In each flake the molecules stand not quite at right angles to the flake, but lean over like wheat in a field blown by the wind. The difference between the anthracene and the naphthalene structures lies only in the length of the molecule, which makes the flake thickness of the former greater than that of the latter. Moreover, the actual increase in length which is found by the X-ray measurement is exactly what it should be if, in the first place, the one molecule consists of three benzene rings in a row and the other of only two, according to chemical theory, and in the second place, the width of the ring is the same as that of the carbon ring which is found everywhere in the diamond structure. We might suppose, in fact, that the molecule of naphthalene as built into the crystal structure was simply carved out of the diamond without alteration and then fringed with hydrogen atoms. A similar set of atoms carved out of the graphite flake would do equally well so far as length is concerned, because the graphite layer is, according to Bernal, the diamond layer pressed flat without any sideways extension. But if the carbon atoms were in the supposed graphite condition, it might be expected that naphthalene would be a conductor and be opaque like graphite, which is not the case. The direct analysis itself is not yet able to say whether the three attachments of each carbon atom to its neighbours in the same molecule are all on one plane. It is to be remembered that there are attachments between each molecule and its neighbours in the same layer, but these must be far weaker than the bonds binding together the atoms in the same molecules; they are stronger, however, than the end-to-end attachments which break on the cleaving of the crystal. These last must be feeble because the crystal cleaves so easily.

So far, therefore, the result of the analysis of these crystals is, in the first place, to give confidence in the existence of a mutual support between the established organic chemistry and the new methods of analysis; and to show us also how closely the behaviour of the crystal may be connected with its general structure. As to details, the indication seems to be that the carbon atom has—at least nearly so—the same characteristics as the atom of the diamond; but that one of the four valencies is unused. We have even some grounds for saying that the unused valency, or the unoccupied corner of the carbon tetrahedron, is that which lies on the face of the molecule, not on its edge. The crystal of naphthalene tetrachloride, *i.e.* naphthalene with four added chlorine atoms, shows the same structure as that of naphthalene, and has very similar dimensions except that it has broadened by an amount which would correspond closely with the result of adding the chlorines at the places indicated.

Measurements have been made of some of the dimensions of other crystals containing ring molecules, and the results fit in, so far as they go, with the idea that the ring is an actual structure of definite dimensions and form, slightly altered it may be by additions or substitutions of other atoms or groups of atoms, or strained because it has to be fitted into its place in the crystal, nevertheless recognisable in its different circumstances, as the chemist would expect. To settle these points more satisfactorily, to turn guesses into certainties is, of course, the work that is before us.

Very interesting results are obtained by Müller and

Shearer from the study of the long-chain molecules of the fatty acids, hydrocarbons, and similar substances. It appears that when these substances in the solid state are pressed on to a flat surface, they form flaky crystals like graphite or naphthalene, and it becomes easy to measure the thickness of the monomolecular layer. The experimental results are beautifully definite, and their interpretation can be given with great chance of being correct. It seems probable that the molecule is perpendicular to the layer, not slanting. If it were the latter, one would expect the amount of slant to be variable so that it would not be possible to connect the thickness of the layer with the length of the molecule only. Now, it is a remarkable fact that the thickness of the layer grows at a uniform rate as the chain is increased by the addition of carbon atoms, and that for very nearly all, if not all, the different kinds of chain molecules that have been examined, this rate has one or other of two values. For every two carbon atoms that are added the increase in length is either 2·50 Å.U. or 2·00 Å.U. very nearly.

If we were to suppose that every carbon atom in the chain had four points on it, disposed like the corners of a regular tetrahedron, at any one of which an attachment could be made to a neighbour, in other words, if we supposed the atom to be as in diamond, then a chain of carbon atoms would take one or other of three forms, one of which is a screw. Putting the distance between the centres of two carbon atoms equal to the distance found in the diamond, namely, 1·54 Å.U., it can readily be calculated that the length of chain *A* (Fig. 1) is 2·50 Å.U. for every two atoms

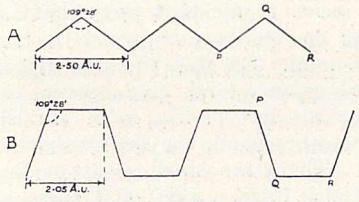


FIG. 1.

added, and of chain *B*, 2·05 Å.U. The agreement with experiment seems to be more than a coincidence, and it may be provisionally assumed that in these chains either the *A* or the *B* form is adopted, and the linkage of carbon atoms with their neighbours is on the diamond plan. In other words, if *PQR* are the centres of three atoms, the angle *PQR* is equal to the angle between two of the lines joining the centre of a tetrahedron to the corners.[3]

One of the most striking results is the fact that the length of the main body of the chain is independent of the nature of any additions to its ends or replacement of any of its side hydrogens by an oxygen atom as in the ketones. Even the removal of two or four hydrogens from the body of the chain leaving two carbons connected, respectively, by a double or a triple bond, makes no appreciable difference in the length. It would not have been a matter of surprise if such treatment had caused a bend in the chain, on account of the relative shifting of points of attachment on the carbon atom that might be due to other points of attachment being unused. The removal of a pair of hydrogens from the chain makes no more difference to the chain than the stripping of an opposing pair of leaves from the stem of a plant.

A very curious point in the behaviour of the long chains is their apparent doubling in length when one end is formed of a so-called active group, as, for example, in the case of the fatty acids. When this is the case two chains join end to end, the active groups being together, and again the result is just the same as if two sticks were joined into one, the process of joining being concerned with nothing beyond the two active ends. This form of structure is illustrated in a very interesting way in the X-ray spectra. If a section is made of a substance consisting of layers of these doubled molecules, so as to show their stratification, then there will be a uniform distribution of diffracting centres—electrons—throughout the mass, with alternating thin layers of excess through the active ends, and thin layers of deficiency through the inactive ends, the methyl groups. This has the curious effect of intensifying the odd orders of the diffraction spectra. To understand this, it is only necessary to remember that if we were to make a series of fine rulings on a diffraction grating which exactly interleaved the stronger original rulings, the result would be the strengthening of the even orders; such an effect is found in the case of rock salt and was an important help in the determination of its structure. If now the additional rulings, instead of being like the original but weaker, could be of reversed effect, a deficiency instead of an excess, it would be the odd, not the even orders that would be strengthened. The same effect is found in the case of the ketones. When the substituted oxygen is in the middle of the chain, each layer of hydrocarbon molecules shows a generally uniform distribution of electrons with an excess at the middle where the oxygen atom is placed, and a deficiency at either end. When the substituted oxygen is not in the middle, the reinforcement of the odd orders disappears.

These many observations of the behaviour of the long-chain molecules seem to point to the conclusion that the carbon atom in the chain is, like the carbon atom in the diamond atom, possessed of four points of attachment regularly disposed about it, and that the non-use of one does not alter the disposition of the others.

It is scarcely necessary to consider in any detail the points given by structures like tartaric or succinic acid as to the behaviour of carbon atom. It is enough to say that, while the full interpretation may be yet to come, the general indications are in accordance with what has already been said.

These first tentative conclusions as to the behaviour of the carbon atom in the solid body are of interest, in spite of the fact that so little, relatively, has been accomplished in the solution of the structure of organic crystals. What remains to be done must have great consequences, and what little has been done already seems to possess many points of novelty and of interest, and these two facts taken together may be sufficient justification for this attempt at a review of the present position of the inquiry.

[3] A minute but perfect crystal of stearic acid has recently been examined by the X-ray method by R. E. Gibbs, who has found it to belong to the monoclinic class. The long molecules are not perpendicular to the cleavage plane, but are inclined at about an angle of 63°. This result is not necessarily in contradiction with any of the above suggestions.

The Biology of the Suez Canal.

THE Cambridge and Royal Society Expedition which set out last September to investigate the biology of the Suez Canal (see NATURE, October 4, p. 520) arrived at Suez at the end of the month, and at once went under canvas on the shores of the Bitter Lakes, being provided with boats, etc., by the generosity of the Canal Company. Here the members remained for four weeks, afterwards proceeding to Suez for a like period. They are now at Ismailia living on a house-boat lent by the Canal Company, this being towed from place to place as desired. Later they propose to move to Port Said for the last four weeks of their stay.

The Bitter Lakes, which are about 36 kilometres long by 12 broad, becoming much narrower to the south, yielded surprising results. There is a central area of about 6 fathoms, that overlies an extensive salt bed. This is covered by black mud, which proved to be absolutely devoid of life, although the density and temperature of the water immediately over it are relatively little higher than elsewhere; it may be presumed, however, that the salinity of the Lakes must have decreased since the Canal was opened. This deeper ground merges into extensive areas of shallower waters (0-3 fm.) by the shores, the surrounding land being almost typical desert. The waters were investigated in 1882 by Keller, who found them almost devoid of life, while Fox now writes enthusiastically as to the richness and variability of the organisms of this shore region. Keller found no anemones or echinoderms, 1 species of crab, 2 sponges, and a very few worms, while Fox records anemones as very common, also a few alcyonaria, echinoderms represented by sea urchins, starfishes, brittle stars, and holothurians, many species of crabs and sponges, with an abundance of worms and representatives of most other groups of organisms, including excellent soles. Bare sand, almost devoid of life, is found in patches, but most of the bottom is covered with a rich growth of algæ and phanerogamic plants. There is a striking average increase in size of some of the individual species of animals as compared with those which Fox previously collected for research purposes at Suez, the most striking being a large black Synapta about 45 cm. long as compared with the usual length of 25 cm. There proved to be considerable diversity of fauna and flora off different shores of the Lakes, and contiguous patches of the bottom were often found to carry different plants and animals, so that the mapping out of the bottom regions proved a task of great difficulty.

"The salt pools on the shores," writes Mr. Fox, "although interesting, have been disappointing owing to the poverty of their fauna. All contain one fish and one gastropod, both species in great numbers. There is no plankton and no other animal. The fish and mollusc both feed on algæ. The surprising thing is the high salinity which the fish and mollusc endure. My hydrometer registers 1000 in distilled water, 1204 in saturated salt solution. The Red Sea off Suez is 1031, the Bitter Lakes 1035-1045. These fish and molluscs live happily in 1175." (These are relative figures that may require adjustment for temperatures, etc.)

At Suez the Expedition has been mainly concerned with collecting the fauna and flora for comparison with those of the Bitter Lakes. Exact data as to temperatures, salinities, acidities, etc., have been obtained. There would seem here to be greater variability in the bottom life as compared with the period antecedent to the opening of the Canal. For this reason the Expedition has confined its work to ten selected stations, mostly with soft bottom, only once having visited the "coral" reefs which lie about 3 miles to the south. The greater part is sand; phanerogamic plants are uncommon, and algæ almost absent. The latter, however, occur abundantly under the piers, and Mr. Fox discusses how far the general absence of algæ in the Gulf of Suez may be due to an inhibition produced by the intensity of light, the possibility of this as the chief factor being largely discounted by the strong growth of plants in the Bitter Lakes. The Expedition has also studied with great care the organisms attached to vessels, to piles, and to buoys, cleaned on known dates, and has put out wooden floats. These latter should give data both as to the factors helping in the distribution of the organisms and as to the rates of growth of many forms.

In his comparison of the two regions he has so far studied, Mr. Fox concludes that the fauna on the piles of piers is equally abundant, "but the shallow bottom and coast fauna is more abundant in the Lakes. It seems to me that the richer Lake fauna may depend on the bottom, which is mostly sand mixed with mud. On this the phanerogamic weed grows in abundance and gives cover to animals. Further, detritus feeders like mud. In the Bay of Suez, on the other hand, the shallow bottom is more often sand. There are small areas of sand in the shallows of the Bitter Lakes, and these are devoid of weed and very poor in animals, as at Suez. The difference in richness then may be due to a difference in bottom. The striking facts about the lakes would be that (1) the higher salinity does not prevent a rich varied fauna, (2) it does not inhibit growth in size, (3) there are peculiar effects, such as the sex of Neptunus, almost all males."

The work of the Expedition has clearly been much expedited and made far pleasanter by the kindness, generosity, and personal interest that has been taken in it, not by the directors alone, but by all the officials of the Canal Company. They have lent boats and camping equipment, carried mails and helped in the commissariat. The head of the Coast Guards has lent launches, and the officials of the Government have uniformly been friendly. The Canal Company clearly has an area under its control of great scientific interest, if periodically examined. The present Expedition can only, at most, map out its different faunistic regions, and it will remain for a further expedition to examine these quantitatively, so that science may get the full value of the present enterprise.

J. STANLEY GARDINER.

The Coming of Age of Mechanical Flight.

ON December 17, 1903, twenty-one years ago, the famous brothers, Wilbur and Orville Wright, made their first flights with a power-driven aeroplane. Model steam-driven aeroplanes had flown before, and there is some evidence of the partial success of Clement Ader's *Avion* in 1897. But the Wright brothers were the first human beings to rise in the air in a power-driven flying machine and to descend in safety. Altogether four flights were made on that memorable day in 1903, the first lasting 12 seconds and the last 59 seconds. There were only five spectators present on the sandhills at Kitty Hawk, North Carolina, when the flights were made, but there appears to be no question of the correctness of the facts. December 17 is, therefore, regarded as one of the most important dates in the history of mechanical flight and is known in the United States as Aviation Day.

The machine with which the remarkable feat was achieved was a biplane fitted with a petrol engine made by the Wrights. The engine weighed about 7 lb. per horse-power, and the total weight of the aeroplane was 750 lb. Prof. S. P. Langley, who had devoted himself to the scientific investigation of the problems of flight, ran the Wrights very close, and had his machine not been damaged when being launched at two trials made on October 7 and December 8 of the same year, the honour of building the first machine to fly with a human being aboard might have been his. It was Langley's early experiments, and his belief in the possibility of human flight, which were among the influences that led the Wrights to undertake the preliminary investigations that preceded their actual work.

The success of the Wright brothers was largely due to their thorough study of what had been done before, and the interest attaching to the twenty-first anniversary justifies a brief review of the history of the aeroplane. Foremost among pioneers must be placed Sir George Cayley, sometimes called the father of British aeronautics, W. S. Henson, and J. S. Stringfellow. Of the work of Henson and Stringfellow at Chard, in Somerset some eighty years ago, there are many relics in the Science Museum, South Kensington, while the Smithsonian Institution at Washington contains Stringfellow's engine of 1866. The inauguration of the Royal Aeronautical Society in 1866, and the holding of the first Aeronautical Exhibition in 1868, emphasised the growing interest in the subject, and these events coincided with the earliest experiments of Otto Lilienthal. The names of Le Bris, of Alphonse Penaud, and of Clement Ader belong to a nation which was to witness some of the most splendid flying exploits. Langley's work began in 1887, and the year 1896 saw the flight of his steam-driven model. To the 'nineties also belongs the wonderful gliding experiments of Lilienthal in Germany, Pilcher in England, of the veteran Octave Chanute in the United States, and of Capt. Ferber at Fontainebleau.

It was with a knowledge of what had been accomplished by these pioneers that Wilbur and Orville Wright began their work. Born respectively in 1867 and 1871, the Wrights as young men had a bicycle business in Dayton, Ohio, and it was there they turned their attention to gliding and flying. The summer of 1900 saw their first experiments on the Kill Devil Hill sandhills, which were repeated the two following years. In the course of these experiments, says Col. Lochwood Marsh, they "confirmed Lilienthal's theory of the reversal of the centre of pressure on cambered surfaces at small angles of incidence: they confirmed the importance of high aspect ratio in respect to lift: they had evolved new and more accurate tables of lift and pressure on cambered surfaces: they were the first to use a movable horizontal elevator for controlling height: they were the first to adjust the wings to different angles of incidence to maintain lateral balance: and they were the first to use the movable rudder and adjustable wings in combination." The three summers given to gliding were followed by three years' experiments on power-driven machines. In 1903 they made their first flight; in 1904, for the first time, a circle was completed in the air; and in 1905 Wilbur Wright flew a distance of 24 miles at 38 miles an hour, the first successful long flight.

Meanwhile, a band of devoted French pioneers, including Ferber, the Voisins, Farman, Blériot, and Delagrange, quite independently approached success, and on November 12, 1906, in the Bois de Boulogne, the Brazilian, Alberto Santos Dumont, made the first officially recorded flight in Europe. From this time on, record has succeeded record, inventions, investigations, and accidental discoveries have multiplied apace, and the small band of pioneers has become an army.

The fine flight of Orville Wright at Fort Meyer, U.S.A., together with the displays of Wilbur Wright at Le Mans in 1908, gained for flying a popularity hitherto unknown, and the following year saw Blériot cross the English Channel, Cody make the first flight in England, and the meeting of the masters of flying at the famous Rheims gathering. It was in 1910 that Paulhan and Grahame-White had their great struggle for the *Daily Mail* prize of 10,000*l.* for a flight from London to Manchester. Many casualties, however, had to be recorded in these early days, and among them were the deaths of the Hon. C. S. Rolls at Bournemouth, and of Georges Chavez, who on September 23, 1910, flew over the Alps in a Blériot monoplane, only to meet his death in the hour of triumph.

Two years later came the formation of the Royal Flying Corps, and in 1914 the aeroplane took its place on the battlefield as an engine of war. In August 1914 the British Air Services mustered 272 machines. Four years later there were more than 22,000 efficient machines, and new ones were being delivered at the rate of 90 daily. The advances made during the War were summarised by Sir J. E. Petavel in his address to the Bournemouth meeting of the British Association in 1919. Speeds had risen from 80 miles an hour to 140 miles an hour, and the engine horse-power in a single machine had been increased from 100 to 1300.

With the cessation of hostilities came the exploration of the possibilities of commercial flying. In May 1918 a mail service was started between Washington, Philadelphia, and New York, and 1919 saw the inauguration of the London to Paris service. The same year saw the crossing of the Atlantic via the Azores

of the American flying boat NC4, piloted by Lieut.-Commander Read, and the great flight by Alcock and Whitten-Brown in the Vickers-Vimy machine which has now passed into the possession of the British nation. To the same period belongs the feat of Godoy, who crossed the Andes at a height of 19,700 feet, and the first England to Australia flight by Ross-Smith and his brother and two mechanics. With continents and seas crossed in many directions, the circling of the earth was only a matter of time. To accomplish this, however, meant the expenditure of a large sum of money. Surveys had to be made, stores collected, and routes patrolled. Of Squadron-Leader Maclaren's glorious attempt, and the splendid achievement of Lieuts. Smith and Nelson, of the United States Navy, during the present summer, there is no need to write. It was in the United States that the aeroplane was born, and there can be no grudging of the United States her round-the-world-triumph in the year which sees its coming of age.

Current Topics and Events.

ON December 13 occurs the bicentenary of the birth of the celebrated German natural philosopher, Franz Ulric Theodor Aepinus, remembered to-day for his "Tentamen Theoriae Electricitatis et Magnetismi," published at St. Petersburg in 1759. Born in Rostock, Saxony, Aepinus was descended from a leading theologian of the Reformation. After studying medicine, he devoted himself to mathematics and physics, and at an early age became a member of the Berlin Academy of Sciences. Like many other foreign men of science, he was attracted to the Russian capital, and became attached to the Imperial Academy of Sciences, inaugurated by Catherine I. on the plans of Peter the Great. Aepinus in 1757 was appointed to a chair of natural philosophy, afterwards became a tutor in the royal family, and endeavoured to found schools throughout the empire. In later years, like his great contemporary, Euler, he was patronised by Catherine II. He died on August 10, 1802, at Dorpat in Livonia, whither he had removed four years earlier. He wrote memoirs on mathematics, astronomy, optics, and mechanics, and in 1764 created great interest by a discussion of the transit of a planet across the sun's disc. Founded upon a modification of the single-fluid theory of electricity, his "Tentamen Theoriae Electricitatis . . . " has been described as the first systematic and successful attempt to apply mathematical reasoning to the subjects of electricity and magnetism. He also indicated the theory of the electrophorus, which, however, was constructed by Volta.

IN the middle of the last century the name of Alexis Perrey of Dijon was scarcely less known as a student of earthquakes than that of his contemporary Robert Mallet. The annual catalogues that he compiled, his regional memoirs on earthquakes, and the three laws which he stated as governing the periodicity of earthquakes were widely known. Perrey was the personal friend of such men as Ampère, d'Abbadie, Cauchy, Elie de Beaumont, and Quetelet. Yet his death in 1882, only seven years after his last paper was printed, attracted little, if any, attention. The societies with which he was so closely connected published no obituary notices, and even the dates of his birth and death were unknown to those outside his own circle. After the lapse of forty-two years, this defect has been supplied by a long and interesting account of his life and work recently published in the *Mémoires* of the Dijon Academy of Sciences, of which Perrey was treasurer for nearly twenty years. A very full analysis of his work, with a complete bibliography of his writings, is contributed by M. E. Rothé, director of the central seismological office at Strasbourg. The biographical section is written by M. H. Godron, Perrey's grandson, and from this we learn that he was born on July 6, 1807, appointed lecturer in pure mathematics at the Royal College of Dijon, and professor of applied mathematics (an office created for him) in the Faculty of Sciences. In 1867, owing to ill-health, he retired, though he continued writing his seismological memoirs while at Lorient for seven or eight years longer. He died in Paris on December 29, 1882.

IN reference to our note in the issue of November 8, p. 690, dealing with the origin of pearls, a correspondent writes that "about 300 B.C. Megasthenes, writing from somewhere about the middle of India, mentions the pearl fishing in the Straits of Manaar," but this is in reference to "the sea pearl called by the natives Margarita," and not to the possibility of a pearl in vegetable tissues. Megasthenes accompanied the Macedonian general, Seleucus Nicator, in his Asiatic campaigns about 307 B.C. Theophrastus (378–286 B.C.), pupil of Aristotle, but perhaps a greater master of science, specifically refers to them as coming from bivalve molluscs and as used for necklaces. Oppert translates a far earlier Assyrian inscription from Nineveh: "In the sea of the changeable winds his merchants fished for pearls; in the sea where the North Star culminates they fish for yellow amber"; pearls are also recorded as part of the tribute of the Chaldees. The Shoo King records that "the wild tribes about the Hwae brought oyster-pearls and fish" to the great Emperor Yu as tribute, 2205–2197 B.C.; these were probably pearls from freshwater mussels. Homer describes Juno as having "bright drops (τρίγκηνα) suspended from her ears," perhaps pearls, but probably golden drops. There is abundant evidence, however, of the use of pearls and pearl shell in all the ancient Eastern civilisations, and the Mahawansa records a gift of pearls and chanks (large-coiled marine molluscs found in the Gulf of Manaar) from King Wijayo (Ceylon) to his father-in-law before 500 B.C. Very beautiful are some of the beliefs about pearls, such as the concrete essence of the moon collected by the action of the negative principle in Nature (Giles's "Chinese Dictionary"), and the drops of rain falling into the open oyster shells and

concreting (Pliny), and these are equalled by the sixteenth century astrologer Cardan's theory that they are polished by being pecked and played with by doves.

THE policy of excluding Germans from international congresses is dealt with in an article in the November issue of the *Scientific Worker* by Prof. G. H. Hardy. In the course of his remarks, Prof. Hardy notes that at the International Mathematical Congress held at Toronto last summer, the representatives of the American Mathematical Society expressed their indignation at being summoned to the Congress without knowing that, according to the statutes of the International Research Council, German representatives were excluded. A resolution in favour of the removal of this ban was supported by the representatives of America, Denmark, Great Britain, Holland, Italy, Norway, Sweden, and Switzerland, but as it was contrary to the statutes it could not be carried. Unless the International Research Council itself removes the ban, the Union of Mathematics may collapse.

CAPT. KNUD RASMUSSEN, the Danish Arctic explorer, on his return to Norway from Alaska, gave some details, published in the *Times*, of his three years' journey of 20,000 miles from Greenland along the coast of North America. His object was to follow the route by which the Eskimo originally migrated westward, studying various tribes on the way. Parting from the other members of his expedition in King William land in April 1923, he met an Eskimo tribe called Netsilic, who were living completely in the Stone Age, and were in unceasing feud with tribes farther east. With some difficulty he succeeded in visiting the Netsilic settlements and gaining the confidence of the tribesmen. The exact locality of this tribe is not stated, but in this connexion Mr. Stefansson's recent discovery of the copper Eskimo in Victoria Land is of interest. Although Capt. R. Amundsen passed along much the same route in 1903–1905 as Capt. Rasmussen, the existence of white men is almost regarded as a myth by many tribes. In Alaska inland tribes of Eskimo were discovered. They have no knowledge of kayaks, but descend the rivers in large skin boats in order to buy blubber from the coast tribes. No language difficulty occurred until the Nunbaniut tribes, in the South Yukon district, were encountered. With them an interpreter had to be used owing to the wide divergence of their speech from the usual form of Eskimo. Capt. Rasmussen hoped to continue his researches in Siberia, but after crossing Bering Strait was forced to abandon the attempt owing to opposition by the Russian authorities. Large ethnographical and biological collections, as well as many cinematograph films, have been brought to Europe.

THE ship *Discovery* which is to be employed in research into whaling in South Georgia and the South Shetlands, and, incidentally, in scientific work affecting oceanography, meteorology, and magnetism, is still undergoing reconstruction at Portsmouth, and it is not likely that she will be commissioned for several months to come. If time permits, it is proposed that the *Discovery* should proceed to Stanley, Falkland Island, carrying out a programme of scientific observations on the way; and that from Stanley she should proceed to South Georgia, arriving there about the commencement of the whaling season in October 1925. Meanwhile a marine station in connexion with the expedition is being established at Grytviken, South Georgia. The building was constructed in sections in England to facilitate erection locally. Provision has also been made for a laboratory, and a considerable portion of the necessary scientific equipment has been shipped. Simultaneously with the erection of the marine station, a wireless station, and other buildings belonging to the Colonial Government, are being constructed under contract with the Marconi Company. The scientific staff at the marine station will consist of three zoologists and a hydrologist with a laboratory assistant, viz. *Zoologists*: Mr. N. A. Mackintosh (in charge), Mr. J. F. G. Wheeler, Mr. L. H. Matthews; *Hydrologist*: Mr. A. J. Clowes; *Laboratory Asst.*: Mr. A. Saunders. The officers of the expedition who have already been appointed are as follows: Scientific Officers—*Director of Research*: Dr. S. W. Kemp; *Zoologists*: Mr. A. C. Hardy, Mr. J. E. Hamilton, Mr. E. R. Gunther; *Hydrologist*: Mr. H. F. P. Herdman. Ship *Discovery* Officers—*Commanding Officer*: Lieut.-Commander J. R. Stenhouse; *Medical Officer*: Lieut.-Col. E. H. Marshall; *Chief Officer*: Mr. Ernest E. F. Letts.

PROF. P. F. FYSON, of Berhampore, Bengal, in a comment on the abridgment published in NATURE of August 30 of Prof. J. W. Gregory's presidential address to the Section of Geography of the British Association at Toronto, though agreeing that medical research has removed the old bogies of special tropical diseases, considers that in that address the effect of the unrelenting high temperature of the tropics was underrated. He believes, however, that the heat can be mitigated to a very considerable extent by the adjustment of clothing and habits. The European in India wears clothes of the same style as in his temperate home, whereas the Indian man, when not dressed to meet Europeans, wears nothing above the waist, or on legs and feet. According to Prof. Fyson, if the European is to stand tropical temperatures he must do likewise. His clothes reduce the cooling surface of the body to face and hands, and covering the rest by at least two layers of clothing interferes with the natural regulating action of the skin. He considers that women suffer more than men, chiefly because it is more difficult for them to discard undergarments. The chief reason for wearing European clothes is said to be Mrs. Grundy, who is assisted by Nature, as a hirsute white skin is not beautiful, and the white man is very sensitive to irritation by insects. Most men, even on a warm evening, wear boots or two pairs of socks at dinner to protect the ankles from mosquitoes. Prof. Fyson considers that to colonise the tropics successfully the white man, and still more the white woman, will have to throw off the idea that the naked hirsute skin is indecent, and be prepared to adopt some such dress as the Indian. They must

also, like the Indian, split each day into two, and work only in the morning and evening, resting in the middle of the day. These changes in dress and habit will only be brought about if public opinion be educated in the direction of rational dress for all occasions and for different climates. In reference to these comments, it may be remarked that Indian colleges work through the morning and afternoon without any long siesta, and though heat is doubtless the special characteristic of the tropical climate, it does not alone explain its unhealthiness, since specially hot tropical localities are often healthier than others with a lower temperature.

IN a new edition of a most important work on the textile fibres it is stated that "India is destroyed as a possible source of supply [of long staple cottons] for the English mills." This statement was rightly challenged in a review in these columns (September 20, p. 422), where it was hinted that such cottons are actually being produced in India on a considerable scale, and are eagerly bought up in Lancashire. A most important revival in the cultivation of better types of cotton is in progress in India, and, for this, great credit is due to the patient, untiring efforts of the Indian Central Cotton Committee. Hitherto, however, most of the agriculturists who have attempted the improvement of cotton strains in any part of the world have found it difficult to get their experimental products tested under mill conditions or graded on exact scientific data. The crowning achievement in India, therefore, is the foundation of a Technological Research Laboratory where this guidance may be secured to the grower. As director, the Committee has been fortunate to secure Prof. A. J. Turner, recently professor of textiles in the College of Technology, Manchester, and various Lancashire machinists have presented standard plant for an experimental mill. The foundation-stone of the Research Laboratory was laid on December 3 by the Viceroy of India, who also opened the experimental spinning mill.

A CORRESPONDENT writes in reference to the report on the "White Indians" found among the Chucunaque Indians of Panama by Mr. R. O. Marsh (*See* NATURE, Nov. 22, p. 761), to point out that this tribe had already been visited by Mr. F. A. Mitchell-Hedges and Lady Richmond Brown in the course of their expedition of 1922–1923. Mr. Marsh, on the other hand, did not reach the upper waters of the Chucunaque until the spring of 1924. Lady Brown recorded the occurrence among the Chucunaque of the albinos, whom Mr. Marsh described as "White Indians," in her book "Unknown Tribes: Uncharted Seas." It may be noted that although Lady Brown did not make a special study of the question, as did Mr. Marsh, her estimate that the albinos formed 10 per cent. of the population is identical with his. In this matter it would be difficult on either side to sustain a claim to absolute priority in view of the fact that the occurrence of white individuals in Darien was noted by the early Spanish voyager Vasco Nunez de Balboa and by the buccaneer Wafer in 1699, as well as by several later writers. Albinism is comparatively frequent among the Indians of America.

ON Friday, December 5, at the Junior Institution of Engineers, Mr. J. B. Polland gave a demonstration of metal cutting under water by the oxy-acetylene blowpipe. Mr. Polland stated that an oxidising and not merely a heating flame is used for cutting purposes. The centre of the jet of the blowpipe, therefore, consists of the actual cutting flame, while the envelope round that is more heating and yet of such a nature that its heat is dissipated more quickly in water. Round the whole of this jet is a further envelope of air which acts as an insulating medium between the flame and the water. To illustrate the fact that it is only the centre of the jet that really does the work Mr. Polland held his hand under water right in the more luminous part of the flame without ill effect. For general work the oxygen and acetylene are supplied under pressure from gas cylinders; the air or oxygen need not be pure or dry. The pressure required is determined by the depth of water at which the blow-pipe is used; the blow-pipe has been used in depths of 60 feet.

SIR JOSEPH THOMSON and Dr. W. C. Unwin have been elected honorary members of the Institution of Civil Engineers.

AN assistant chief veterinary research officer is required for Kenya. Applications for the post must be made upon a prescribed form obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1.

THE collections illustrating stationary engines and locomotives, belonging to the Science Museum, South Kensington, are once more accessible to the public. They have been transferred from the old galleries to new accommodation on the ground floor of the eastern block of the new museum building at South Kensington (Exhibition Road).

THE Huxley Memorial Medal for 1924 of the Royal Anthropological Institute was presented to Dr. René Verneau, of Paris, at a meeting of the Institute held on November 25. Before the presentation of the medal, Dr. Verneau delivered the Huxley Memorial Lecture, for which he had chosen the title "La Race de Néanderthal et la race de Grimaldi: leur rôle dans l'humanité."

THE South African Institute for Medical Research, Johannesburg, requires a bacteriologist, preferably a medical man with special experience in plague, for research work. He must be competent to prosecute original investigations and be willing to engage in field work. Applications for the post, with references to two scientific men, should be sent to "Bacteria," c/o The Director, Lister Institute, Chelsea Gardens, S.W.1.

THE Christmas Lectures for Young People arranged by the Royal Geographical Society will be given at 3.30 on December 29 and January 2 in the Æolian Hall, 135 New Bond Street, W.1, by Major R. E. Cheesman, on "Wild Life of the Arabian Desert,"

and Dr. H. R. Mill on "Some Explorers I knew." Written applications for tickets should be made to the Chief Clerk of the Society by December 20.

APPLICATIONS are invited by the Association of Producers of Nitrate of Soda in Chile for three posts in connexion with the central research department which the Association is to organise in that country. The positions in question are a directorship of research and two sub-directorships. Candidates should be chemists or chemical engineers of first-class scientific training and experience in the investigation, design, and operation of large scale processes and plant, and, if possible, between thirty-five and forty-five years of age. Applications should be made to the Secretary, The Chilean Nitrate Committee, Friars House, New Broad Street, E.C.2.

THE twelfth annual meeting of the Indian Science Congress will be held in Benares on January 12–17. His Highness the Maharaja of Benares, Sir Prabhu Narain Singh Bahadur, has consented to be patron of the meeting, and Dr. M. O. Forster, Director of the Indian Institute of Science, Bangalore, will be president. Communications should be addressed to Prof. S. P. Agharkar, General Secretary, Indian Science Congress, 35 Ballyganj Circular Road, Calcutta. The local secretaries for the meeting are Prof. L. D. Coueslant, Department of Engineering, P.O., Benares Hindu University, and Prof. K. K. Mathur, Department of Geology, P.O., Benares Hindu University, to whom all inquiries as to accommodation should be addressed.

THE issue of part 12A of volume iv. of the *Journal de Physique et Radium* completes the volume for 1923. The part contains a description of the apparatus and experiments of a physical character exhibited at the Grand-Palais on the occasion of the jubilee of the Société Française de Physique. Although short, these descriptions are to the point and well illustrated. The complete volume has nearly 600 pages devoted to original communications, and nearly 1200 to a bibliographical review of current literature, the subject and author indexes to which occupy more than 200 pages. In future each original communication to the *Journal* is to be preceded by a summary supplied by the author, as in the *Physical Review* and the Proceedings of the Physical Society of London.

THE Report of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne for the year 1923–24 is a record of valuable work, in many directions, in the interests of natural history, done in a quiet and unobtrusive way, with results which are bound to be of permanent value. The Society took its share in the negotiations which have resulted in the Farne Islands being purchased and vested in the National Trust as a bird sanctuary, and it is fitting that the Museum which owed its inception to John Hancock should have been the scene of the meeting at which this important scheme was inaugurated. The Museum of the Society is undergoing rearrangement, particularly as regards the geological department, and room has at last been found to start a botanical exhibition series. It is to be hoped that the appeal, which is so earnestly and moderately made for increased support, will meet with the deserved response, for the Society has a long and distinguished record behind it, and is doing most valuable work, not only in the Museum which it supports, but also through the activities of the energetic band of naturalists which it includes amongst its members.

Our Astronomical Column.

SKJELLERUP'S AND GRIGG'S COMETS. — Messrs. Crawford and Meyer were the first to suggest the probable identity of Skjellerup's Comet 1922 I. with Grigg's Comet 1902 II. They re-examine the question carefully in Lick Obs. Bull. No. 354. They made a new determination of the orbit of 1922 I., finding a period of 5·01894 years. Perturbations by the earth were applied from March to July 1922. The elements were carried back unperturbed until July 2, 1906, and the very large perturbations by Jupiter in 1905–1906 were carefully calculated. The result is not at first sight in favour of the identity of the two comets, as it makes perihelion in 1902 several months earlier than that of Grigg's Comet. But they add that a reasonable change in the period adopted in 1922 would largely modify the great Jupiter perturbations of 1905 (minimum distance 0·08). Moreover, there were appreciable perturbations by Jupiter about 1915 that have not been applied. It is fully demonstrated that the considerable change in the inclination and other elements from 1902 to 1922 is well within the possible amount due to Jupiter. The question will probably remain unsettled until the return in 1927, which will give an accurate value of the mean motion in 1922 and permit of a more accurate carrying back.

VARIABLE STARS. — The *Japanese Journal of Astronomy and Geophysics*, 1924, No. 3, contains two papers on variable stars by Shinzo Shinjo and Toshima Araki. One deals with the correlation between period and light-range in the Cepheids and long-period variables. The light-range is shown to increase with the period, except for a slight retrogression between periods $0{\cdot}8^d$ and 4^d. The group with mean period $0{\cdot}17^d$ have a mean range of 0·70 magnitude, while the range for the group with a mean period of 500 days is more than 5 magnitudes. Moreover, on plotting the ranges and periods as ordinates and abscissæ, a definite bounding curve can be drawn (parallel to the mean curve) which includes *all* the plotted points, indicating a very intimate connexion between period and range.

The other paper is written in support of the theory that both long-period and Cepheid variability is due to revolution in an eccentric orbit of a huge meteoric swarm about a star. The systems X Ophiuchi, Mira Ceti, and 13 Ceti are examined from this point of view, and the periodic terms in the light equations of the variables are considered to be due to perturbations from third bodies (which are sometimes visible, sometimes not). The necessary eccentricity of orbit is examined; for most of the stars it lies between 0·75 and 0·92. No mention is made of the fact on the other side that the interferometer measures of Betelgeuse did not show duplicity, but appeared to indicate a variation of diameter.

Research Items.

PYGMY FLINTS FROM THE PENNINES.—A detailed account of the pygmy flint industry and sites in the Huddersfield area forms part of "Early Man in the District of Huddersfield," by Mr. James E. Patch, which is published as one of the Tolson Memorial Museum (Huddersfield) Publications. The close study of this industry which has been made by Mr. Francis Buckley shows that there is a class of pygmy flints, consisting of small and narrow-pointed tools and small narrow knives, which belong almost peculiarly to the Pennines. The best come from March Hill, where they are associated with the angle gravers and other early types of graver. A second point which emerges is that a large class of pygmy tools made from comparatively broad blades and generally not finely pointed or worked on the side is closely related to Belgian groups. It is thought that the Pennine class is developed from Upper Aurignacian, but where and how, it is not possible to say; while there is probably no Capsian influence in their source as there occur locally both pressure-flaked pygmy tools (Solutré influence) and the busked gravers (Aurignacian influence), neither of which is present in the African pygmy series. It is possible that the latter class came direct from Belgium. It is more Tardenois in type than the earlier and is not developed from it. The character and distribution of the types and sites suggests that Huddersfield and district provided temporary camping grounds for tribes and parties of men migrating to the north and west.

INDIAN CRANIA FROM SOUTH AMERICA.—In view of the scarcity of certain types of South American crania, some importance attaches to measurements published by Dr. H. ten Kate in vol. xvi. N. Sér. of the *Journal de la Société des Américanistes de Paris*. They comprise six skulls, one Carib, two Akawoi, one Arawak, and three Goajiros, also one living subject, a Lengua girl. A comparison is made with other material when available. The greatest head length is 182 mm. (Arawak); the greatest head breadth is 148 (Carib and Goajiros). The indices give the following results:—Sub-brachycephalic, Goajiros (two); hyperbrachycephalic, Carib, Akawoi (one), and Goajiros (one); mesaticephalic, Akawoi (one); sub-dolicocephalic, Arawak. One Akawoi and the three Goajiros were leptoprosopic, and the Carib and Arawak euryprosopic. One Akawoi and one Goajiro were platyrhine, the Arawak and a second Goajiro mesorhine, and the Carib, the third Goajiro, and second Akawoi leptorhine. The orbital index gave one microseme, Arawak, and the remainder megaseme. Prognathism is noted in Arawak, Akawoi, and two Goajiros. The living Lengua subject, a girl of about fifteen years, had a cranial index of 79·3, a nasal index of 86, and showed well-marked prognathism.

ABNORMAL MORPHOLOGY OF THE SHOOT OF OSMUNDA.—In the Manchester Memoirs, Vol. 68, No. 5, 1924, Prof. W. H. Lang describes some curious deviations from the normal in the development of young plants of *Osmunda regalis*, the phenomena being possibly connected with injury or with unusual conditions of cultivation in a greenhouse heated during the winter months. In addition to recording the production of shoot axes from the tip of what appears to be cylindrical green equivalents of a leaf, as well as laterally from such cylindrical rudimentary leaves or from a petiole with a lamina, Prof. Lang records a number of cases in which juvenile leaf forms pass over at their extremity into aposporously produced prothallial expansions, bearing rhizoids.

FUNGI ROTTING APPLES IN STORAGE.—As the result of the systematic examination of apples in storage during 1921–23, for the Food Investigation Board, M. N. Kidd and A. Beaumont publish in the Transactions of the British Mycological Society, vol. x., September 1924, the most complete list yet supplied of the fungi found associated with rotting apples. In examining these fungi to see whether they were responsible for the decay with which they were associated, inoculations from single spore cultures have been carried out in most cases, the method used being a new one. "Small pieces of glass tubing about 2 mm. long, previously plugged with cotton-wool, were fastened by means of luting wax to the surface of the apple, and then were partially filled with sterile liquid media and spores of the fungus sown in the liquid. By this method germination takes place under favourable conditions, and every facility is given the fungus to invade the healthy tissue."

WATER-CONTENT OF YEAST CELLS.—The November issue of the Journal of the Institute of Brewing contains a paper by N. C. Beetlestone, dealing with the actual proportion of moisture in the yeast cell. The moisture content of pressed yeast is composed of the "inherent" moisture of the cells themselves, together with the "adherent" moisture occupying the inter-cellular spaces. The total moisture is determinable readily and accurately. The yeast is mixed with water and filtered, and the specific gravity of the filtrate is measured; then a known weight of the residual yeast is treated with a definite volume of maltodextrin solution of a certain specific gravity, and by measuring the specific gravity of the liquid after filtration, it is possible to calculate the percentage of inherent moisture of the cells. The result obtained in this way varies somewhat with the age of the yeast, the extreme figures being 52·7 and 45·8 per cent., and the mean 50·8 per cent. The method is subject to various errors, but the above figures show that, under normal conditions, the yeast cell contains approximately one-half of its weight of water.

NEW SPECIES OF CHILINA.—The South American freshwater genus of molluscs, Chilina, sole representative of its family, is not so well known but that the record of additional species is noteworthy. Mr. W. B. Marshall has now been able (Proc. U.S. Nat. Mus., vol. lxvi.) to add six new species and a new subspecies to the known list. Three of these came from obscure lakes and rivers in the Andes, along the border between Chile and the Argentine; one from an undefined locality in southern Chile; Lake Nahuel Huapi, province of Rio Negros, Argentina, furnished another; whilst one was obtained many years ago, with fourteen other species of molluscs, from the stomach of a bird on Lake Wafrel, Chile.

THE GEOTHERMIC GRADIENT.—The evidence of the Polish petroleum wells on the geothermic gradient has been recently carefully tested by Dr. H. Arctowski, and discussed in his "Nouvelles Recherches sur les gradients thermiques dans les puits à pétrole de Boryslaw, Krosno et Bitków" (*Bull. Soc. polon. Natur., Kosmos*, 1924, 45 pp.). He finds that the temperature gradient varies in the wells tested from 32·3 metres per 1° C. to 41·7 metres, with a mean of 39·7 metres. This gradient is less than the mean of the European observations summarised by Prof. Daly, which he estimated as 31·7 metres per 1° C., but is near the mean of 41·8 metres of the American

wells. Dr. Arctowski remarks that the differences between the gradients of different areas in Europe are greater than between them and the American wells; and he attributes the differences to many local causes, including variations in subterranean temperature, which are due in some cases to igneous intrusions, while others, he suggests, may be the result of former climatic variations.

STRATIGRAPHY OF WESTERN AUSTRALIA.—The Journal and Proceedings of Royal Society of Western Australia, vol. ix. pt. II, 1923, includes the valuable presidential address by Mr. E. de C. Clarke on "The pre-Cambrian System of Western Australia." He classifies these rocks into five divisions, of which the oldest is the Yilgarn Series, which consists mainly of gneisses and schists. Intrusive into this are the rocks of the Kalgoorlie Series, which include mainly basic intrusive rocks. The third, the Mosquito Creek Series, occurs in the north-western part of the State, and is composed of metamorphosed sediments. It was succeeded by great intrusions of granites. The uppermost division, the Nullagine Series, consists of unaltered sediments with many basic igneous rocks. The age of this division is uncertain, and may be as late as Ordovician. The secondary sulphates and cherts of the Nullagine Series are described by Dr. E. S. Simpson, and he attributes the age of the series to somewhere between post-Huronian and pre-Carboniferous; he regards it as probably Keweenawan, the uppermost division of the pre-Cambrian. Mr. T. H. Withers had described a new Cretaceous cirripede, *Calantica ginginensis*, an interesting addition to the fauna of the Gingin Chalk.

THE USSOI LANDSLIP OF 1911.—The Pamir earthquake of February 18, 1911, was the occasion of a landslip of exceptional magnitude. A geological account of this, by J. Préobrajensky, has been published by the Comité Géologique as livraison 14 of the Matériaux pour la géologie générale et appliquée. The paper is in Russian, without an abstract in any other language, but is illustrated by photographs and maps from which, and from figures in the text, we extract the following particulars. The length of the slipped mass, across the valley, was 14,000 English feet; the width, along the valley, 17,500 ft.; and the depth, from the old ground level to the lowest point on the crest of the slip, was 1750 ft. The cubic contents of the slip are worked out as 2,219,509,670 m.^{3} and the weight as 5,992,676,109 tonnes; the ratio of the bulk of the original rock to the slipped mass is 0·816. The height through which the centre of gravity of the mass fell was 2380 ft., and the horizontal distance through which it shifted, 7350 ft. The depth of water in the lake formed by the slip was 1155 ft. on August 19, 1915, and was still rising. The mass of this slip, in round numbers 6 milliards of tons, is less than that derived by Prince Galitzin from Col. Spilko's survey, yet it places the landslip in a class by itself, for none other, of historic times, which has been measured, comes within one-fifth of its magnitude; it was surpassed, in a greater degree, by the prehistoric Flims landslip, which contains about 42 milliards of tons of rock.

ASPHALT IN PAPER MANUFACTURE.—In the September issue of the Bulletin of the Standard Oil Company, California, are given details of the application of asphalt to the manufacture of heavier varieties of paper. This is a new and interesting departure in the arts, and one destined to become of great commercial importance. Briefly, the manufacture of heavy papers, fibre boards, cartons, etc., consists in treating the original fibrous material to remove impurities, macerating the product, and pulping with water; by suitable process and subsequent drying by heat and pressure the fibrous sheets are formed. With many types of heavy paper, cardboard, and the like, the outer layers are often of better quality material than the infilling pulp, but latterly a demand has risen for a high-quality paper which shall also be water and vermin proof; this is desirable where wrappers or cartons are used for exporting fragile or perishable commodities, as in the United States. Instead of employing cheap infilling material, a layer of asphalt is substituted, or even more than one, according to requirements, such layers being intercalated between several layers of pulp film, depending on the ultimate thickness of the paper or card to be made. For this purpose fluid asphalt is mixed with a small percentage of suitable clay, water is added, and agitation set up. The resulting product is then introduced into the normal paper pulp and the whole dried; water is driven off, and the resulting sheet is richer by the inclusion of one or more layers of impermeable asphalt. The process is patented and is now being carried out on a commercial scale in California, where local resources, both of asphalt and clay, are utilised. It is claimed that not only is the paper or fibre board waterproof, but that its strength is increased approximately 20 per cent. compared with non-asphaltic board of similar thickness; also that its durability is greater than that of ordinary heavy paper or cardboard. Technically, this utilisation of asphalt is another interesting example of asphalt-water emulsion brought about by the agency of very fine and partially colloidal matter such as clay, though all types of clay known to geologists would not serve the purpose efficiently.

THE ELECTRIC ARC WITH NON-INCANDESCENT CATHODES.—In the *Zeitschrift für Physik* of October 17, Dr. A. Günther-Schulze criticises the conclusion of H. Stolt, deduced from his experiments with a rotating brass or copper cathode, that an arc without an incandescent cathode spot is possible. Only approximate calculations can be made of the temperature to be expected in a stationary cathode spot, since the conductivity and specific heat of the metal are not accurately known, but the magnitude of the spot has been found to diminish when the thermal conductivity increases, and for iron the area was $1{\cdot}4 \times 10^{-4}$ cm.^{2} per ampere. Since brass has about the same thermal conductivity, the size of the spot will be about the same for that metal. The cathode fall is estimated as 15 volts, and an approximate calculation gives 2300° C. for the temperature of the spot, the actual temperature being higher owing to the formation of a film of oxide at the surface. It is also shown that when the spot moves over the surface, as in Stolt's experiment, a temperature of 2500° C. is possible. The spot was not seen by Stolt owing to the brightness of the arc, but in the mercury arc the cathode spot can easily be seen, moving swiftly over the surface, owing to the low brightness of the arc. The fact that the surface of the revolving brass cathode lost its polish confirms the author's views, since in a glow discharge a cold cathode is not attacked, even with a cathode fall of 300 volts.

AN ELECTRONIC BATTERY.—In an address delivered to the Birmingham and Midland Institute, Mr. J. B. Kramer has recently described a piece of apparatus which he has named an electronic battery. The upper surface of a plate of carbon is coated with a radioactive substance, and a plate of metal is placed above and parallel to it, with an intervening air gap. When the plates are connected to the terminals of an electrometer a difference of potential is indicated, the

terminal connected to the carbon being negative and that connected to the metal positive. The maximum potential difference was obtained with zinc. It was possible to obtain a similar, though generally smaller, effect when the two plates were of different metals. Mr. Kramer suggests that the effect is not due to α- or β-rays, but to γ-rays, which may cause a distortion or deformation of the atomic systems of the zinc and carbon atoms, thus rendering one positive and the other negative, owing to the comparative tightness of the bonds by which the electrons are coupled to the nuclei of the two elements. He considers it probable that very few, if any, of the expelled α- and β-particles reach the top plate, and that their energy and charges are spent in collisions or in recombinations.

NEW PHOTOGRAPHIC DESENSITISERS.—MM. Pathé-Cinéma (*British Journal of Photography*, p. 699) find that "basic Scarlet N," made by the Cie. Nationale des Matières Colorantes, is an excellent desensitiser and has several advantages. The weak reddish-brown tint which it imparts to the film is much more easily washed out than the intense red given by saffranine. It does not stain the skin or finger nails as saffranine does, and never produces the general chemical fog that pinacryptol is liable to do. They find also that very many dyes have an intense desensitising action when used in exceedingly weak solutions, one part in a million or even weaker, but at the same time produce a very notable degree of fog. But there are certain other dyes which, if added, get rid of the fogging power while leaving the desensitising power unaltered. As examples of these compound non-fogging desensitisers the authors give formulæ for baths containing rhoduline violet purified (Bayer), methylene blue, and rhoduline sky-blue (Bayer), to each of which pure acridine yellow is added as the protective dye. These baths are very dilute and give scarcely any or no colour to the film. Other protective dyes are auramine, benzoflavine, auracine, cachou brown, and acridine orange, and doubtless many others will be found by further investigation.

X-RAY EXAMINATION OF REAL AND CULTIVATED PEARLS.—M. A. Dauvillier, in the *C.R. Acad. Sci.*, Paris, October 27, describes his results, using Laue photographic diagrams obtained with the K-rays of rhodium and of silver and a quartz tube, with several hours' exposure and a reinforcing screen of calcium tungstate. The real pearls, as might be expected from theory, show regular rings, which are sometimes very sharp, and are due to the doublets $K\alpha$ and the $K\beta$ lines; mother-of-pearl gives more or less regular Laue figures formed of patches, which are more diffuse than those caused by crystals of calcium carbonate. The mother-of-pearl figures show a certain amount of hexagonal symmetry when the rays are perpendicular to the cleavage planes; when the rays are parallel to these planes the patches are much more numerous, and the symmetry is no longer hexagonal. Cultivated pearls show both the rings, which are due to the outer layer of real pearl, and patches due to the mother-of-pearl core. It is of course unnecessary to cut the pearl in order to make this test. The method appears to be suitable for detecting imitations of other kinds.

THE β-RAY SPECTRUM OF THORIUM B + C.—Dr. W. Pohlmeyer describes an investigation, using the ionisation method, in the *Zeitschrift für Physik* of Oct. 10. The dimensions of the chamber K, in which the rays were magnetically deflected, were large enough to minimise the effect of the secondary rays produced on the walls, which were lined with cardboard to reduce further this effect. A wire coated with thorium-B in equilibrium with its products of disintegration, thorium-C + C′ + C″, was placed 1 cm. above, and parallel to, a slit S_1, of dimensions 3 × 10 mm., in a lead plate forming the top of K; β-rays of a certain velocity were bent in circles through a large stop by the magnetic field, and were thus focussed on a second slit S_2 at the top of K, and passed into the ionisation chamber through a thin air-tight partition. The ionisation chamber was protected from the direct effect of the preparation by lead blocks. The field was varied step by step, and the ionisation measured for each step. Several lines of thorium-B and of thorium-C + C″ were observed in the resulting curve, and the influence of some of the weaker lines was clearly shown. The spectrum was shown to be limited on the high-velocity side, confirming the results of Baeyer, Hahn, and Meitner. The intensity of the two strongest thorium-B lines is large compared with the continuous background. The experiments, and a discussion of the conditions, show that this background is to be ascribed to secondary influences, including the broadening of the numerous lines obtained in the photographic spectrum, owing to the necessarily large width of the slit S_1 and the preparation wire. Its existence does not invalidate the assumption that the primary β-rays leave the nucleus with a definite velocity.

EFFECT OF PRESSURE ON ORGANIC SUBSTANCES.—The dependence on pressure of the adiabatic cooling of some organic substances in the liquid state has been investigated by N. A. Pushin and E. V. Grebenshchikov (J. Chem. Soc., Oct.). The results show that phenol changes to a denser modification under a pressure of 2250 kg./cm.^{2} and at a temperature of 64·4°. Of all the substances investigated (alcohol, urethane, glycerol, castor oil, etc.), the greatest coefficient of adiabatic cooling (dt/dp) was shown by benzene; the coefficient decreases with increasing pressure in all cases. Some *p*-toluidine and phenol mixtures were also investigated; the results point to the formation of *p*-toluidine phenolate.

STERIC HINDRANCE AND COMPLEX RING COMPOUNDS.—It is well known that a chemical action is often profoundly modified by the presence of groups which exert a definite influence in promoting or in hindering its normal course. No entirely satisfactory solution of the problem will be possible until more abundant experimental data are available. A useful contribution to this subject has been made in vol. 18, No. 2, of *Fortschritte der Chemie, Physik und physikalische Chemie*, "Über die Bildung von Chinon-imiden und Phenoxazonen aus o-Amino-phenolen." Nach Versuchen von E. Mürbe, K. Saurwein, G. Deines und J. Schornstein (Berlin: Gebrüder Borntraeger, 1923, 3*s*.), by K. von Auwers, who with the help of four collaborators has studied the oxidation of derivatives of o-aminophenol. Full details are given of the preparation and oxidation or attempted oxidation of these compounds, and after a critical survey of the results the author has drawn the conclusion that steric hindrance is responsible for any deviation from the normal reaction, which is as follows: an orthoaminophenol is first oxidised by hydrogen peroxide or by air in alkaline solution to a bimolecular quinoneimide, which then condenses further to a phenoxazone. The action may, however, be arrested at the first stage or even entirely inhibited by the presence of certain substituents. The influence of halogen atoms and of the following groups, namely, CH_3, NO_2, CN, COOH and COOEt, in different positions, has been carefully studied and the results are classified.

New Chemistry Department, University of Edinburgh.

THE Chemical Laboratories, the foundation stone of which was laid by the King on July 6, 1920, were formally opened by the Prince of Wales on December 3. The University had resolved in 1913 to build a new chemistry department, and detailed plans were drawn up for its construction, but the outbreak of war led to the postponement of the scheme. Early in 1919 the matter became of immediate urgency, as it had by that time become evident that large numbers of ex-service men were about to enter on university courses in pure and applied science, as well as in medicine. The University met the situation by resolving first to appoint a professor of chemistry in relation to medicine, who would be accommodated in the old laboratories, and second, to erect a new chemistry department on a site affording greater facilities for adaptation and extension than the site originally contemplated.

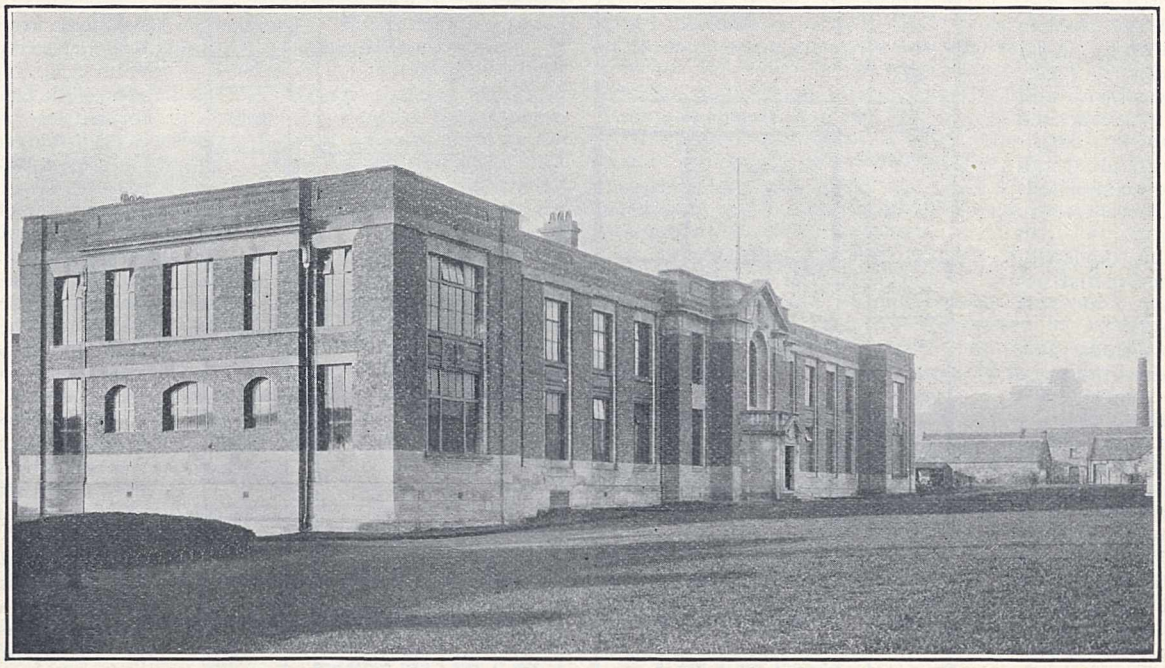


FIG. 1.—The King's Buildings, University of Edinburgh (Chemistry Department).

The University accordingly purchased some farm land on the southern outskirts of the city, about a mile and a half from the Old College. This land, of 115 acres in extent, is intended to provide sites for all the scientific departments of the University, which will, as necessity determines and as money becomes available, move out to the King's Buildings, the new group being so named with His Majesty's permission.

The Chemistry Building (Fig. 1), excavation for which was begun in November 1919, has a frontage of 220 feet and a depth of 320 feet. It was constructed by Mr. A. F. Balfour Paul, architect, on sketch plans submitted by the professor of chemistry, Sir James Walker. The front block is of two storeys; the remainder is of one storey only, with the exception of a small section to the south-east which has a basement for an engineer's house, cloak-rooms, etc. In this basement is a separate entrance for elementary students. The construction is mainly of brick relieved by stonework on the frontage, which faces due north. The whole building is fireproof, floors and roofs being of reinforced hollow tile.

The general lay-out is indicated by Fig. 2. Three parallel corridors running north and south meet at one end the east and west corridor of the front block, and at the other end are free for extension. Between the central and side corridors are the main laboratories and lecture rooms with their subsidiary offices and service rooms. These are all lit on the factory shed principle by a saw-tooth roof, glazed with north slope window-lights. On the outer face of each side corridor is a range of rooms lit by large windows in the walls. These serve as balance-rooms, etc., for the main laboratories, and as research rooms. On the ground floor of the front block are the physico-chemical laboratories, dark-rooms, and special rooms for gas-analysis, etc.; on the upper floor are the library, administrative rooms, staff common-room, research rooms, and laboratories destined for crystallography, X-ray work, and the like.

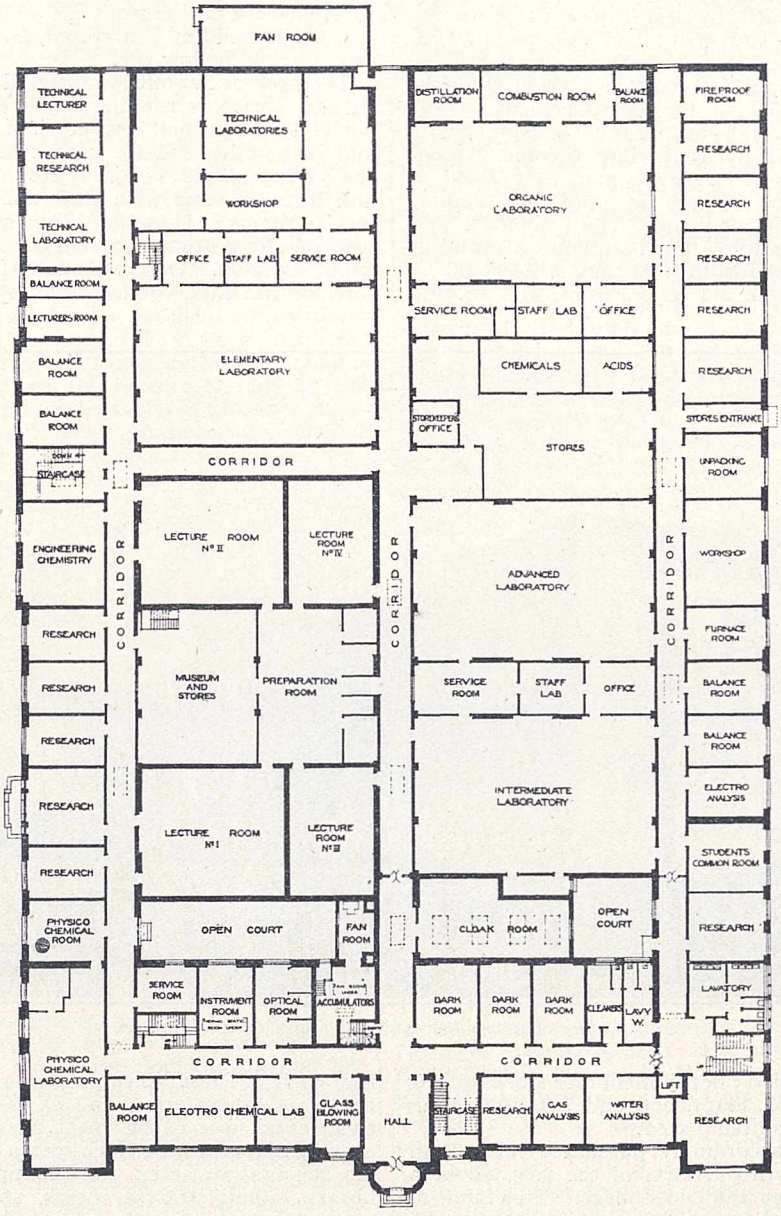
The main laboratories are four in number, each 45×70 feet internal measurement. They are fitted with benches to accommodate $72 \times 4 = 288$ students in the elementary laboratory, $72 \times 2 = 144$ students in the laboratory of the second year, 48 students in the advanced inorganic laboratory, and 40 students in the advanced organic laboratory. The physico-chemical rooms can provide working places for about 30 students. Thus the department could take more than 260 students working simultaneously, and has a bench capacity for 550 students. In the special research rooms at present equipped, accommodation can be found for 25 post-graduate workers, a number

capable of being doubled when all the rooms are completed.

A section of the department is devoted to technical chemistry, the object being to familiarise students in a general way with technical plant and processes. There are three small general working laboratories, two research rooms, and a workshop, with office, stores, etc. The equipment is for the most part of a mobile type, the main rooms being fitted on the walls with service pipes for water, gas, steam, electric light and power, compressed air and vacuum, to which small-scale plant can be connected. From 15 to 20 students can simultaneously receive instruction in this section.

There are four lecture rooms, two large (seating capacity 160) and two small (seating capacity 100 and 70 respectively). These are lit by cupolas and three of them can be darkened by lowering a false ceiling operated electrically. The four lecture rooms are served by a single preparation room, adjoining which is a commodious lecture museum.

The heating of the department is effected by means of low-pressure steam, and the ventilation is by extraction, the main inlet duct being under the central corridor, and all air being admitted to rooms over steam pipes or radiators. Each main laboratory is served by an independent fan connected with draught-holes on the students' benches, a scavenging fan being also provided at a high level. The draught-cupboards of the department are connected with two special high-power fans. Each pair of lecture rooms has a fan which runs normally at a low speed, but is capable of changing the air of the room completely in a few minutes between lectures. The air is admitted under the lecture bench and extracted through two sets of apertures in the back wall of the lecture room, one set at head level and the other near the roof.



PLAN OF GROUND FLOOR

FIG. 2.—New Chemical Laboratories, University of Edinburgh.

Electricity is supplied from the city at 230 volts A.C. and 460 volts D.C. for power. A large motor generator yields direct current at 100 volts for wall plugs, and for charging accumulators, of which there are two sets of 20 cells each—one for electro-analytic and electro-synthetic work, the other for physico-chemical work.

The first section of the department was fully occupied in October 1921, the second in October 1922, and the third and final section in October 1924. The actual cost of the buildings, inclusive of scientific equipment and all other charges, has been somewhat less than 200,000*l*.

At a luncheon following the admission of the Prince to the honorary LL.D. degree, the Principal announced that the deficit of 88,000*l*. on capital incurred since the War had in the preceding few days been met to the extent of 75,000*l*. by subscriptions, including a donation of 50,000*l*. from Sir Alexander Grant.

The Adelaide Meeting of the Australasian Association.

THE seventeenth meeting of the Australasian Association for the Advancement of Science was held in Adelaide, South Australia, on August 25–30 inclusive.

The number of members who attended the meeting is estimated at 750, and delegates from all the important scientific institutions and societies in Australia and New Zealand were present. The delegates who attended exceeded 100 in number, and these represented at least fifty institutions, including the Australian National Research Council, the New Zealand Institute, the various State Royal Societies, the various universities both of the Commonwealth and of New Zealand, the Federal and State Government Departments, the British Medical Association, the various mining, engineering, and chemical institutes, together with kindred institutions.

The retiring president, Sir George Knibbs, inducted the president for 1924–26, Sir John Monash, on the evening of August 25. The president's inaugural address on "Power Development" attracted widespread attention throughout Australia and New Zealand.

Prof. G. Elliot Smith, of University College, London, attended the meeting, and assisted Section F (Anthropology) in urging the Federal Government to found an Australian chair of anthropology at the University of Sydney. The Association also supported a resolution of the Australian Universities' Conference to establish a chair of forestry at the University of Adelaide.

The presidential addresses to Sections included the following: A (Astronomy, Mathematics, and Physics), Prof. D. M. Y. Sommerville, "The Development of the Ideas of Space and Time"; B (Chemistry), Prof. A. C. D. Rivett, "National Research"; B (Subsection Pharmacy), Mr. E. F. Gryst, "Pharmaceutical Progress"; C (Geology and Mineralogy), Dr. H. C. Richards, "Volcanic Activity in Queensland"; D (Zoology), Prof. W. E. Agar, "Some Problems of Evolution and Genetics"; E (Geography and History), Capt. J. K. Davis, "Sailing Directions"; F (Ethnology and Anthropology), Mr. H. D. Skinner, "Origin and Relationships of the Material Culture and Decorative Art of the Maoris of New Zealand"; G (Social and Statistical Science), Prof. D. B. Copland, "Monetary Policy and its Reaction upon Australia"; H (Engineering and Architecture), Prof. H. E. Whitfeld, "Efficiency in Modern Life"; I (Sanitary Science and Hygiene), Dr. J. S. Purdy, "Vitamines and Fruit in Diet"; J (Mental Science and Education), Mr. J. Nangle, "Vocational Guidance"; K (Agriculture and Forestry), Prof. R. D. Watt, "The World's Food Supply"; L (Veterinary Science), Dr. S. Dodd, "Cancer in Domesticated Animals"; M (Botany), Mr. L. Rodway, "Ecologic Conditions of Vegetation in Tasmania."

A general statement was made by the permanent honorary secretary regarding the pressing needs of the Association, inasmuch as it is coming to be seen that science in Australia and New Zealand needs to extend its usefulness, especially in view of the impetus given to the study of Pacific problems by the recent Pan-Pacific Science Congress, and the Food Conservation Congress, held in Australia and Honolulu respectively. This could be accomplished by the Australasian Association acting as co-ordinator of, and spokesman for, the various divergent interests of scientific and technical societies. In other words, the best work could be done apparently by an affiliation of all the scientific institutions with the Australasian Association for the Advancement of Science, and with the hearty co-operation also of the Australian National Research Council and the New Zealand Institute.

The present machinery of the Australasian Association is too cumbrous for this purpose, and it is found necessary to take a central office in Sydney with an officer in permanent attendance to assist the permanent honorary secretary.

A constitution of few articles is needed with flexible by-laws or regulations to each of the main articles. Continuity of membership is needed, and some permanency also for secretaries of Sections, whereby recommendations to Governments and other authorities might be well considered before presentation.

Perth, Western Australia, was selected as the place of the eighteenth meeting of the Association, the date chosen being August 1926. The president for this meeting will be Sir Thomas R. Lyle. The Government of Western Australia has promised 1200*l.*, mainly towards defraying the cost of the publication of the Proceedings.

The nineteenth meeting will be held at Hobart, Tasmania, in January 1928, with the promise of financial support from the Tasmanian Government.

E. C. ANDREWS.

Preservatives in Food.[1]

THE report before us contains an account of the preservatives and colouring matters found in different articles of food, together with the Committee's opinion upon the nature and quantities of these substances which should be permissible, taking into consideration, on one hand, their effect upon the body, and on the other, their efficiency in preserving, or making attractive, the different articles of diet in which they are found. Apart from the main body of the report, a series of appendices gives the names of the witnesses examined, and excerpts from the laws of other countries on the use of preservatives and colouring matters in foods, with details as to those which are permissible and which prohibited: one other appendix will be referred to in more detail below.

The principles which guided the Committee in the interim report on the use of preservatives in meat, which have already been noticed in these columns (NATURE, September 20, p. 448), are emphasised again in the report under consideration. Since the ideal of the consumption of fresh food alone is impracticable of attainment under modern conditions of civilisation, and cold transport or sterilisation by heat may be unsuitable processes in certain cases, the only course open is to use some preservative, and the Committee has devoted considerable attention to the question as to which preservatives are the least likely to be harmful to the individuals consuming them in small quantities, although often over long periods of time, and yet are reasonably efficient in preventing decomposition or other change in the food or drink product. In certain cases, preservatives have a further disadvantage in that their addition may give a sense of false security and encourage slackness in the preparation of the food: in other cases their use seems to have become a habit

[1] Ministry of Health. Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food. Pp. 84. (London: H.M. Stationery Office, 1924.) 1s. 6d. net.

with some of the manufacturers of certain articles of food, such as pickles, since others do not use them at all.

The report considers first the different substances which have been used as preservatives and their effect upon the human economy; they can be divided into three groups. In the first are hydrofluoric acid, its salts and derivatives (seldom if ever used at the present time), and formaldehyde and its derivatives. The effects of the latter have been already mentioned in the account of the Committee's Interim Report and will not be further considered here. It is sufficient to state that in the opinion of the Committee, with which we are in complete agreement, the substances in this group should be completely prohibited in articles of diet. In the second group are placed boron preservatives and salicylic acid and its salts: these should also be prohibited. Although this conclusion may cause some surprise, the evidence in favour of it is remarkably strong. In the first place, both boric and salicylic acids act as irritants to the alimentary tract; the former, moreover, is only excreted slowly after absorption, so that its action is cumulative. Boric acid or its salts are used at present very largely in cream, butter, liquid eggs, margarine, and potted meats, or dusted over bacon and hams exported to Great Britain: but since these products are frequently sold without the addition of preservatives, it appears quite possible to dispense with them, providing methods of preparation and conditions of transport are satisfactory. This conclusion is strengthened by the fact that at the present day the milk supply is satisfactorily maintained although the addition of preservatives is forbidden, a state of affairs which, twenty-five years ago, was considered to be impossible of achievement in some quarters. As regards salicylic acid, which is used chiefly in beverages, benzoic acid has about the same effectiveness as a preservative and is less irritant to the stomach, and is therefore preferable.

The third group comprises the least harmful of the preservatives in benzoic acid, sulphurous acid, and their salts: the report gives a list of the foods and beverages in which they may be permitted, together with the maximum amounts allowable. Sulphur dioxide may be permitted in sausages, jam, dried and preserved fruits, beer and cider, and wines, cordials, and fruit juices, in amounts of a few grains per pound or pint. Benzoic acid should be allowed only in the following beverages: coffee extract, non-alcoholic wines and cordials, and sweetened mineral waters and ginger-beer.

Turning to the question of colouring matters, the Committee advises the prohibition of the use of copper sulphate as an agent for preserving the colour of green vegetables. They consider that this will not affect the sale of canned vegetables, seeing that peas canned without the use of copper find a ready sale in Great Britain. As regards other colouring matters, a few pigments containing iron and some natural organic colours such as gamboge, saffron, caramel, and cochineal are considered harmless: but of the synthetic aniline dyes, relatively few have been considered harmless in other countries, and the Committee recommends that a list of those permitted should be drawn up by the Minister of Health: this is necessary, since many of these dyes are potent antiseptics in dilute solutions; moreover, they cannot be grouped in classes, since a harmful product may be closely related to one that is quite innocuous.

Finally, the report considers the best method of making its conclusions effective: among its recommendations here is one that the amount of preservative or nature of colouring matter permitted should be definitely laid down by law, and another that the processes of preparation of food for human consumption should be under closer control. In this connexion, improved methods and facilities of transport and storage are urgently required. In one of the appendices is given an interesting example of the co-operation of a trade in reducing the amount of preservative present in a food, by its members agreeing not to use the article containing it in certain types of foodstuffs prepared by them. The report should do much to raise the standard of preparation of food in Great Britain.

Works of Early Man in East Anglia.

AT the autumn meeting of the Prehistoric Society of East Anglia, held at the rooms of the Geological Society, Burlington House, London, on November 12, Mr. R. A. Smith, and afterwards the president, Mr. Henry Balfour, in the chair, special reference was made to the loss sustained through the death of the late Mr. E. T. Lingwood, of Westleton, who, in addition to great abilities and enthusiasm as a practical excavator and collector of flint implements, had for years done very valuable voluntary work by drawing large numbers of the specimens selected for illustration in the annual Proceedings of the Society. Had Mr. Lingwood lived, a proposal to offer him honorary membership of the Society would have been brought forward at the next annual meeting, and it was unanimously resolved by the London meeting that this distinction should be offered to Mrs. Lingwood, together with an expression of the sympathy of the members of the Society.

An important announcement concerning the protection of Grime's Graves, Norfolk, as a national monument was made by the hon. secretary, Mr. G. Maynard, of the Ipswich Museum, who stated that H.M. Office of Works has accepted a suggestion made on behalf of the Society and has taken steps to include in the schedule a considerable area of the open warren which borders the well-known group of ancient flint mines on the Weeting Hall estate. The additional area includes the sites of the recently discovered pits on the slopes of the Grime's Graves ridge which are being investigated by Mr. A. L. Armstrong.

It was also announced that with the approval of the Office of Works, the owner of the estate has given permission for the erection of a shelter over the mouth of the pit cleared out by the Society in 1914 and subsequent years. This protection is designed to prevent the silting up of the entrance to the galleries at the bottom of the pit, and to facilitate entrance to the old mine workings. The delimitation of a footpath across the warren to the site has also been agreed to. Information as to the probable cost of the shelter is being obtained, and the council of the Society is shortly to be asked to consider the question of taking up the scheme.

Mr. J. P. T. Burchell described some stratified finds on the North Kent coast, where the peculiar elongated flint implement known from its abundance in the bed of the Thames as the "Thames pick," is found in plenty at the foot of the cliffs but is without a definite geological horizon. The cliffs examined are at Bishopstone near Reculver, and Hampton near Herne Bay. At the former site, hand-axes of Chelles and St. Acheul type have been found in the ochreous gravel which is capped by brick earth, with Neolithic flakes and cores in its upper levels.

Sunk in the top of the brick earth and adjoining

a shell-heap with Early Iron Age pottery, a hearth has been found containing flint flakes and a small circular implement. An interesting discovery is that an undisturbed stratum of gravel, 5 inches deep, seals in the Iron Age hearth and midden; and above this is 1½ feet to 4 feet of loam with flints and more pottery and burnt flints to the surface. As the Thames pick can scarcely belong to the Iron Age and is probably later than the drift, the only course is to refer it to the lower part of the brick earth.

Mr. W. H. Cook reported on the discovery of a flint implement working-site of late St. Acheul or early Le Moustier date in the Medway valley. Several thousands of flint artifacts were found lying in heaps covered by brick earth and apparently undisturbed since the mid-Pleistocene period. Excavations in the chalk near Frindsbury opposite Rochester have revealed a chalk slope more than half a mile in length leading down to the alluvial plain of the Medway. On the chalk slope are a series of gravels and brick earths resting at various levels on well-defined platforms or terraces. At 90 feet above the river level and corresponding to the 100-foot terrace of the Thames and Somme are the beds of the ancient Medway, which are of the same Chellean-Le Moustier age. The recent discovery was made in a shallow deposit of dark clayey brick earth probably representing the alluvia of the ancient 100-foot terrace river, as it occurs on the upper limits of the terrace and lies in a hollow of an ancient calcareous surface loam which is clearly older than the terrace deposits. In addition to palæolithic hand-axes, scrapers and grattoir, hammerstones, masses of flint flakes and numbers of massive core pieces were found. None of the cores were, however, of the tortoise-backed type. An accumulation of coarse sub-angular fragments of chalk, apparently equivalent to the well-known Coombe rock of Northfleet, etc., was found at the junction of the chalk with the drift beds at various levels, but it is clearly of later age than the 100-foot terrace.

Dr. Cyril Fox, of Cambridge, dealt with evidence of continuity of occupation of a site known as Bellhus, at Abington Pigotts, Cambridge, from Early Iron Age down to late Medieval times. The settlement had probably been founded in La Tene I. times (400–250 B.C.), possibly as a result of the general tendency elsewhere exemplified during this Age for migration to take place from the pasture-land to the more fertile districts bordering the alluvium, and thus connected with the early development of corn growing. The evolution of the pottery forms during the Early Iron Age was discussed and many examples shown. The abundance of 1st century A.D. finds seems to show that no serious setback in prosperity accompanied the Roman conquest and the story of the settlement only became obscure after A.D. 390. Certain pottery forms, particularly the Roman mortarium, seem to show an evolution into types which can be clearly distinguished as Early Saxon.

Mr. A. L. Armstrong reported upon the past season's work at Grime's Graves, Norfolk. The continuance of last year's excavations has shown that the simple shaft-pits discovered on the outer slopes of the site are placed close together in rows. The extremely compact nature of the filling and absence of surface indications were again noted, as well as the absence of galleries and deer horn picks. The work appears to have been done with short hand-picks of bone. Excavation of a large hearth in one of the old shaft hollows on the higher ground has yielded several examples of pottery now dated as Hallstatt, Early Iron Age.

University and Educational Intelligence.

EDINBURGH.—The Prince of Wales visited the University on December 3, for the purpose of opening the new Department of Chemistry, King's Buildings, which has recently been completed at a cost of about 200,000*l*. Immediately afterwards, at a special graduation ceremony in the M'Ewan Hall, the Chancellor of the University, Earl Balfour, conferred on His Royal Highness the honorary degree of LL.D. At the subsequent luncheon, the Principal announced that Sir Alexander Grant had given 50,000*l*., that the Carnegie Trust was likely to add 15,000*l*., and gifts from other sources amounted to 10,000*l*., which, he stated, would bring relief, encouragement, and hope to those who administer the affairs of the University, though the University's need remained yet so great that he trusted there was a larger harvest to follow.

To commemorate the hundredth anniversary of the foundation of the Royal (Dick) Veterinary College, a Centenary Post-graduate Fellowship has been instituted. A Fellowship Fund has been established, and a deed has recently been signed by which trustees have been appointed to administer the Fund. The aim of the Fellowship is the assistance of promising graduates who may wish to pursue further study and research, and it is hoped that in this way the advancement of veterinary science may be promoted. The amount of the Fund is at present 5802*l*., but the trustees feel confident that additional contributions may be expected from those who benefit from the discoveries of veterinary science, as applied to animal husbandry and public health.

LEEDS.—Applications are invited for two posts, namely, an assistant lectureship in agricultural botany and a demonstratorship in the same subject. Particulars may be obtained from the registrar, to whom applications for the posts should be sent by, at latest, December 22.

LONDON.—The following doctorates have been conferred:—*Ph.D.* (*Science*): Miss M. A. C. Boas (Lister Institute of Preventive Medicine) for a thesis entitled "Part I. A Method for estimating Calcium and Phosphorus Retention in young growing Rats; Part II. The effect of Green Food in the Diet on the Calcium and Phosphorus Metabolism of Rats as compared with that of Cod Liver Oil"; Amar Nath Puri (Rothamsted Experimental Station) for a thesis entitled "Soil Colloids—A Study of Phenomena relating to Surface Forces in Soil"; Mr. H. Gregory (Imperial College—Royal College of Science) for a thesis entitled "Experimental Determination of the Thermal Conductivities of Gases," and other papers; Mr. E. Spencer (Imperial College—Royal College of Science and University of Liverpool) for a thesis entitled "Investigations of Problems connected with the formation of Authigenous Minerals in Clays, Coals, and Limestones from India and elsewhere"; Mr. Murray Stuart, for a thesis entitled "The Potash and Rock Salt Deposits of the Punjab and Kohat"; Mr. G. F. J. Temple (Birkbeck College) for a thesis entitled "Researches in Whitehead's Theory of Relativity," and another paper; Mr. H. G. Turley (Battersea Polytechnic) for a thesis entitled "Experiments on the Walden Inversion. The α-Hydroxy Acids and their Derivatives with special reference to Lactic Acid." *Ph.D.* (*Engineering*): Mr. G. F. Dutton (Imperial College—City and Guilds College) for a thesis entitled "Some Acoustic Properties of Telephones."

Applications are invited for the Keddey Fletcher-Warr studentships for the promotion of post-

graduate research. The studentships are tenable normally for three years, and are of the annual value of not less than 200*l*. They are open to men and women of European descent who are graduates of a British university or of similar standing, preference being given to a graduate of the University of London. Further particulars are obtainable from the Academic Registrar, University of London, South Kensington, S.W.7. The latest date for the receipt of applications is January 31.

THE Faraday House Electrical Engineering College, Southampton Row, W.C.1, has an opening for an assistant lecturer in mathematics and physics or chemistry. Preference will be given to an engineering graduate. Written applications should be sent to Dr. A. Russell, at the College.

THE University College of the South-west of England, Exeter, has sent us a copy of the annual reports of its Council and Senate for 1923–24. The Council has co-operated with the Plymouth Education Authority in planning an extension of the work of the College to Plymouth. A scheme has been framed for the institution of degree and diploma courses in engineering (civil, electrical, marine, and mechanical) and in commerce, to be conducted in Plymouth, and for the extension of the law teaching and extra-mural work now carried on there by the College. Pending the maturing of the scheme and the provision of the requisite funds, the College Council will be represented on a sub-committee constituted for the purpose of advising the Plymouth Education Committee on the administration of the Plymouth Technical Schools, and the Principal of the College will give part of his time to acting as supervisor in these schools.

THE New York correspondent of the *Times* records that Mr. George Eastman, founder of the Eastman Kodak Company, who has already given away half his holdings of stock in that concern, has made gifts of the remaining half to several institutions of learning. At the lowest estimate this half is worth about 3,000,000*l*. Of this amount, about 1,700,000*l*. will go to the University of Rochester, and about 900,000*l*. to the Massachusetts Institute of Technology. This will bring the total of Mr. Eastman's gifts to the latter institution up to 3,000,000*l*. The remaining money, about 400,000*l*., will go to the Tuskegee Institute, the Hampton Institute, and the Southern Schools for the Education of Negroes, but these gifts are contingent on gifts of a like total from others.

THE annual statement for 1923–1924, of the Rhodes Scholarships, has recently been issued by the Rhodes Trust, Seymour House, Waterloo Place, London, S.W.1. The number of scholars in residence during the year was 220, of whom 109 were from the British Empire and 111 from the United States. Grouping the scholars according to their studies, it appears that mathematics claimed 60 and natural science and medicine 57, while education, forestry and agriculture, and anthropology claimed 4, 2 and 1 respectively. The present academic year opened with 180 scholars in residence. Information about Rhodes Scholarships may be obtained on application to the offices of the Trust. In the United States application may be made to President Aydelotte, Swarthmore College, Swarthmore, Pennsylvania; in Canada to Mr. J. M. Macdonnell, National Trust Company, Ltd., Montreal, P.Q.; in Australia to Mr. J. C. V. Behan, Trinity College, Parkville, Victoria; in South Africa to Mr. P. T. Lewis, South African Chambers, St. George's Street, Cape Town.

Early Science at the Royal Society.

December 14, 1664. The experiment mentioned by Monsieur Huygens of making a thermometer with a cane of salt-water and a glass-ball poised in it, was tried; and it was found that the glass-ball rose and subsided, according to the alterations of heat and cold. It was ordered, that it be kept and compared with the other thermometers, in order to see whether it be so nice and sensible as they.—There was read a paper sent from Oxford by Mr. Boyle to the secretary, containing certain proposals of Mr. Austen, about the planting of fruit and timber-trees which Mr. Austen desired might be recommended to the parliament. It was referred to the committee for agriculture.

December 16, 1663. Mr. Waterhouse gave notice of a letter received by him from Mr. Children, signifying, that the thermometer sent to him was broken: as also, that he would shortly communicate his manuscripts of observations of the weather, and first of all those of three several persons made upon every day of the year 1648.—Mr. Hooke proposed an experiment to be made with the compressing engine, of applying a gun to it, to see with what force it will be able to shoot a bullet, arrow, etc. The operator was ordered to prepare a gun for this purpose.

December 17, 1668. At this meeting were present two Italian gentlemen, the Marquis Ricardi, and Signor Seoni, both introduced by Count Umbaldino. They acquainted the society of the singular respect, which the Cardinal Leopold de Medicis had for them, and that he desired to have his excuse made for not having himself returned his acknowledgments for the "History of the Society" [Sprat's] sent to him, which he had been hindered from doing by his lately received dignity of Cardinal; but that since that time he had desired and already obtained the Pope's permission to correspond with the society, of which he now intended to make use, to let them see the esteem, which he had of them and their institution.—The president thanked these gentlemen for acquainting the society with so favourable an inclination of his Eminence to them, and that they would study to entertain so noble and promising a correspondence with all reciprocal services.

December 18, 1679. Mr. Henshaw read a paper, which he had from Dr. Plot, copied from the Records in the Tower, containing an account of the strange recovery of certain persons a long time after their having been executed.

December 19, 1666. It was ordered that at the next meeting the experiment be made of transfusing the blood of a sound dog into a mangy one; and that the operator provide necessaries for it, to begin the operation about twelve o'clock that day. Mr. Boyle suggested that it might be considered to make an estimate of what proportion of blood is let out. Dr. Pope moved, that a trial might be made of letting out half the blood of a dog, and of supplying it with warm milk, or, because milk may coagulate, with a liquid of barley-cream. Mr. Boyle mentioned, that not only care must be had of the kind of liquor to be injected, but also of the manner and place of the injection; in default whereof the liquor would drive the blood before it to the heart and by too great abundance crowding in there kill the animal. To avoid which, it might be injected by degrees, and in the remoter parts from the heart, as in a crural vein.

1667. Mr. Coga being introduced gave an account of the effects of the experiment of transfusion repeated upon him, viz., that he found himself very well at present, though he had been at first somewhat feverish upon it; which was imputed to his excess in drinking too much wine soon after the operation.

Societies and Academies.

LONDON.

Royal Society, December 4.—A. **Fowler**: The structure of the spectrum of ionised nitrogen. New observations of the second line spectrum of nitrogen (N II or N^+) have been made in the region λ6650 to λ2200, and 52 lines have been classified. In this region, all the terms which have been identified belong to singlet or triplet systems. These have been found to combine with each other in agreement with the selection rules which are applicable to other spectra in which p' and d' terms appear. The absolute values of the terms cannot yet be stated, but a value of 70,000 has been provisionally assigned to $2p$, in accordance with the value suggested for $1p$ by astrophysical data. The largest term identified is a p term, and it may be inferred that the series electron in singly ionised nitrogen normally occupies a 2_2 orbit, so that the atom of N II has two electrons in 1_1 orbits, two in 2_1 and two in 2_2 orbits. It is also the probable arrangement of orbits in the neutral atom of carbon, the spectrum of which has not yet been resolved into series. Three groups of lines which involve one of the p terms are remarkable as showing large displacements (> 0·5 A) to the red in vacuum tubes containing nitrogen at relatively high pressures.—H. **Jeffreys**: On the formation of water waves by wind. The wind presses more strongly on the slopes of the waves facing it than on the sheltered slopes, and when the resulting tendency of the waves to grow is just able to overcome viscosity, waves are first formed. A numerical constant in the theory can be adjusted to make the wind velocity required to produce waves agree with observation; and when this is done the predicted wave-length of the waves first formed agrees with observation without further assumption. To account for the skin friction of the wind over the seas as the resultant drag due to the horizontal thrust of the wind on the exposed sides of the waves, wave velocity must be about three-quarters of the wind velocity, which is in accordance with observation. The formation of waves with such a velocity, however, appears to require values of the eddy-viscosity much smaller than are indicated by observations of ocean currents.—J. E. **Jones**: (1) On the determination of molecular fields. III. From crystal measurements and kinetic theory data. With the information obtained about argon in earlier papers from its properties as a gas, theoretical calculations are made of the interatomic distances to be expected in argon as a crystal. Crystalline argon has recently been obtained, and its structure measured and examined, and it is thus possible to fix the molecular field of argon. Theoretical calculations are also made of interatomic distances in potassium chloride and calcium sulphide which are in good agreement with observations. (2) On the atomic fields of helium and neon. The atomic field of helium is determined from measurements on its isotherms and viscosity, that of neon from measurements of its viscosity, and heat conduction and the crystal constants of sodium fluoride and magnesium oxide.—F. S. **Tritton**: A centrifugal method of making small pots of electrically fused refractory materials. A method is described of making small pots of refractory materials (magnesia, alumina, zirconia, and tungsten metal) by electric arc fusion combined with centrifugal action. The material, shrunk by previous fusion and finely powdered, is placed in a silica cup and a deep central depression is made in the powder. Two graphite electrodes fit closely into this depression. In the case of alumina or zirconia, in order to prevent the formation of carbides, a stream of oxygen is blown between the electrodes and the refractories during fusion. Pots of fused magnesia made in this way have been successfully used for holding molten iron oxide, which penetrates all other known refractories.—J. W. **Nicholson**: Spheroidal wave functions. The paper develops a new class of solutions of the equation of wave motion, in oblate spheroidal co-ordinates, satisfying boundary conditions which can be made identical with corresponding conditions in problems of solutions of Laplace's equation. The new solutions are not of the form of products of functions of single "normal" co-ordinates appropriate to the spheroid, but they nevertheless can be applied readily to the exact solution, without the use of harmonic series, of problems of diffraction of waves by circular discs.—J. V. **Howard** and S. L. **Smith**: Recent developments in tensile testing. When a steel test piece is pulled beyond a limiting stress, the removal and re-application of the load causes a loop to be traced in the load-extension diagram recorded by the Dalby autographic load-extension recorder. The extension which occurs when a loop is being traced is analysed into a proportionally elastic portion and a non-proportionally elastic portion (recoverable slip) which depends only on stress. Permanent set is the ultimate cause of rupture, and is caused by the act of looping. The stress required to produce a standard mean loop-width provides a means of comparing different steels as regards that property of the metal which is revealed by this method of testing. Under certain conditions of heat treatment and composition, no recovery takes place at ordinary temperatures; nor does steel recover if left in a state of stress.—F. C. **Harris**: The photo-elastic constants of glass as affected by high temperatures and by lapse of time. The stress-optical coefficients of several glasses, of known chemical composition, at different temperatures up to 400° C., with only one exception, show a general increase with rise of temperature. The exception was an extra dense flint, containing a high percentage of lead. The stress-optical coefficients increase comparatively rapidly during the first year or two after being cast, and finally settle down to a steady value.—A. L. **Narayan** and D. **Gunnaiya**: Absorption and dispersion of thallium vapour. The non-luminous vapour of thallium absorbs lines of sharp and diffuse series. At about 900° C. a number of bands of diffuse and complex structure, and some lines, made their appearance, probably due to Tl_2 molecules. The vapour does not exhibit any selective absorption in the region 0·9μ to 1·35μ, and that therefore $1,\pi_2 - 1,\pi$, is not the single-line spectrum of the metal. The work confirms the findings of H. Geisler and Prof. McLennan, that at λ5350·6 the vapour exhibits anomalous dispersion, though feebly. Further, the experiments indicate more prominently the existence of anomalous dispersion at λ3775·7.—R. d'E. **Atkinson**: Note on Vegard's theory of the aurora. The presence of solid nitrogen would not account for auroræ at great heights since (1) there probably cannot be a strong enough field to lift crystals; (2) the volume charge they would carry would be impossibly large if enough light were to be obtained; (3) the largest crystals that could be lifted would probably be completely vaporised by one electronic impact; (4) solid nitrogen probably cannot emit a narrow line. The possibility of low enough temperatures is disproved. The experimental evidence of Vegard is inconclusive. Two alternatives, in which the aurora is explained as a purely gaseous luminescence, are outlined, and the possibility that the gas might be oxygen instead of nitrogen (so far as 5578 is concerned) is discussed.—M. **Weinberg**: The spark spectra of indium and gallium in the extreme

ultra-violet region. The spark spectra were examined in both quartz and vacuum-grating regions. Since they oxidise very easily in air, their spectra in the quartz region were taken in hydrogen. There are altogether 107 indium lines in the quartz region, some of which are extremely faint. They extend over a range of 1855 to 2337 A.U. There are fewer gallium lines in this region. These range over 1855 to 2364 A.U. Both elements in the vacuum grating spectrograph show a great mass of lines in the extreme ultra-violet. On elimination of the impurities, however, it was found that there were 828 gallium lines ranging over region 157-2059 A.U., and 464 indium lines ranging over 161-2082. In gallium there were a few very faint lines extending so far down into ultra-violet as $\lambda = 126{\cdot}8$ A.U.—S. W. **Richardson**: The general law of electrical conduction in dielectrics.—T. **Lewis**: The interpretation of the results of Bucherer's experiments on e/m. The whole of the traces obtained by Bucherer in his e/m experiments may be used in order to verify the mass formula for the electron. The experimental traces confirm the validity of the Lorentz formula for high velocities provided electrons with these high velocities are emitted in sufficient number to produce the desired photographic effect. Electrons must be emitted with velocities up to at least 0·94 of the velocity of light. This is higher than the velocities recorded by Ellis up-to-date, but well within the range observed by Danysz.—A. M. **Mosharrafa**: On the quantum dynamics of degenerate systems. A set of quantum restrictions is suggested for degenerate conditionally periodic systems, in the form $Y_j = \tau_j h$, where Y_j is a specified "adiabatic invariant." The conditions are applied to the case of the hydrogen atom in the presence of an external electric field and lead to the adoption of "half-integral orbits" in the Stark effect. The origin of fractional quantum numbers is to be sought in the mechanism of degenerate systems.—E. G. **Dymond**: On the precise measurement of the critical potentials of gases. Automatic differentiation of the characteristic curves increases the sharpness of the bends in them. The reasons for the divergence of the value found for the first excitation potential of helium, 20·9 volts, from that calculated from the optical data, are discussed.—I. **Langmuir** and K. H. **Kingdon**: Thermionic effects caused by vapours of alkali metals. At high filament temperatures, positive ion emission becomes limited by the rate at which vapour comes into contact with the filament, all atoms striking the filament being converted into ions. This permits quantitative measurements of vapour pressure to be made. At lower filament temperature, electric image force causes a fraction θ of filament surface to be covered by a layer of adsorbed ions, which share electrons with the underlying metal. The resulting double layer causes increase in electron emission and corresponding decrease in positive ion emission. Electron emissions of more than 0·3 amp. per cm.^{2} at 1000° K. may be obtained in cæsium vapour 30° C. The theory of dilute adsorbed films ($\theta < 0{\cdot}2$) is developed. Equation of state for adsorbed film is found to correspond to ideal gas laws. For more concentrated films, attractive forces draw the ions together, and under certain conditions separate 2-dimensional phases appear. Heat of evaporation of adsorbed cæsium atoms on tungsten in the form of ions corresponds to 4·0 volts for dilute and 4·3 for concentrated films. From adsorbed oxygen on tungsten, heat of evaporation of cæsium ions is 5·1 volts.—C. Tate **Regan**: Dwarfed males parasitic on the females in oceanic angler-fishes (*Pediculati Ceratioidea*). Dwarfed males parasitic on the females are described in Ceratias (female, 1000 mm., male, 105 mm.) and Photocorynus (female, 65 mm., male, 10 mm.). Outgrowths from snout and chin of the male unite in front of the mouth and fuse with a papilla of the female. The skin of the two fishes is continuous, and beneath it the outgrowths of the male and the papilla of the female consist of highly vascular fibrous tissue: the blood systems of the two are continuous, a unique type of parasitism. In the male, teeth are absent and the gut is vestigial. Other ceratioids examined are all immature females: no free-swimming males are known in the group. The ceratioids are bathypelagic, piscivorous, solitary, and sluggish: they float about in the darkness of the middle depths of the ocean. It is suggested that the difficulty experienced by mature fish in finding a mate led the immature males to attach themselves to the females at the first opportunity, with the result that in the end the males became dwarfed and parasitic.

Royal Microscopical Society (Industrial Applications Section), October 22.—R. H. **Greaves**: Supersaturated solid solutions. In many alloy systems, the limit of saturation of the α solution decreases with fall of temperature. This is so with a group of ternary alloys of copper and aluminium with nickel, also with manganese and with other elements. These α solid solutions can be obtained in the supersaturated condition at atmospheric temperature by quenching. Subsequent heat treatment hardens the alloy by precipitating the excess of the dissolved constituent. To obtain maximum hardness, the whole of the excess must be precipitated in extremely fine particles (critical dispersion). These are far below the limit of visibility under the microscope ($0{\cdot}25\mu$ or 1000 atoms diameter). This does not seem possible with the alloys mentioned, since a treatment which ensures complete precipitation at the same time induces coalescence. It is possible, however, in aluminium alloys and is illustrated by the ageing of duralumin, and some other alloys containing magnesium, at atmospheric temperature. Increased resolving power would enable the study of the precipitated particles into the region of the critical dispersion, but it has been possible to interpret the structure by inference from other tests, and the practical problem of correct heat treatment has therefore not been delayed.

Faraday Society, November 17.—A. P. **Laurie**: Note on the expansion of water while freezing. Assuming that the atomic diameters based on Bragg's crystal model for ice are true for liquid water, and that liquid water at 0° is a trihydrol, it follows as a geometrical necessity that there will be an expansion from 1 to 1·088 when ice melts. This gives a sp. gr. for ice of 0·918; and the experimental value is 0·917, thus confirming the original assumptions.—R. W. E. B. **Harman** and F. P. **Worley**: The hydrolysis of alkali cyanides in aqueous solution. The vapour pressure of hydrogen cyanide over solutions of potassium cyanide was compared with that over solutions of hydrocyanic acid, and it is shown that the degree of hydrolysis of sodium cyanide at 25° at all concentrations is the same as that of potassium cyanide. The effect of temperature was also studied. The constancy of the hydrolytic constants at different concentrations at each temperature, the agreement of the values at different temperatures with the Van 't Hoff isochore, and the agreement between the calculated heat of hydrolysis and the measured heat of neutralisation appear to confirm the accuracy of the values arrived at for degree of hydrolysis at the various concentrations and temperatures employed.—S. S. **Joshi**: Viscosity of reversible emulsions.

Viscosities of water-in-oil emulsions prepared from castor oil, olive oil, and paraffin oil by means of four monovalent soaps are determined. Viscosity increases with increase of the dispersed phase and is a maximum at the reversal point, which is followed by a sudden drop in viscosity upon inversion. The concentration and the specific chemical nature of the emulsifying agent have no effect on the viscosity of the emulsion. Hatschek's equation for the viscosity of the emulsoids is not followed; observed viscosities are in approximate agreement with those estimated by Einstein's equation for suspensoids; Arrhenius' equation applies better still. The size of the grains of the water-in-oil emulsions may increase with increase in the proportion of the aqueous phase.—D. B. **Macleod**: On the viscosities of liquids at their boiling-points. Boiling-points are unsatisfactory temperatures at which to compare the viscosities of liquids. By correcting the boiling-points to a condition of equal free space, the viscosities of liquids become proportional to their molecular weights in the liquid state. Such a condition of equal free space corresponds very closely to a reduced temperature on the basis of Van der Waal's equation of state.—D. B. **Macleod**: The kinetic theory of evaporation. It is assumed that the ratio of the density of the vapour above a liquid to the density of the liquid is really the ratio of the number of molecules with sufficient speed to escape from the liquid to the number with insufficient speed. Thus if D_v and D_e are the densities of the vapour and liquid respectively, then

$$\frac{D_v}{D_e}=\frac{N_s}{N_i},$$

where N_s is the number of molecules with sufficient speed to escape and N_i the number with insufficient speed. It is shown that the results which follow from this assumption are so simple and satisfactory as to make the truth of the assumption extremely probable. The experimental data used are those given by Ramsey and Shields.—J. T. **Howarth** and F. P. **Burt**: New design for apparatus to measure the coefficient of deviation from Boyle's law and the determination of this coefficient for acetylene. A modified apparatus for measuring the compressibility of gases has been designed in which the whole volume of the gas and also the mercury column which registers the pressure are kept at the temperature of melting ice. The coefficient of deviation from Boyle's law at 0° C. for acetylene between 0 and 1 atmosphere is $-0{\cdot}00884$.

MANCHESTER.

Literary and Philosophical Society, December 2.—T. A. **Coward**: Migration may be visible or invisible. The passage of large bodies of waders, and of swallows, martins, and swifts during daylight, are examples of visible migration; but the majority of species pass unseen in favourable circumstances, probably because they travel at night or at too great an elevation for human vision. When these species are seen in any numbers, as during unfavourable weather at the coastwise lights, migration is abnormal. The fact that birds frequently travel against the wind or with the wind on a flank does not prove that they prefer this method; nor does the fact that airmen but seldom meet with birds at high altitude annul the possibility of high flight; the birds may have wandered into unfavourable currents. Coasts and river valleys are followed, but there are also cross-country migrations. Wind driftage and contrary currents explain many of the occurrences of migrants in unexpected places.

SYDNEY.

Royal Society of New South Wales, September 3.—Dr. C. Anderson, president, in the chair.—E. **Cheel**: Notes on Boronia in the Pinnate Section, with a description of a new species. The plants, which are from the Richmond River district, have a superficial resemblance to the "Pink Boronia" (*B. floribunda*) of the Sydney district, but the leaves are smaller and the whole plant is more or less hairy and not glabrous, as is the case with "Pink Boronia." The oil contained in the leaves has a fragrant odour, somewhat resembling safrol, and it is therefore proposed to call the new plant *Boronia safrolifera*.—T. **Hodge Smith** and Tom **Iredale**: Evidence of a negative movement of the strand line of 400 feet in New South Wales. A series of sandstone blocks has been trawled along the 70 fathom line from Long Reef, north of Sydney, to south of Montague Island, a distance of about 200 miles. The soundings along this line show coarse sand and rocks, and the boulders are composed of very coarse sand grains similar to that of a beach, and not like the fine soft sand normally found at such depths. One of these blocks was a mass of scallop and other shells cemented together with this coarse sand. The shells belong to littoral species at present living on the coast of Tasmania, while the existing molluscan fauna at the place differs notably in detail from the association of molluscs in this block. These blocks seem to represent an ancient coastline which has been drowned in recent times, probably simultaneously with the movement that broke through Bass Strait.—S. L. **Martin**: The change of resistance of molybdenite due to light. If the contacts are shielded, a strip of molybdenite 0·001 cm. in thickness suffers a decrease in electrical resistance, when light is incident on it, the red end of the spectrum producing the greatest change. This change is constant, providing the current density is less than about 0·1 amp. per sq. cm. and is proportional to the intensity for small intensities. For white light, the source being a hundred candle power pointolite lamp at a distance of 75 cm., the change was of the order of 1 ohm in 500.

Official Publications Received.

Agricultural Research Institute, Pusa. Bulletin No. 153: Tamarind as a Source of Alcohol and Tartaric Acid. By H. N. Batham and L. S. Nigam. Pp. 8+2 plates. (Calcutta: Government of India Central Publication Branch.) 3 annas; 4*d*.

Mysore Geological Department. Records, Vol. 22, 1923. Part 1: Annual Report for the Year 1923. Pp. iii+44. (Bangalore: Government Press.) 1 rupee.

Seconde Assemblée de l'Union Géodésique et Géophysique Internationale, Madrid, Octobre 1924. Espagne. Offert par le Comité Espagnol. Pp. 148+52 plates. (Madrid: Instituto Geográfico.)

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1920. Neue Folge, 57 Band. Pp. xiv+A36+B36+C41+D11+E11. (Wien: Gerold und Komp.)

University of California Publications in Zoology. Vol. 26, No. 4: The Boring Mechanism of *Teredo*. By Robert Cunningham Miller. Pp. 41-80 +plates 3-6. (Berkeley: University of California Press.) 60 cents.

Ministry of Public Works, Egypt: Physical Department. The Discharges and Levels of the Nile and Rains of the Nile Basin in 1919. By Dr. Percy Phillips. (Physical Department Paper No. 11.) Pp. vi+84+3 plates. (Cairo: Government Publications Office.) 5 P.T.

British Scientific Instrument Research Association. Sixth Annual Report for the Year 1923-24. Pp. 20. (London: 26 Russell Square, W.C.1.)

Madras Fisheries Department. A Contribution to the Life-History of the Indian Sardine; with Notes on the Plankton of the Malabar Coast. By James Hornell and M. Ramaswami Nayudu. (Report No. 5 of 1923, Madras Fisheries Bulletin, Vol. 17.) Pp. 129-197. 14 annas. Report on the Inspection of Pearl Banks in the Gulf of Mannar and Palk Bay in March and April 1923. By James Hornell. (Report No. 6 of 1923, Madras Fisheries Bulletin, Vol. 17.) Pp. 199-214. 3 annas. (Madras: Government Press.)

United States Department of Agriculture. Department Bulletin No. 1249: Food Habits of some Winter Bird Visitants. By Ira N. Gabrielson. Pp. 32+5 plates. (Washington: Government Printing Office.)

Agricultural Experiment Station, Michigan Agricultural College. Special Bulletin No. 133: Fertilizers; What they Are and How to Use Them. By M. M. McCool and C. E. Millar. Pp. 26. Special Bulletin No. 134: Greenhouse Insects. By E. I. McDaniel. Pp. 75. Special Bulletin No. 135: Seasonal Management for Commercial Apiaries. By Russell H. Kelty. Pp. 58. (East Lansing.)

Diary of Societies.

SATURDAY, DECEMBER 13.

MIDLAND INSTITUTE OF MINING ENGINEERS (at Danum Hotel, Doncaster), at 2.15.—J. H. Cockburn: Mines (Working Facilities and Support) Act, Pt. I., 1923.—Dr. J. Herezegh: The Collieries of the First Danube Steam Navigation Co.—J. C. F. Statham: The Utilisation of Waste Heat and Surplus Gas from Coke Ovens.

PHYSIOLOGICAL SOCIETY (at Middlesex Hospital), at 4.—T. Lumsden: A Simple Method of recording Respiratory Movements.—D. E. Bedford and S. Wright: Venous Pressure in Man.—J. R. George and J. H. Woodger: Some Points in Connection with the Cytology of the Pancreas.—J. H. Woodger: The Early Germ Cells of the Fowl Embryo.—C. Russ: An Instrument which is set in Motion by Vision or by Human Proximity.—Prof. Swale Vincent: The Effects of Fatigue on the Adrenal Bodies.—S. L. Baker: Demonstration of Lesions in the Human Pancreas.—W. M. Clifford, Gladys Hartwell, and V. H. Mottram: A Stethograph for Student Use.—T. Lumsden: Tracings showing the Effect of Bulbar Anæmia on the Respiratory Rhythm.—T. I. Bennett and E. C. Dodds: The Effects produced by the Assimilation of Large Amounts of Glucose.—Prof. J. Mellanby: Secretin and Pancreatic Juice.—J. W. Pickering and R. J. Gladstone: The Coagulability of Hæmophilic Blood.—W. J. O'Donovan and D. T. Barry: Different Types of Venous Pulse in Health.—B. P. Babkin: Reflex Hyperglycæmia.—Ff. Roberts: The Output of the Heart with Circulation Short-circuited.—J. H. Crawford: The Action of Sparteine Sulphate on Experimental Fibrillation of the Auricles.—Gladys Hartwell and V. H. Mottram: Recovery from a Period of Malnutrition in the Growing Animal.—E. D. Adrian: The Chronaxie of Ventricular Muscle.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section (at Municipal College of Technology, Manchester), at 7.—F. W. Rowe: The Value of Technical Information in Foundry Work.

HULL ASSOCIATION OF ENGINEERS (at Hull Municipal Technical College), at 7.15.—J. Key, Jr.: Autogenous Welding (Lecture).

MONDAY, DECEMBER 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. C. Raphael and others: Discussion on The New Wiring Regulations of the Institution.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—G. Rogers: Automatic and Semi-automatic Mercury-vapour Rectifier Substations.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates Section), at 7.—E. G. Davies: Some Aspects of Works Management, with a View to Cutting Costs of Production.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. J. Davis: Shop Fronts and their Treatment.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. L. J. Russell: Science and Philosophy.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major R. E. Cheesman: The Deserts of Jafura and Jabrin.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scotland Section) (at Royal Technical College, Glasgow).

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court).

TUESDAY, DECEMBER 16.

ROYAL DUBLIN SOCIETY, at 4.15.

ROYAL STATISTICAL SOCIETY, at 5.15.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Dr. T. E. Stanton: Report on the Measurement of the Pressure of the Wind on Structures.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. G. Warne: Development of Steam and of Oil Engine Machinery for Propulsion.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 15 Savoy Street, W.C.), at 7.—Further Particulars and Demonstrations of Recent Advances in Electric Lamps and Lighting Appliances, based on the Report presented at the Opening Meeting on November 18 (with special reference to Shop-window Lighting).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: A Winter Holiday.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. Dunlop: The Internal Combustion Locomotive.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Rev. H. W. Williams: Some Customs, Beliefs, and Traits of the Maori.

WEDNESDAY, DECEMBER 17.

SOCIETY OF GLASS TECHNOLOGY (London Meeting), at 2.30.

ROYAL METEOROLOGICAL SOCIETY, at 5.—C. E. P. Brooks: The Problem of Warm Polar Climates.—Sir Napier Shaw: Winds and Temperature in a Dry Atmosphere.

LONDON AND PROVINCIAL ANTI-VIVISECTION SOCIETY (at Victory House, Leicester Square, W.C.), at 5.30.—Dr. H. F. Woods: Cancer Research and Why it Fails.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. J. D. Falconer: The Geology of Nigeria (Lecture).

NEWCOMEN SOCIETY (at 17 Fleet Street, E.C.), at 5.30.—E. A. Forward: The Development of the Cylinder Boring Machine.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—H. C. Reeves: Mangahao Hydro-electric Power-station.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at Art Workers' Guild, 6 Queen Square, W.C.), at 6.—B. Rackham: The Stained Glass at the Victoria and Albert Museum.

RADIO SOCIETY OF GREAT BRITAIN (Annual General Meeting) (at Institution of Electrical Engineers), at 6.—C. F. Elwell: Photo-electrics (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.

ROYAL MICROSCOPICAL SOCIETY, at 7.45.—Dr. F. W. R. Brambell: The Part played by the Golgi Apparatus in Secretion and its Subsequent Re-formation in the Cells of the Oviducal Glands of the Fowl.—Prof. Ekendranath Ghosh: A New General Classification of Protozoa.—Dr. R. J. Ludford: Further Notes on the Demonstration of the Golgi Apparatus by Osmium Impregnation Methods.

INSTITUTE OF CHEMISTRY (London Section), at 8.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (Annual Meeting) (at Royal Society of Medicine), at 8.30.—Dr. J. Rickman: The Development of the Psycho-Analytical Theory of the Psychoses.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Section) (at Chamber of Commerce, Birmingham).

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Section).

THURSDAY, DECEMBER 18.

LINNEAN SOCIETY OF LONDON, at 5.—Major T. F. Chipp: The Fruiting of the Groundnut, shown in lantern slides.—E. J. Collins: The Physiological Aspect of Blight Infection (*Phytophthora infestans*) of Potatoes.—W. P. Westell: Remarkable Form of *Pastinaca sativa*, new to Britain.—Major R. B. S. Sewell: A Study of the Andaman Sea Basin.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—A. R. Watson Watt: Recent Studies on Radiotelegraphic Atmospherics.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—D. Murray: Speeding up the Telegraphs: A Forecast of the New Telegraphy.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates Meeting) (at Watergate House, Adelphi), at 7.30.

INSTITUTE OF CHEMISTRY (Belfast and District Section) (at Queen's University, Belfast), at 7.30.—Dr. R. C. Johnson: The Rutherford-Bohr Atom from a Chemical and Physical Standpoint.

CHEMICAL SOCIETY, at 8.—W. H. Patterson and J. Duckett: A Method of Determining the Presence or Absence of Complex Salts or Ions in Dilute Aqueous Solutions. Dr. C. K. Ingold: The Nature of the Alternating Effect in Carbon Chains. Part I. The Directing Influence of the Nitroso-group in Aromatic-substitution.—Dr. C. K. Ingold and S. D. Weaver: The Additive Formation of Four-membered Rings. Part VI. The Addition of Azo-compounds to Ethylenes and some Transformations of the Dimethylene-1:2-di-immine Ring.—F. R. Goss, Dr. C. K. Ingold, and Prof. J. F. Thorpe: The Chemistry of the Glutaconic Acids. Part XVII. Three-carbon Tautomerism in the Cyclopropane Series. Part 4.—Dr. C. K. Ingold: The Condition Underlying the Formation of Unsaturated and Cyclic Compounds from Halogenated Open-chain Derivatives. Part IV. Products derived from Halogenated α-methyl Glutaric Acids.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—J. W. Radcliffe: The Blending of Materials in the Woollen Trade with relation to Dyeing.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section).—Prof. F. C. Lea: The Effect of Low and High Temperatures on Materials.—J. M. Lessells: The Elastic Limit in Tension and its Influence on the Breakdown by Fatigue.

FRIDAY, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Report of the Wire Ropes Research Committee.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section, jointly with Institute of Chemistry) (at Chamber of Commerce, Swansea), at 6.30.—Prof. R. V. Wheeler: Fire Damp Explosions (Lecture).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—R. H. Lawton: Specialisation *v.* Versatility.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—Discussion: Steam *v.* Electric Auxiliaries.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates Meeting) (at Watergate House, Adelphi), at 7.30.—H. E. Merritt: Tooth Gearing.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 7.30.—J. L. Taylor: Theory of Longitudinal Bending of Ships.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Institution, Middlesbrough), at 7.30.—Dr. E. V. Telfer: Technique and its Acquisition in Shipbuilding.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Col. the Master of Sempill: Aircraft in Japan.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at Municipal Technical School, Leicester).—S. R. Trotman and R. W. Sutton: The Destruction of Wool by the Action of the Atmosphere.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section).—J. W. Wilson: Celatine Colours and their Application.

PUBLIC LECTURES.

SATURDAY, DECEMBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Glory that was Thebes.

TUESDAY, DECEMBER 16.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. Bickerton: The Correlation of Science (3). Waves and Vibrations.

KING'S COLLEGE, at 5.30.—M. Kaye: F. H. Bradley—The Absolute and Human Personality.