THURSDAY, JUNE 18, 1903.

A SCHEME OF VITAL FACULTY.

Human Personality and its Survival of Bodily Death. By Frederic W. H. Myers. In two volumes. Vol. i. pp. xlvi+700; vol. ii. pp. xx +660, including elaborate index. (London: Longmans, Green and Co., 1903.) Price 2*l.* 2*s.* net.

IN introducing this book to what must be regarded for the most part as a hostile audience, I would claim for it that it is a record of the life-work of a pertinacious and industrious student, in a region beyond the borderland of present orthodox science; and would explain that it has for its object the better comprehension and coordination of a multitude of human faculties, some of them recognised as real though obscure, others not yet generally recognised as existing. The phenomena of sleep, of genius, of multiple personality, of hysteria, of hypnotism, of hyperæsthesia, and of trance, are among those generally recognised by medical specialists and practically treated; though, in truth, most of them seem to be regarded chiefly or solely as pathological curiosities. The phenomena of sensory and motor automatism, of telepathy, and of clairvoyance, are not among the human faculties yet generally recognised. By long study Myers was able to accept them all, in various degrees, and he discerned a thread of connection running through them, so that he felt it possible gradually to design a comprehensive scheme which should include them all,—a building, as it were, in the composition of which each constituent filled its appointed place, so that no part was left forlorn and unsupported by adjacent materials, and so that the eye of science subsequently glancing over it might be willing to recognise the possibility and appropriateness of structures which when isolated had seemed strange and fantastic and incredible.

The construction of such a unified scheme, welding together phenomena often spoken of as occult with others which, though recognised by science, were difficult of interpretation and classification,—like genius, for instance, or hysteria in its many aspects,—was Myers's end and aim; and the result is embodied in two closely-printed volumes. Whether he has succeeded, it is for posterity and for psychologists to say. His treatment is not likely at once to commend itself to philosophers, and it is not as a philosopher that he writes; his treatment aims at being scientific, but it is unusual in being very distinctly literary in form. I shall not argue the matter, but shall content myself with giving such few extracts from the earlier portion of the book as may legitimately present to a critical audience the object and motive power of the whole treatise, a treatise on human personality and vital faculty, which, whether successful or not, is, at all events, more comprehensive and more ambitious than anything which has hitherto been attempted by man in that direction.

If the objection is made that Myers was not a man of science, he himself would have admitted it at once; but I am not so ready to admit it for him. Without the technical training, he seemed to me definitely to have many of the faculties and instincts and powers of a man of science, combined with such a mental grasp, vivid imagination, and power of expression, as would put most of us to shame.

However that may be, I would point out that men not professionally scientific have had a profound influence on scientific progress before now, and if I were to seek for an analogy to the effect which I expect these volumes will have upon the development of the psychical sciences, I would liken it by anticipation to the effect of the "Novum Organon" upon the physical sciences. Francis Bacon was a man of letters, not a scientific man, but he recalled all educated men to the possibility of exploration by experiment and observation, and so cleared the ground and paved the way for the general acceptance of the results of Gilbert and other great and truly scientific men of the same and subsequent eras, whose pioneering work might else have been lost in a mist of dislike, disbelief, and obscurantism.

Myers has shown that obscure psychical phenomena can be legitimately investigated by observation and experiment, and can be regarded as part of a sufficiently comprehensive scheme of natural knowledge; him, then, I liken to Bacon. If we ask who corresponds to the Gilbert of the same age in the psychical sciences, few of us would have any hesitation in bringing forward such names as those of Wallace and of Crookes.

In so far as it may be said that Bacon did not wholly appreciate the work of Gilbert, so we may say something similar of Myers's attitude to what he was constrained to consider the somewhat too trusting disposition of that eminent man Dr. Wallace; though of the more stringent methods and results of Sir W. Crookes he was keenly appreciative.

I am merely stating facts without comment, and will now content myself with a few explanatory and helpful extracts, showing Myers's recognition to the full of the importance of strictly scientific procedure, his appreciation of the stringency and value of scientific proof, and of the difficulties attending scientific investigation in so unknown and comparatively unexplored a territory as that of the psychical nature and spiritual faculties of man.

"The method which our race has found most effective in acquiring knowledge is by this time familiar to all men. It is the method of modern Science—that process which consists in an interrogation of Nature entirely dispassionate, patient, systematic; such careful experiment and cumulative record as can often elicit from her slightest indications her deepest truths. That method is now dominant throughout the civilised world; and although in many directions experiments may be difficult and dubious, facts rare and elusive, Science works slowly on and bides her time—refusing to fall back upon tradition or to launch into speculation, merely because strait is the gate which leads to valid discovery, indisputable truth. . . .

"It is my object in the present work—as it has from the first been the object of the Society for Psychical Research, on whose behalf most of the evidence here set forth has been collected—to do what can be done to break down that artificial wall of demarcation which has thus far excluded from scientific treatment precisely the problems which stand in most need of all the aids to discovery which such treatment can afford.

"Yet let me first explain that by the word 'scientific' I signify an authority to which I submit myself—not a standard which I claim to attain. Any science of which I can here speak as possible must be a *nascent* science—not such as one of those vast systems of connected knowledge which thousands of experts now steadily push forward in laboratories in every land—but such as each one of those great sciences was in its dim and poor beginning, when a few monks groped among the properties of 'the noble metals,' or a few Chaldean shepherds outwatched the setting stars."

As an illustration of the temper of mind which Myers brings to bear, and conceives ought always to be brought to bear, to the understanding of obscure phenomena, I will take the case of witchcraft, and quote as follows:—

"The lesson which witchcraft teaches with regard to the validity of human testimony is the more remarkable because it was so long and so completely misunderstood. The belief in witches long passed—as well it might—as the culminant example of human ignorance and folly; and in so comparatively recent a book as Mr. Lecky's 'History of Rationalism,' the sudden decline of this popular conviction, without argument or disapproval, is used to illustrate the irresistible melting away of error and falsity in the 'intellectual climate' of a wiser age. Since about 1880, however, when French experiments especially had afforded conspicuous examples of what a hysterical woman could come to believe under suggestion from others or from herself, it has begun to be felt that the phenomena of witchcraft were very much what the phenomena of the Saltpêtrière would seem to be to the patients themselves, if left alone in the hospital without a medical staff. And in 'Phantasms of the Living,' Edmund Gurney, after subjecting the literature of witchcraft to a more careful analysis than anyone till then had thought it worth while to apply, was able to show that practically all recorded first-hand depositions (made apart from torture) in the long story of witchcraft may quite possibly have been *true,* to the best belief of the deponents; true, that is to say, as representing the conviction of sane (though often hysterical) persons, who merely made the almost inevitable mistake of confusing self-suggested hallucinations with waking fact. Nay, even the insensible spots on the witches were no doubt really anæsthetic—involved a first discovery of a now familiar clinical symptom—the *zones analgésiques* of the patients of Pitres or Charcot. Witchcraft, in fact, was a gigantic, a cruel psychological and pathological experiment conducted by inquisitors upon hysteria; but it was conducted in the dark, and when the barbarous explanation dropped out of credence much of possible discovery was submerged as well."

Myers's attitude to the in some quarters prevalent creed called spiritualism has been frequently misunderstood, but it is illustrated by the following extract:—

"A large group of persons have founded upon these and similar facts a scheme of belief known as Modern Spiritualism, or Spiritism. Later chapters in this book will show how much I owe to certain observations made by members of this group—how often my own conclusions concur with conclusions at which they have previously arrived. And yet this work of mine is in large measure a critical attack upon the main Spiritist position, as held, say, by Mr. A. R. Wallace, its most eminent living supporter—the belief, namely, that all or almost all supernormal phenomena are due to the action of the spirits of the dead. By far the larger proportion, as I hold, are due to the action of the still embodied spirit of the agent or percipient himself. Apart from speculative differences, moreover, I altogether dissent from the conversion into a sectarian creed of what I hold should be a branch of scientific inquiry, growing naturally out of our existing knowledge. It is, I believe, largely to this temper of uncritical acceptance, degenerating often into blind credulity, that we must refer the lack of progress in Spiritualistic literature, and the encouragement which has often been bestowed upon manifest fraud—so often, indeed, as to create among scientific men a strong indisposition to the study of phenomena recorded or advocated in a tone so alien from Science."

He then relates the rise of a society for investigating psychical matters in a new fashion, among eminent men at Cambridge, who felt that the time was ripe for an attack on superstition and on world-old legendary tradition concerning an unseen world and occult influences—the subject-matter, in fact, of all religion—by purely scientific terrestrial methods, and in the conviction

"that no adequate attempt had yet been made even to determine whether anything could be learnt as to an unseen world or no; for that if anything were knowable about such a world in such fashion that Science could adopt and maintain that knowledge, it must be discovered by no analysis of tradition, and by no manipulation of metaphysics, but simply by experiment and observation—simply by the application to phenomena within us and around us of precisely the same methods of deliberate, dispassionate, exact inquiry which have built up our actual knowledge of the world which we can touch and see. I can hardly even now guess to how many of my readers this will seem a truism, and to how many a paradox. Truism or paradox, such a thought suggested a kind of effort, which, so far as we could discover, had never yet been made. For what seemed needful was an inquiry of quite other scope than the mere analysis of historical documents, or of the *origines* of any alleged revelation in the past. It must be an inquiry resting primarily, as all scientific inquiries in the stricter sense now must rest, upon objective facts actually observable, upon experiments which we can repeat to-day, and which we may hope to carry further to-morrow. It must be an inquiry based, to use an old term, on the uniformitarian hypothesis; on the presumption, that is to say, that if a spiritual world exists, and if that world has at any epoch been manifest or even discoverable, then it ought to be manifest or discoverable now."

As to the objection frequently urged against psychical investigation, on the ground of the asserted triviality and apparent worthlessness of some of the faculties which are the object of study, Myers says:—

"In investigating those faculties we have been in no wise deterred by the fact of the apparent uselessness of some of them for our waking ends. *Useless* is a pre-scientific, even an anti-scientific term, which has perhaps proved a greater stumbling-block to research in psychology than in any other science. In science the *use* of phenomena is to prove laws, and the more bizarre and trivial the phenomena, the greater the chance of their directing us to some law which has been overlooked till now."

Before embarking on his long and laborious quest—the enumeration and dissection of instances, and the finding of a hypothesis that should fit and weld them all together—he concludes this part of his introduction with the following modest claim:—

"The truest success of this book will lie in its rapid supersession by a better. For this will show that at least I have not erred in supposing that a serious treatise on these topics is nothing else than the inevitable complement and conclusion of the slow process by which man has brought under the domain of science every group of attainable phenomena in turn—every group save this."

In the belief that this book marks an epoch in the history of psychical science, and that it will ultimately react with beneficial effect on the progress and enlargement of the scope of science generally, I venture to introduce this life-work of my friend to the readers of NATURE, or at least to such of them as are not already familiar with the subject.

OLIVER LODGE.

SCHOOL GEOMETRY REFORM.

A School Geometry. Parts i. and ii. By H. S. Hall, M.A., and F. H. Stevens, M.A. Pp. x + 140. (London: Macmillan and Co., Ltd., 1903.) Price 1s. 6d.

Experimental and Theoretical Course of Geometry. By A. T. Warren, M.A. Pp. viii+248. (Oxford: the Clarendon Press, 1903.) Price 2s.

Elementary Geometry. By Frank R. Barrell, M.A., B.Sc. Section i., part i., pp. xi + 116. Price 1s. Section i., part ii., pp. vii+117 to 168. Price 1s. (London: Longmans, Green and Co., 1903.)

Solid Geometry. By Dr. Franz Hocevar. Translated and Adapted by C. Godfrey, M.A., and E. A. Price, B.A. Pp. vii + 80. (London: Adam and Charles Black, 1903.)

A PERSON may be a Cambridge Wrangler, and yet unable to make a simple graphical construction with accuracy. The ordinary schoolboy's knowledge of practical geometry is generally worthless or nil, and his knowledge of pure geometry, the result of his premature encounter with Euclid, is of like character.

But this state of affairs is being rapidly changed. As Messrs. Hall and Stevens say in the first volume of their new geometry, "The working of examples should be made as important a part of a lesson in geometry as it is so considered in arithmetic and algebra."

The book contains an excellent collection of easy graphical and deductive exercises, many of the examples requiring numerical answers. The latter are given at the end. A boy working through this course should acquire a working knowledge of geometry, and a fair insight into the methods of deductive logic.

The volume contains the substance of Euclid book i., and is based on the recommendations of the Mathematical Association; the sequence of Euclid is in the main adhered to. There are two parts, the latter dealing with areas. In this the experimental course is incorporated with the deductive exercises, and assigned equal importance with the latter. This is a good feature, and is to be continued in a further volume which the authors have in preparation. In the present case, it seems to be a defect that the plan has not been carried out to the same, or even a greater, extent in part i., which is concerned with lines, angles, and rectilineal figures. Here it would appear to be especially necessary to make the experimental course predominate. But the subject of school geometry is in a state of transition, and the authors have probably thought it well to proceed cautiously.

Mr. Warren's volume is also based on the report of the Committee of the Mathematical Association. The course includes the fundamental properties of the triangle and circle. Ratio and proportion, similar figures, and polygons are likewise considered. The experimental treatment occupies the first half of the book, and in the second half the same ground is covered, the propositions being formally established by deduction.

The two volumes by Mr. Barrell comprise the first of three sections of a new school geometry which, when complete, will extend to Euclid xi. and the mensuration of the simple geometrical solids. It is written in accordance with the new syllabus of the Cambridge Local Examinations, and the report of the Mathematical Association. Part i. is intended to take the place of Euclid, book i. Part ii. corresponds with Euclid, book iii., 1–34, and also includes a portion of book iv. In the treatment adopted, the experimental and practical course is worked in along with the deductive geometry, and is always made subordinate to the latter. We should like to see the demonstrative geometry relatively less prominent. A feature to be noticed is that the author gives three meanings of a plane angle, in the last of which the angle is regarded as the plane space swept out by a line of indefinite length (one way) turning about one end; the amount of turning is not the angle, but the measure of its magnitude. The author is right in stating that this conception is implied in many of Euclid's phrases. The numerical answers of lengths and areas are given to three significant figures, and of angles to the nearest ten minutes. In the latter case decimals of a degree would perhaps have been preferable.

The actual personal use of mathematical instruments for graphical computations is probably largely foreign to many of the authors of the new text-books, and the treatment suffers on this account. There must be much future development before any text-book can be allowed to become crystallised.

Now that the study of pure geometry is to include numerical as well as graphical computations, it may become necessary, and it is certainly very desirable, to introduce simple tables of functions of angles so as to be able to solve right angled triangles completely, instead of being restricted as at present to the property of complementary angles and the use of Euclid i., 47.

The "Solid Geometry" by Dr. Hocevar will illustrate how this branch of the subject is presented to youths in Germany. Chapters i. and ii. deal with the properties of the line and plane in space, and the solid angle, but in a much less formal manner than is the case in Euclid xi. The remaining chapters relate to the properties and mensuration of the prism, cylinder, pyramid, cone, sphere and regular polyhedra. Exercises are provided in great variety, chiefly of the numerical type, and all necessary answers are collected at the end of the volume, where the reader will also find a useful index.

The translators say that, as the course of elementary plane geometry will be shortened on account of recent changes, teachers will be able to introduce solid geometry at an earlier period than formerly. The choice of the best complete school course of geometry is a very important matter at the present time. We should like to see solid geometry taught in connection with projection, and think that the elementary geometry of vectors should be introduced.

SHIP'S MAGNETISM.

Elementary Manual for the Deviations of the Compass in Iron Ships. By E. W. Creak, C.B., F.R.S., Retired Captain R.N. Pp. xii+150; with 4 charts. (London: J. D. Potter, 1903.)

IN his preface the author explains that the present work aims at being the successor of the "Elementary Manual" by the late Sir F. J. Evans. It is

"intended for the use of seamen of the Royal Navy and Mercantile Marine and Navigation Schools, and as an introduction to the Admiralty Manual for the Deviations of the Compass."

After a table of contents, there is a short introduction embodying some elementary definitions. Sections i. and ii., pp. 1–25, give an elementary description of the properties of magnets, with illustrations intended to supply a general idea of the action of the earth as a magnet, followed by a brief account of the phenomena of terrestrial magnetism which are of most importance to navigators. Section iii., pp. 26–42, describes the ordinary "Thomson" and liquid compasses and various auxiliary instruments. It also describes that temple of accuracy the Compass Observatory at Deptford, and gives valuable advice on such practical matters as the storage of compass cards, and the choice of a site for the standard compass on board ship. Sections iv. to vi., pp. 43–108, are mainly technical.

Section iv. treats of the "swinging" of ships to determine the deviations of the compass. It describes the sources of change in the deviation, more especially the effects due to "heeling" of the ship and to change of geographical position. It also gives some interesting particulars as to the large changes of deviation produced by the firing of heavy guns in warships. Section v. describes the effects of "soft" and "hard" iron. It introduces the reader to semicircular and quadrantal deviation by describing experiments whereby analogous effects can be produced by magnets or by soft iron situated near a compass.

Section vi. associates different constants in the ordinary mathematical theory of ship's magnetism—which the reader of the work is apparently intended to consult in the Admiralty Manual—with the action of imaginary magnets occupying specified positions in the ship. It then takes the actual results obtained in swinging certain warships, and shows how to construct deviation tables from them. This is done with great minuteness, and should be specially valuable to those who are unable to master the theoretical part of the subject. Section vii., pp. 109–131, treats of hollow iron spheres, Flinders bars, and other means of mechanical correction of the compass. There is a short account of the Peichl quadrantal corrector, which the author considers specially adapted for the case of compasses in conning towers of warships, where the earth's horizontal force is generally much reduced by the action of the ship's own magnetism. Amongst some concluding notes the author mentions the highly magnetisable and the nearly unmagnetisable alloys of iron recently discussed by Prof. Barrett and Mr. Hadfield as having a possible future in connection with compass work.

At the end of the book are some tables and a copious index. Table i. serves to facilitate the calculation of deviation tables. Table ii. tabulates some elementary trigonometrical functions. Tables iii. and iv. embody recommendations as to the dimensions of soft iron spheres and Flinders bars most suitable for the correction of deviation errors of assigned magnitude. At the end are charts of the earth's isogonal and isoclinal lines, and the lines of equal horizontal and vertical force, calculated for the epoch 1905.

So far, at least, as warships are concerned, the author's practical knowledge of the subject is probably unrivalled, and the value of the book as a mine of experience is hardly likely to be questioned. On the theoretical side there is more room for two opinions. The author takes a very humble—it is sincerely to be hoped too humble—view of the mathematical attainments of British navigators. His attitude to theory is the very antithesis of that of Mascart in his recent "Magnetisme Terrestre" (chapter xiv.). Mathematical results are occasionally introduced by a statement which does not amount to a complete proof, but might be mistaken for one, when a proof could be given without assuming advanced mathematical knowledge. Various of the references to magnetic and general theory scattered throughout the book are also capable of more exact statement from a physical standpoint.

The fact that the author defines the C.G.S. units in his introduction, but sticks to inches and other British or wholly arbitrary units in his text and charts, affords food for reflection. In one or two sections of the book there seem an appreciable number of minor misprints, more especially in one or two of the numerical examples, and attention might usefully be given to their elimination in the probable event of a second edition of the work being called for. C. C.

OUR BOOK SHELF.

Encyclopaedia Biblica, a Critical Dictionary of the Literary, Political and Religious History, the Archaeology, Geography and Natural History of the Bible. Edited by the Rev. T. K. Cheyne, D.Litt., D.D., and J. Sutherland Black, M.A., LL.D. Vol. iv. Q to Z. Pp. xxxii+cols. 3989 to 5444. (A. and C. Black, 1903.)

THIS work, now completed, contains, as the publishers inform us, about as much printed matter as twelve volumes of the "Dictionary of National Biography." They have also published a thin-paper edition, which when bound in one volume is only about three inches thick. This encyclopædia has commanded for its several departments the services of specially qualified writers, and will occupy for some time to come a high position as a work of reference for Biblical questions. As, however, it affords willing hospitality to the representatives of the most advanced criticism, it will be interesting in the course of a few years as a standard of comparison to show how far these opinions have been able to hold their own. Discussions of this kind occupy a large space even in geographical and historical articles and sometimes make it difficult to extricate physical facts from the maze of contradictory opinions. But these, when found, are clearly and accurately stated, as in the article "Trachonitis," which, however, is merely one of the more conspicuous of a large group. The maps also are a marked characteristic of the whole work—numerous, excellent of their kind, having in many cases contour lines and tints to indicate heights above and below sea level. That, for instance, which includes Trachonitis gives an excellent idea of the physical geography from north of Hermon to south of Pella in the Jordan valley. The short article on "Tabor" also is an admirable epitome of a place interesting both geographically and historically. That on "Tarshish" is a learned discussion on the identification of the place. In that on "Stones (Precious)" we find an almost exhaustive summary of what is known or conjectured about the gems of ancient times, with remarks on those in the high priest's breast-plate and the foundations of the vision city. The articles on natural history are not seldom from at least two contributors, one supplying the scientific the other the historical information. For the former, as under the word "Serpent," Mr. Shipley is responsible, so that we are sure of being on safe ground, while the other contributor adds much curious folklore. Indeed, the frequent references to this are not the least valuable part of the "Encyclopædia." Sir W. Thiselton-Dyer has contributed to the botanical articles, such as the "Vine," in this volume; that also on "Wine and Strong Drinks" is full of interesting information. Many of the theological and critical conclusions, as implied above, will doubtless be disputed, but as a compendium of information on history, archæology, geography, and all kindred topics the "Encyclopædia" is most valuable.

T. G. B.

Country Rambles: a Field Naturalist's and Country Lover's Note Book for a Year. By W. Percival Westell. Pp. xvi+312+xxxvi. (London: Henry J. Drane, 1903.) Price 10*s*. 6*d*.

MR. WESTELL has made a serious mistake; he has let himself become the slave of his note-book. He seems to have made up his mind to write a year's diary for publication, with the result that he has filled it with trivialities which after a few pages will weary the reader, be he naturalist or not. On almost every page we find entries such as the following, which are taken quite at random:—"February 2. The snow will act as a deterrent on the singing of our feathered musicians, although I have often heard Robin and Wren singing in the very depth of winter, evidently cheered by the transient gleam." "March 21. I was tempted out into the garden early by the brilliant sunshine, and did a bit of gardening. Chaffinch 'pinking.' How delicate-looking the first Snowdrop as it peeps through the brown earth!" "June 10 (among other similar entries). What a variety of small beetles cross the path of the rambler, like dark little jewels darting about in the sunlight! There are many hairy caterpillars too. Cannot they move at a rate! How they curl up into the ball of protection!" No wonder that we read on the same page, "How often the Note-book comes out at this season!" Mr. Westell's mind has been working more upon his note-book than upon nature, and he would do well to leave it behind him for some time to come, and to reconstruct his ideas of observation and of a naturalist's work. When he touches a difficult or doubtful problem, he shows us at once what manner of naturalist he is. On p. 125 we read that "an instance is recorded by Herr Muller (*sic*), a well-known German Naturalist, of a Cuckoo sitting on, and hatching, her own fledgling. Three Cuckoo's eggs were found by Herr Muller in a hollow under a tussock of grass, &c." This statement seems to be taken from Dr. Japp's book on the Cuckoo; the Herr Muller is Adolf Müller, the forester; the occurrence he described, though, of course, in itself not impossible, has not been accepted by ornithologists whose opinions at any rate deserve some consideration, *e.g.* Prof. Newton, Mr. A. H. Evans, and Mr. Howard Saunders. Yet Mr. Westell retails this as a proved but extraordinary fact, without making the least attempt either to test the truth of it himself by going to the original source, or to collect the opinions of scientific naturalists on an alleged zoological fact of such great importance. He has to learn that there are other qualifications for a naturalist besides the constant companionship of a note-book and a binocular glass. We are very far from wishing to discourage the proper use of these, or the intelligent enjoyment and observation of nature, but what we cannot possibly encourage is the publication of bulky and expensive volumes like this (weighted, too, by photographs, only some of which are really excellent), which cannot satisfy the real naturalist or even the ordinary reader; and in this we are sorry to disagree with Mr. F. G. Aflalo, who has written a kindly preface to the book. It is to be hoped that Mr. Westell's love of the country and of nature will in the course of time be turned to better account.

Text-book of Organic Chemistry. By Prof. A. F. Holleman, translated by A. Jamieson Walker. Pp. xxvii+555. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903). Price 10*s*. 6*d*. net.

A SHORT time ago an English translation of Holleman's "Inorganic Chemistry" was welcomed by chemists in this country. The translation of the organic part has followed with commendable promptitude. This book is one of the best on organic chemistry which it has been our lot to read. Prof. Holleman approaches his subject with a freshness and vigour of style which make it delightful reading. Furthermore, he is not bound down by precedent or prejudice, and therefore follows no stereotyped style.

The book is written upon theoretical lines, and for this reason Prof. Holleman does not, as a rule, enter into descriptive details of manufacturing processes, and he only occasionally, as, *e.g.*, in the case of iodoform, describes even laboratory methods for preparing substances. This we consider is a good feature of the work—not that methods of preparation on a large scale should be neglected in teaching chemistry, but there are already many books which give *more* or *less* accurate details of manufacturing processes. And as for methods of laboratory preparation, these should be taught in the laboratory. Again, if the student is well grounded in his theory, as he should be if he carefully studies this book, he is less likely to look upon methods of preparation as if they were so many cookery receipts.

The book naturally falls under two heads, the aliphatic and the aromatic compounds. The aliphatic part is certainly more complete than the aromatic, which latter, considering that it contains, beside hydrocarbons of the benzene and naphthalene series, the terpenes, heterocyclic compounds such as pyrrole, furfuran, &c., and the albumens, is shorter than we should have expected. The subject, however, is treated very concisely and generally very clearly. There is rather a want of lucidity, however, in his treatment of the synthesis of indigo on p. 512. The chapter on the diazo-compounds and the short *résumé* of Hantzsch's work in this direction are very good, and his remarks upon the electro-reduction of nitro compounds are also excellent.

Prof. Holleman pays particular attention to the physico-chemical side of the subject, an aspect which has been neglected by most writers of books on organic chemistry. On p. 188, for example, in the chapter upon polybasic acids, he devotes a long paragraph to their physical and chemical properties; again, on p. 196, he gives a clear explanation of the electro-synthesis of dibasic and other acids, while on p. 334 he describes Tafel's fine work on the electro-reduction of purine derivatives. In fact, one of the chief values of the work is the welding together of physical and organic chemistry.

The book is hardly suitable for beginners or for students who *want* (we will not say require) just a smattering of organic chemistry, but for the earnest student of the subject the work is one which can be most highly recommended. The style is good, the method of arrangement is excellent, and we think that there are few who will lay down the book after having studied it and feel disappointed.

Messrs. Wiley have produced the book in excellent style, and have spaced out the formulæ and equations in a lavish manner. Truly science knows no nationality—the book is written by a Hollander, translated by a Scotchman, and published by an American house.

F. M. P.

Education in Accordance with Natural Law. Suggestions for the Consideration of Parents, Teachers, and Social Reformers. By Charles B. Ingham. Pp. xi+125. (London: Novello and Co., Ltd.; New York: Novello, Ewer and Co., n.d.) Price 3*s*. net.

Ever since the publication of Rousseau's "Émile," with its well-known opening sentence, "Tout est bien sortant des mains de l'Auteur des choses, tout dégénère entre les mains de l'homme," there have been writers reflecting more or less satisfactorily the illuminating ray which Jean Jacques directed against the educational formalism of his day. Of course, if educational methods contravene the laws of nature, good results cannot be expected; but it is of supreme importance that writers venturing to define and formulate a system of education in conformity with natural law should at least first make sure that they understand the broad generalisations they call to their aid. An examination of Mr. Ingham's arguments gives rise to the suspicion that he has not completely mastered the conclusions at which men of science have arrived, and that his acquaintance with physical science is scarcely intimate. But Mr. Ingham is an experienced teacher, and has many sensible pieces of advice to offer, and even if the truths he advances are not new, they certainly are not universally adopted yet. To mention a few points on which the author has sound views is alone possible here. He advocates earnestly the need for more scientific methods in education; he pleads for more leisure time for boys and girls, in which they may follow their own devices; and he inveighs against the unsatisfactory early training of girls. He has not, we think, given science a sufficiently important place in the education of young people, but there can be little doubt that if parents could be persuaded to read the book they would have a clearer idea of what the aim of education should be.

A. T. S.

LETTERS TO THE EDITOR.

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

Psychophysical Interaction.

I am interested by the letter of the professor of philosophy in the University of Birmingham on p. 126, and if your readers are not weary of the discussion—as I see no reason why they should be, since it is clearly a difficult question which must be discussed from time to time as science advances—I should like to add a few words.

When Prof. Muirhead says that my recent contention was advocated by Descartes, he is stating what is of interest, but what I did not know; I was not aware that the idea of energy, or even of momentum, was sufficiently clear in his era. But however this may be, he must not think that I regard the statement "that mind cannot produce energy" as axiomatic. It is a question not of axiom, but of fact. It seems to me that live things *do not* generate energy and *do* direct it; so I assert this, not as a necessity of thought, nor as an idea for which I have a special predilection, but simply as an experience. If Descartes maintained the same thesis, so much the more likely is it to be true.

Inert matter—all matter is inert—matter devoid of life then let us say, moves (technically, is accelerated) when and because it is pushed from behind. Live matter moves or is impelled to move from other motives; it is urged by anticipation of the future sometimes, by gratification of appetite for instance, or by avoidance of pain, often. A typical case is a costermonger's vehicle propelled by a bunch of carrots, or by the blows of a stick applied in indiscriminate profusion. There is nothing like that in storm or cataract or tide; nor is there anything like it in motor-car or railway-train, unless we include in the machinery the mind of the engineer.

Prof. Muirhead recommends a pacification of the question in the ultimate *nirvana* of idealistic monism. I am disposed to acquiesce ultimately in this destination, but I feel that there is something more proximate to be attained first. Philosophers go so fast and so far, they do not give the scientific man a chance; he wants to study the landscape and grub by the roadside. The ultimate outlook is doubtless there, very fine and attractive, like the setting sun; but the traveller to the west has much to see and much to do, and a constant gaze too far ahead may only dazzle him and unfit him for his proper work on the terrestrial sphere.

Oliver Lodge.

Oxford, June 12.

The opponents are not getting into close quarters. Dr. Hobson was irreproachable, but the others are using the word "force" all through the discussion, although it is the most unhappy word anyone could use in a controversy about fundamental physical conceptions. Its object is to enable us to contemplate one aspect of an action while we dismiss the other absolutely from our minds, because, when we want to give all our attention to one of the two bodies concerned, it helps us to ignore the other as much as possible.

It is remarkable also that Prof. Minchin should write that "guiding or deviating forces," if they allow the universe to keep its total energy intact, "infallibly alter its total momentum." Prof. Ward seems to have said the same thing, and the curious error remains without specific contradiction. Yet anyone who remembers that if there are n particles in the universe, there are $3n$ velocities for a sprite to amuse himself by tinkering with, will agree that he must, indeed, be a stupid or self-willed sprite who could not arrange to keep Σmv^2, $\Sigma m\dot{x}$, $\Sigma m\dot{y}$, and $\Sigma m\dot{z}$ unchanged while he disported himself with variations of the other $3n-4$ integrals.

Though that is merely a mistake on a side issue, an example on it will serve to put clearly the two different points of view. Suppose that there are two bodies of equal mass $2m$ moving due north with velocities of 9 and 1 units respectively, and without mutual action. The total energy is $m(9^2+1^2)=82m$, the total momentum due north is $2m(9+1)$, that due east is zero. At 12 o'clock the sprite wills that the first body should diminish its velocity due north to 5 and get one of 4 due east, while at the same time the second shall increase its velocity to 5 due north and get one of 4 due west. The bodies obey the sprite, of course, and even though he has by no means confined himself to "guiding or controlling forces," the energy remains the same, for $m(5^2+4^2+5^2+4^2)=82m$, and the total momentum north is $2m(5+5)$, and that east is $2m(4-4)$, *i.e.* $20m$ and 0, the same as before.

Now suppose a materialistic philosopher had been observing all this. Before 12 o'clock his observations of the continued uniform motion of the bodies would have led him to conclude that there was no mutual action between them, *i.e.* the law of the force was that it was zero. At 12 o'clock he would observe a change, and if ignorant that there was a sprite, would conclude that some other system, unseen by him, had come into collision with his system. If he is assured this is not the case, he will be driven to the only alternative, viz. that at 12 o'clock the *law of the action between them* had suddenly changed. (For the philosopher to say that a *force* had acted on the balls at 12 o'clock would be merely another way of saying that their motion had changed, because the definition of force, derived from Newton's laws, is "that which changes the state of motion of a body." Hence, whether he thought the action was due to a sprite, to an external material system, or to a change in the law of action between the bodies, the statement that at 12 o'clock a force had acted on each would be equally appropriate, and whatever supposition be adopted, the force would have the direction and magnitude, viz. that deduced by Newton's laws from the observed changes in the motion.)

Replace the two particles by the entire universe, and the point in dispute is really this. The physicist says, the changes in the motion of each particle at any instant depend solely on the positions of it and all the other particles, *according to laws which do not change with the time*. The form of the dependence, too, shows that there is but one future course of the motion—κ.λ.π.ν.'s singular solutions do not come in—and that it only needs infinite mathematical knowledge to calculate, from the positions and velocities at 12 o'clock to-day, and the unalterable laws of mutual action, what every particle of the system will be doing at, say, 3 o'clock three hundred years hence.

It is open to anyone to deny this position, but he ought, I think, to state exactly how far he does deny it, even though he may not be able to state exactly what he wishes to substitute for it. What it seems to me necessary for Sir Oliver Lodge to deny is that these laws apply to living matter. He must say that if the motions of the material particles of which protoplasm is composed be examined (in conjunction, of course, with those of the rest of the universe), our materialistic philosopher would be compelled to conclude that a change in the law of action had taken place—just as he would in the case of the two particles, if he were certified that they composed the whole universe. The materialist philosopher would then, I imagine, be prepared to receive with attention, at all events, Sir Oliver's assurance that these extraordinary changes were due to an exertion of will- or psychic-power on the part of the protoplasm, and that the law of mutual action between the material particles was not changed at all—it was only "supplemented," I suppose he would say, by the action of mind on matter.

Whether this is really so or not is perhaps open to that reasonable doubt which may exist on any matter which has not been made the subject of conclusive experiment, and any man is entitled to say that he doubts whether an observation of the motions of live matter would not reveal something incompatible with the supposition that the "forces" acting on the particles of the universe are determined according to any fixed law, *i.e.* a law independent of the time.

It would be interesting, but inappropriate, to discuss how far such a supposition will help people in regard to "the efficacy of prayer and many another practical outcome of religious belief," the reality of which Sir Oliver and many others consider to depend on the attitude taken in regard to it. Practically the effect of a general adoption of the supposition would be that for many years to come it would be thought to have removed the difficulties, but after a time these would crop up exactly as before. When men became more familiar with the conception of spirit, they would ask of it also, *what laws it followed*, and in the mental, as in the physical world, the conception of a necessary law of operation would assert its absolute sway among the higher minds who make knowledge their object. For it is only that which is subject to law which can be the object of knowledge. That which is capricious can only be the subject of memory and conjecture. It is not in this direction that any permanent solution of difficulties is to be sought.

EDWARD P. CULVERWELL.

Trinity College, Dublin, May 28.

IN relation to the letters on "Psychophysical Interaction" appearing in NATURE, the initial questioning the discussion works back to is whether we are to recognise in mind the mere knower, or manipulator, as well, of animal action. In relation to such a questioning it may be of use to consider that what is inferred concerning mind as existing anywhere outside oneself is inferred by study of action displays. We possess no faculty which can directly become aware of the psychical outside oneself. It is in action we see it, if at all. The study of animal intelligence infers as to animal intelligence by seeing it in animal action. We meet with peculiar kinds of actions which seem to require intelligence for their origin; and therefore surmise as to animal intelligence. The observation holds of the human intelligences with which we come in contact. We can only get to know the mind of a man through his action that he acts intelligently; therefore he must be intelligent. A man may speak his ideas to us, and by his speaking convince us of his inlying intelligence; but in ultimate analysis talking is as much a muscular performance as walking. Or he may write his thoughts, and we by reading may see in what he has written that he has ideas; but if the mind is mere knower it cannot manipulate action to the writing down of ideas, and therefore this is effected in some other way. For all we may know to the contrary, the man vacant of mind may be more at large than we are apt to suspect, for by the mechanical hypothesis a man may talk rationally and yet not have ideas.

The mechanical hypothesis disposes of the actions of animals by the theory of their being fitted and adapted in reciprocal relation to environment by process of natural selection. Variations in action take place in species, and the species which are favoured with favourable variations in action in the long run survive. The theory explains many of the adjustments of animal action, but not all. There are instances to which the hypothesis can never extend, and they are the instances of action which are put in in circumstances where there is no scope for natural selection to work. Take, for instance, a man learning to play a cornet. The learning to play a cornet is the putting in of an action process, and as such is worthy of biologic consideration. The man learns to play the instrument by manipulating his breathing and fingering the keys. He studies the music before him, and internally, and mentally, decides upon the fingering which is appropriate. His breathing into the instrument is timed by his mental translation of signs given by the printed page. Each stage of his practising is revised by hearing. Where he plays a false note he goes back, and exercises extra attention to do better.

The entire action of players in a cricket field is action adjusted in relation to the motion of the ball. It is action determined by seeing. Deduct the seeing and it cannot be done. And cricket has not been long enough in existence for natural selection to have anything to do with it. So the editing of NATURE is an intelligent-mechanical process. Deduct the intelligence in that process, and it cannot be done. The expert conjurer, equilibrist, or trick cyclist depends upon the alertness of his sensations for the correctness of his performance.

Apparently in the whole proceeding of animal action, excepting the old established automatic, knowing, seeing, hearing, feeling, plays its part. Ants will eat sugar but not saccharin. The *taste* to them is not as sugar. So

the lion runs to his prey with his nose to the ground, and the action of the bloodhound is valuable on account of his fine scent. It seems with mind as mere knower and non-manipulator of action these performances could not be put through.
A. BOWMAN.

144 Well Street, Hackney, May 26.

Musical Sands.

MAY I record the discovery of musical sands at places along the shore between Ramsgate and Kingsgate. The sand occurs in small patches close to the chalk cliffs, the largest patch being found at Joss Gap. In composition the sand is very similar to that of Studland Bay, but the individual grains are more polished, and the proportion of denser minerals far higher. Of course, the sand can only be experimented upon when it has been uncovered by the sea for a sufficient length of time to enable it to become dry, and it gives remarkable results when tested in the ordinary way—especially when placed in a china vessel and struck with a wooden plunger.

June 8.
CECIL CARUS-WILSON.

THE STUDY OF BACTERIAL TOXINS.

THE study of the toxins produced by bacteria is one of the most important branches of bacteriological research. The solution of some of the main problems of immunity and disease depends upon the knowledge that can be gained with reference to the nature of the bacterial toxins and their mode of action upon the animal body.

The methods introduced by Pasteur, Koch, and other observers have rendered it possible to detect and to isolate the specific agents in a number of infective processes. The number of infective diseases that have been definitely associated with the action of bacteria is considerable, *e.g.* tuberculosis, cholera, diphtheria, typhoid fever, &c.

It was natural that the earliest attempts to prevent the invasion of the animal body by these microparasites should be based more or less on the principles of Jennerian vaccination. An attenuated virus, for example, was taken and used directly as a vaccine in order to produce, if possible, an active immunity to the disease in question. This system of protective inoculation was tested in a number of diseases, and notably in infective diseases of the lower animals. The anthrax vaccine employed for the protection of cattle and sheep is a typical example of such immunising methods, whilst in recent years analogous methods of protective inoculation have been extensively used in certain diseases of man.

The study of the microparasites associated with diphtheria and tetanus showed that organisms of this type possessed not merely infective but likewise marked toxic properties. It was further established that these toxic properties were the determining factors in the production of the graver symptoms in cases of diphtheria and tetanus. It therefore became apparent that in diseases of this order, the point of cardinal importance was to combat, if possible, the toxins produced in their course. The laboratory experiments made with the diphtheria and tetanus organisms demonstrated that the poisons were soluble products of the bacterial cells in question, and were excreted into the nutrient fluids in which they had been cultivated. These toxins were proved to be of a specific nature, as they reproduced the essential general symptoms of the diseases.

Diphtheria and tetanus are therefore intoxications of the body, due to the action of specific soluble poisons produced by the parasites at the seat of infection. The toxins, on being introduced into suitable animals in carefully regulated doses, produced an active immunisation of the animals characterised by the formation in their blood of anti-bodies as regards the toxins in question—in other words, antitoxins resulted. The antitoxic serum, when added to the toxin *in vitro*, robbed the toxin of its poisonous properties, and, probably in virtue of some chemical combination between toxin and antitoxin, a neutral mixture resulted. The serum containing these specific anti-bodies, on introduction into other animals, conferred on them a passive immunity. They were protected against the action of the toxin in question, and, most important of all, the serum was efficacious in the case of an already existing intoxication—it possessed curative as well as protective properties. If a large animal, such as a horse, was actively immunised by injection of the soluble toxins, considerable quantities of these antitoxic substances were formed and accumulated in its blood and blood-serum. In this way the serum of an animal highly charged with antitoxins became a valuable and innocuous vehicle for the introduction of these preventive and curative substances into the human system. The natural defensive forces of the body were thereby reinforced, and in the right direction. This method of serum therapeutics has had brilliant results in the case of diphtheria, and has been demonstrated to be a feasible therapeutic method in the case of tetanus. These maladies belong to the group of *intoxicative* diseases. There remained, on the other hand, a large number of diseases in which a general multiplication of the microorganisms in their host appeared to be the salient feature. It has been usual to call these, in contradistinction to the former, *infective* diseases. The successful results in the case of diphtheria led to the extensive study on similar lines of infective organisms generally. A systematic search was made for soluble bacterial poisons, as their detection would be likely to lead to valuable additions to antitoxic serum therapeutics.

The researches in this direction met with unexpected difficulties and disappointments. The results obtained in the case of diphtheria and tetanus were not found to be of general application. Each organism had therefore to be taken on its own merits, and individually studied. It speedily became apparent that, as regards a considerable number of infective agents, the conditions were not the same. On cultivation in fluid media no distinct evidence of the production of soluble poisons could be obtained, or, if present, they were so in an inappreciable amount. The attempts, therefore, to produce antitoxins by the injection of such culture fluids into animals did not promise to be of much practical value. This, as a matter of fact, has proved to be the case; the various serums prepared were found to possess little or no curative value. Many infective organisms did not apparently produce their injurious effects through the agency of soluble toxins, and consequently curative methods based on the assumption resulted in failure. Research was thrown back once more upon the living infective agents, and the possibilities there might be of protecting the body directly against their invasions, or, in other words, of producing not a poison but a bacterial immunity. Bactericidal substances were found to be present in the blood of individuals who had passed through an attack of certain infective diseases, and the bactericidal action was specific as regards the infective agent in each case. For example, the blood of a patient recovering from typhoid fever is bactericidal to the typhoid organism. In the absence of soluble immunising products, there was a strong presumption that these substances were to be sought for within the bodies of the bacteria. The bacteria in that case, if injected directly into the system, would tend to produce an active immunisation of the body, and would reinforce the bactericidal properties of the tissues in specific directions. The method most generally favoured for this purpose was the injection of killed cultures of the bacteria in question. The typical examples are the vaccines employed in cholera, plague, and typhoid fever for prophylactic purposes. The killed cultures of the several organisms are injected directly into the healthy individual in calculated doses, and the method is generally described as one of protective inoculation. In all these cases the immunising value of the vaccine appears to lie essentially in the dead bodies of the bacteria it contains. The active immunisation that occurs depends upon a solution of the dead bacteria by the blood and tissues, and a consequent liberation of any immunising substances peculiar to the cells. The properties developed by the blood of the treated individuals are antibacterial and not antitoxic, or if so only to a small degree. If one assumes that the properties of the blood in such instances are purely of a bacteriolytic character, there would be no protection necessarily afforded against any poisonous substances that might be present in the bacterial cells, and liberated from them in the process of their dissolution or in the course of the disease. Whatever the point of view, the conviction is now an established one that in a number of infective diseases it is the direct study of the specific cellular agents that will be most likely to lead to results of therapeutic value. The important conclusion has been arrived at that there are two kinds of bacterial poisons—soluble toxins, which are secreted by the bacteria, and cellular toxins, which are contained within their body substance. The toxins may be either extra- or intracellular. The diphtheria and tetanus poisons, already referred to, are examples of the first group, and are to be met with in the nutrient fluids in which the organisms are cultivated. The typhoid and plague toxins are examples of the second group, and are practically absent from the culture fluids in which the specific organisms are grown. The poisonous principles are contained within the bodies of the microbes. The dead bodies of typhoid bacilli, although destitute of all infective properties, are yet toxic when introduced into animals in virtue of the intracellular toxins they contain—the animals succumb to an intoxication.

In the case of many diseases formerly regarded as purely infective in character, it has now become apparent that, in addition to the infective, the poisonous properties of the invading bacterial cells have to be taken into account. Any therapeutic endeavours of a curative character, it appears to the writer, ought therefore to be based on the presumption that every infection implies, sooner or later, an intoxication.

The number of infective organisms in connection with which research has failed to demonstrate soluble toxins of possible clinical importance is considerable. The presumption in such cases is that the missing toxins are intracellular, and that if antitoxic principles of treatment are to be devised they must be based on a knowledge of the nature and properteis of these cellular poisons. A vital question consequently for bacteriologists at the present moment is the relation of intracellular toxins to immunity. The study of the intracellular constituents of bacteria has, it will be obvious, assumed great importance on account of the issues involved. It is interesting to note, by way of parenthesis, how generally biological research is being attracted to the direct study of the cell, and how widely it is being recognised that the processes of life, whether of a natural or a morbid character, are in their essentials of an intracellular nature. In this respect the researches of Buchner were of wide biological significance. They were suggestive of much more than a theory of a cell-free alcoholic fermentation of sugars. And in the bacteriological field the original investigations of Koch, and the preparation by him of tuberculin from the tubercle bacillus, drew general attention to the important results that might be obtained from the study of the bacterial cell and its constituents. Various methods are employed with this object in view. The killed cultures of bacteria may be used, and their physiological effects determined by injection into animals, or by chemical means extracts may be prepared from the organisms and their effects similarly tested, or mechanical methods may be adopted in order to obtain the fresh intracellular juices.

In the investigations carried out by the writer, in conjunction with Mr. Rowland, during the past four years, mechanical methods were selected as the best adapted for the general purpose in view, viz. the study of the intracellular toxins and ferments of bacteria and other cells. The first essential was the elaboration of a method to obtain the plasma of such minute cells as the bacteria. The aim was to procure the fresh cell juices and to avoid their possible modification by heat or by chemical agents. For this purpose the cells were mechanically triturated by a *cold* grinding process. The necessary cold was most conveniently obtained by the use of liquid air. It was found that the cells could be mechanically broken up when in the brittle condition produced by immersion in liquid air, without any admixture of sand or other foreign substances. A number of bacteria and other cells have been triturated in this fashion, and their fresh intracellular constituents obtained. The results in the case of the typhoid bacillus will serve to illustrate the general line of research being followed. The typhoid organisms were grown on ordinary beef broth agar, and after careful washing with distilled water were disintegrated in a mechanical contrivance at the temperature of liquid air ($-180°$ C.). The disintegrated mass was freed from insoluble suspended particles by centrifugalisation, and an opalescent fluid, representing the cell-juices of the organism, resulted. The typhoid cell-juices obtained by this method, on inoculation into animals in small doses, invariably proved toxic or fatal. It was therefore concluded that the typhoid bacillus contains within itself an intracellular toxin and that it is possible to extract it from the organism.

The typhoid cell-juices were further tested for immunising and other properties, and were administered subcutaneously to suitable animals. The experiments showed that the serum of the monkey, after injection of the typhoid cell-juices, possessed antibacterial and antitoxic properties, inasmuch as the serum protected experimental animals against the typhoid bacilli, and also against the intracellular toxin obtained from them. The serum was found to possess curative and preventive properties as regards the typhoid bacillus and the intracellular toxin extracted from the same organism. The research thus afforded proof that in the case of one species of pathogenic bacterium, the intracellular juices of the organism, when injected into a suitable animal, give rise to the production of a serum which is both bactericidal to the organism itself and antitoxic as regards a toxin contained in its substance.

The results already obtained are such as to encourage further inquiry as to the possibility of their practical application in the case of typhoid fever, as well as to determine in how far such properties of the cell-juice are shared by other pathogenic microbes. The particular method employed has proved of value in the study of a distinct class of toxins and ferments brought to light by recent research which are contained and operate within the cell and bacterium, in contradistinction to the well-known class of toxins which are extracellular, *i.e.* extruded during life from the cell to the surrounding medium. The importance attached to the intracellular group of bacterial poisons is evidenced by the increasing attention that is now being paid to their study.

ALLAN MACFADYEN.

SCIENTIFIC KITE FLYING.

SYSTEMATIC observations of the temperature and humidity of the upper air have been made for many years past, both in America and on the Continent, kites being the means employed mostly in America, and kites and balloons on the Continent.

The plan adopted is to send up a kite of some 60 to 80 square feet of lifting surface, the line used being steel music wire instead of string, additional kites being attached to the line as occasion requires. The end kite, or the line close to it, carries a self-recording instrument, and in this way observations at a height approximating to or even exceeding three miles are sometimes obtained, although it is not often that the air motion in the various strata is such as to render a height of more than 10,000 feet possible. The obstacle to be overcome is the pressure of the wind upon the line, which soon reduces the angular altitude of the kite, and it is on this account, rather than on the greater strength of steel for the same weight, that steel music wire is preferable to string, the resistance of the wire on account of its smaller section being so much less.

FIG. 1.—Rhombus kite, 7 ft. 6 in. by 6 ft. by 3 ft. 6 in.

There are few days on which a small elevation may not be reached by a kite, but days really suitable are not plentiful. It is self-evident that a suitable wind is the first requisite, and to obtain a great height a suitable wind must prevail from the lowest to the highest strata reached. We cannot, of course, alter the wind, but fortunately we are able to move the point to which the kite line is attached, and this practically comes to the same thing as altering the force of the wind. The most convenient means of doing this is to fly the kites from the deck of a steam vessel, and during last summer observations were thus obtained for seven weeks almost daily.

The work was inaugurated by a committee of the Royal Meteorological Society, cooperating with a committee appointed by the British Association.[1] They hired a small steam tug of 55 feet length and 14 feet 6 inches beam. The vessel was stationed at Crinan, which is at the north end of the Crinan Canal, on the west coast of Scotland, and, Sundays excepted, kite ascents were made from her deck every day, no matter what the weather, from July 8 to August 26. The vessel could not steam more than seven knots, and the wind velocity necessary to raise a kite is from nine to twelve knots, so that on occasions when it was a dead calm no kite could be started. It happened, however, that no day was calm throughout, so that some time during the hours of daylight the opportunity of reaching at least 1500 feet elevation was afforded. Had the tug been capable of ten instead of seven knots, I have little doubt but that a height of 5000 feet might have been attained every day.

Using one or two kites only, no difficulty was experienced. The most troublesome point was getting the kite together when the wind was strong. The tug was small, and had no bulwarks, so that there was no shelter of any kind on deck, but her smallness was certainly an advantage in another way. A larger vessel would have produced eddies in the wind, and probably have rendered it difficult to start the kite direct from the deck. As it was we had no trouble, and it was very seldom that a kite failed to rise steadily from the starting point. In calm weather the vessel was

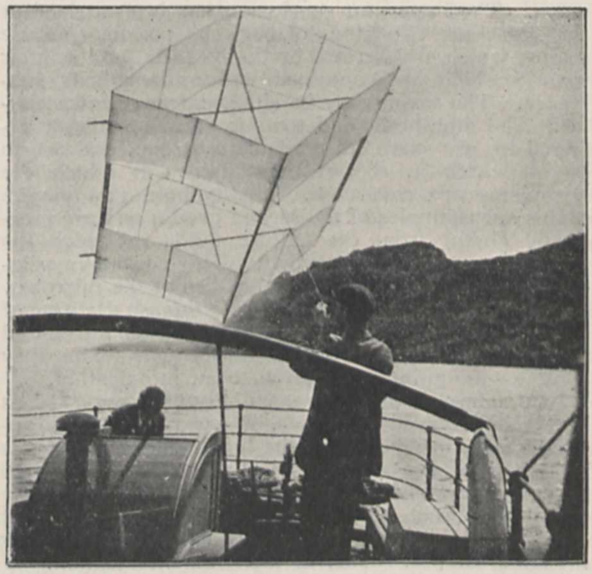


FIG. 2.—Starting a kite from the tug.

kept steaming against, or nearly against, the wind so as to produce sufficient relative motion to raise and maintain the kites. In rough weather she was taken out against the wind for some ten or twenty miles until a position was attained from which a clear run down the wind was possible, and the kite was then started. A wind of force 5 on the Beaufort scale is the most suitable wind for kite flying. This is known technically as a fresh breeze, and is sufficient to produce a moderate amount of white on the sea surface. One of the kites of the usual size for scientific kite flying will, in such a breeze, exert a pull of about 50 lbs. The wire used will bear a strain of some 300 lbs., and weighs about 16 lbs. to the mile, so that one kite in such circumstances will take nearly two miles of wire, and, if it be a good one, will raise the instruments to about 5000 or 6000 feet. The pull of 50 lbs. is well within the limits of stability of the kites, and is on the whole about the most convenient to work with, if one can be certain of the goodness of the kite. At Crinan the tug was so manœuvred that a tension of 40 lbs. for each kite on the line might be main-

[1] See paper on "The Method of Kite-flying from a Steam Vessel, and Meteorological Observations obtained thereby off the West Coast of Scotland" (*Quarterly Journal of the Royal Meteorological Society*, April).

tained, but kite flying is an art of which we were then without previous experience, and so it was well to err on the safe side. A steam vessel is extremely convenient for kite flying, as by altering either her speed or direction the strain upon the wire, provided the vessel is not already going full speed against or with the wind, can be varied with the utmost nicety.

With more than two kites difficulties often occur, owing to the fact that very different wind velocities may prevail at different heights. If the wind is greatest at the surface, adding more kites does not add appreciably to the height of the end one, since no kite can rise into a stratum in which it does not find sufficient wind. This sometimes occurred, but the more usual case was that the wind force increased too rapidly with elevation, so that if the tug were used to increase the relative surface wind to suit the lower kites, it added too much to the strength of the upper wind, and by unduly increasing the force upon the upper kites, put a dangerously high tension upon the wire. If, on the other hand, the tug were moved to suit the upper kites, the lower ones might be becalmed, and useless for lifting purposes, or perhaps even fall into the sea.

Very interesting results have been obtained from these experiments, both in America and on the Continent, but it has been felt that the conditions prevailing over the large oceans are very likely different from those over the continents. The cyclonic disturbances, on the motion of which our weather very largely depends, certainly show a preference for the sea, and it was in the hope that some light might be thrown on their mechanism, and the causes which produce them, that a locality on the west coast of Scotland was chosen for the observations. The evidence obtained from last summer's work is not sufficient to be conclusive, but so far as it goes it tends to show that as a depression approaches, the decrease of temperature with elevation becomes less than it was before. This was the case with every depression that passed while the experiments were in progress, and it leads to the conclusion that the upper air in the neighbourhood of a cyclone is relatively warm, and that the cyclones are convectional effects.

A further result of the observations shows that the temperature of Ben Nevis was in every instance below that of the free air at the same level some sixty miles to the south-west, often from 5° to 8° F. below. That the two air temperatures should have agreed was hardly expected, but the difference was very marked, and it is desirable that the experiments should be repeated in the same locality to confirm the result. The fact, however, that the summit of the mountain is so often wrapped in clouds, when the sky is clear elsewhere, tends to show that the summit must be unduly cold, and it seems likely that the effect is produced by the adiabatic cooling of the air as it is forced up the mountain slope. In fact, the cloud level on all the mountains and hills in the neighbourhood was always much below the point at which the kites entered the clouds. It is also known from the differences in the barometer on the Ben and the values computed from the Fort William readings that the temperature of the intermediate layers of air is not truly represented by the mean derived from the summit and sea-level temperatures.

England being so near the usual cyclonic tracks, observations on the upper air are of especial interest, and it is very desirable that a permanent station for the purpose should be established. It may perhaps be found that unmanned balloons too often fall into the sea to be usefully employed, but the attempt is well worth a trial, and so far as kite observations are concerned, the only difficulty is the financial one.

W. H. DINES.

A NATIONAL DIPLOMA IN AGRICULTURE.

A SO-CALLED national diploma in the science and practice of agriculture can now be obtained by any student who passes the necessary examinations. This diploma has undoubtedly a high-sounding title—it would be difficult indeed to suggest a title of greater weight—and it is therefore not surprising that the number of students entering each year for the examination is steadily increasing, and that successful students should be proud to write the important letters N.D.A. after their names. Now we greatly wish that a truly national diploma in agriculture could be obtained; that a well-ordered scheme of education and examination were authoritatively set forth; and that the skill and knowledge of the nation should be really brought to bear upon the subject. The diploma in question has no right to the title of "national." It is granted by a joint committee of two agricultural societies—the Royal Agricultural Society of England and the Highland and Agricultural Society of Scotland—it should therefore be designated "the agricultural societies' diploma." To claim for it a national importance, and thus to imply that it ranks above all other agricultural diplomas, is simply to mislead the public, and to assert a position to which it has absolutely no right. The question of continuing to grant the diploma in question has lately entered a critical stage; it may be of service, therefore, to set forth in few words the origin and character of the examinations on which it is based.

It must be reckoned as greatly to the credit of the two agricultural societies we have just named that they have been for many years engaged in promoting agricultural education by means of examinations. The Highland and Agricultural Society of Scotland was at the pains to obtain a supplementary charter in 1856 in order that it might add agricultural education to the other functions of the Society. This charter sets forth that "in order to encourage the proper education of agriculturists in Scotland" the Society is empowered to appoint a committee consisting of the professors of agriculture, anatomy, botany, chemistry, natural history, and technology in the University of Edinburgh, with sundry public officials, and seven members chosen by the Society. This committee is to appoint a board of examiners, and to grant diplomas bearing the corporate seal of the Society. The Society has acted on the powers thus given; it has conducted annual examinations in Edinburgh from 1858 to 1899, and granted diplomas according to the terms of its charter.

The Royal Agricultural Society of England possesses no such definite authority as that given to the Highland Society for the conduct of examinations or the granting of diplomas; its charter, given in 1840, merely authorises it "to take measures for the improvement of the education of those who depend upon the cultivation of the soil for their support." The Society has conducted annual examinations in England from 1868 to 1899. Up to 1897 the successful candidates received certificates, but in 1898 and 1899 diplomas were granted.

In 1897 the two societies nominated a joint board of examiners to conduct examinations in the science and practice of dairying, and annual examinations have since been regularly held both in England and Scotland. The successful candidates receive a national diploma in the science and practice of dairying.

In 1899 the two societies took a further step, and appointed a joint board of examiners to conduct examinations in the science and practice of agriculture; the examinations hitherto conducted by the separate societies then ceased. The first examination by the joint board was held in 1900, and such examinations have since been regularly continued. The examination is always held in England. The successful candidates receive a national diploma in the science and practice of agriculture.

Such, then, is the history of the diploma of which we are at present speaking. It is, of course, obvious that any society or societies may hold an examination in any subject they please, and grant certificates to successful candidates; but may such bodies, without proper authority, presume to confer a national diploma? That is the serious question before us. The charter of the Highland Society undoubtedly authorises it to confer a diploma in agriculture in Scotland, but the language of its charter, which we have already quoted, clearly limits its authority to that country. This fact is so manifest that we are now told by the agricultural Press that the Highland Society intends to apply to His Majesty's Government for an extension of its charter. The charter of the English Society contains no authority to grant diplomas.

We have already said that a national diploma in agriculture appears to us as a desirable thing, if it could be granted by national authority and awarded only to thoroughly trained men. If powers to grant such a diploma are now being sought, the terms of the charter granted many years ago to the Highland Society supply some pertinent suggestions. If the diploma is to be really national, if it is to be stamped with a national authority, the schemes of education and examination laid down must not be decided on by the members of two agricultural societies. The charter of the Highland Society names six professors of the University of Edinburgh as members of the education committee. A charter granted with a similar object now would naturally take a similar line, but it would not limit itself to the University of Edinburgh. The *ex officio* members of a national committee should clearly include professors from other British Universities, and representatives of the Government Boards of Agriculture and Education. Until such a general body is constituted and authorised to grant diplomas, it is a misuse of language to speak of a national diploma in agriculture or dairying.

We turn now to the character of the examination at present held for the award of the so-called national diploma. If the diploma granted merely professed to be an agricultural societies' diploma, it would be scarcely necessary to speak on the subject; but the claim to national rank surely implies a diploma examination of first-rate quality, and if it fails of this it certainly demands public criticism.

The diploma in question is granted solely on the result of examinations, no previous course of training being required. The examinations for the diploma embrace many branches of elementary science; half of the subjects are taken by the candidate in his first year and half in his second year. The syllabuses published of the subjects for examination are undoubtedly meagre, some of them strikingly so. This is a real disadvantage, as the teachers who are preparing students for these examinations naturally limit their instructions to the syllabus. The examinations are both written and oral, but include no laboratory work. In each subject the written examination is limited to two hours, save in the case of practical agriculture to which three hours are allotted. The candidates are generally directed to attempt every question in the paper, six to ten questions being set. The whole of the subject of practical agriculture is dealt with in one paper of three hours, followed by an oral examination. The tests applied by the examiners would thus appear to be decidedly superficial. The number of marks allotted to each subject must be supposed to indicate their relative importance in the eyes of the examining board. We find that book-keeping and agricultural chemistry receive the same number of marks, while general chemistry and veterinary science each receive half as many marks as book-keeping! It is, indeed, essential that anyone who is to practise farming should pass an examination in book-keeping, but that a knowledge of agricultural chemistry should be taken to represent no greater previous study or no greater fitness for dealing with the problems of agriculture than a mastery of the art of posting trade accounts is certainly remarkable, and surely indicates a low appreciation of agricultural science by the examining board.

We have now done. The questions we have raised demand earnest attention. The character of our whole system of agricultural education depends on the standard set by what is apparently its highest grade. The present diploma has been given a title to which it has no right, and it has failed to justify by its excellence the rank which has been sought for it.

THE INTERNATIONAL CONGRESS FOR APPLIED CHEMISTRY.

THE fifth International Congress for Applied Chemistry, which sat in the Reichstags-Gebäude of Berlin from June 2 to 8 under the masterly presidency of Dr. Otto N. Witt, professor at the Technical High School of Charlottenburg, will be remembered as a great representative meeting. The actual attendance figure was not announced, probably because many of the members who had previously secured their tickets forgot to enter their names on arrival. But the figure cannot much fall short of 2700. Preparations had originally been made for 1500 members. About 2500 had arrived by the time of the opening of the Congress, and those joining later could not be favoured with invitations to the many pleasant receptions and excursions which had been arranged. Everything possible was, however, done by the local committee, over which Dr. J. E. Holtz presided, and by the general secretaries, Dr. Pulvermacher and T. Karwath. Everybody could gain admission to the grand "Commers." The Diet had made a grant of 15,000 marks, donations had poured in from many sides, and private hospitality was practised most liberally. Chemical works, in the strict sense of the word, were not opened to members, but visits to special exhibitions, scientific institutes, and manufactories would have supplied an amply long and instructive programme even if the sectional proceedings had left members far more spare time than they did. Some sections deliberated from 9 to 1, and again from 3 to 6 and later. The ladies were excellently taken care of during the whole congress week.

Though a more suitable and dignified place for the meeting could not have been found than the magnificent palace of the Imperial Diet, the large committee rooms of which afforded ample accommodation for all the sections, a parliament building is not a laboratory, and some of the sections had to emigrate for their experimental demonstrations. Section vii., fermentation and starch, sat mostly in the Institute for Fermentation, and had an exhibition of its own in the grounds adjoining this institute. Section ix., photochemistry, was isolated—and rather neglected, too—in the Technical High School at Charlottenburg. Section x., electrochemistry and physical chemistry, found a home in the Physical Institute of the University, close to the Reichstag. Each section had its official luncheon restaurant. The plenary meetings took place in the large hall of the Reichstag.

On Tuesday evening, June 2, President Witt welcomed the members in German, French, and English. The formal opening meeting on the next morning, at which Prince Frederick Henry represented the Emperor, was addressed by Prof. Witt; Secretary of State Count Posadowsky-Wehner, on behalf of the Empire; the Prussian Minister of Education, Dr. Studt; Mayor Dr. Reicke, on behalf of the City of Berlin; representatives of the learned and technical bodies which had taken part in the organisation; and the official delegates, Dr. Tilden speaking for Great Britain. As thirty Governments had sent delegates, the representative of Switzerland, Prof. Lunge, was heard as speaker for the minor States. There was a beautiful passage in President Witt's eloquent welcome: The flames of special research burn in the many chapels, and the Congress unites all the worshippers of the one universal science. Mayor Reicke also earned warm applause. The honorary president of the Congress, the veteran chemist Prof. Clemens Winkler, was not well enough to attend. The vice-presidents were Drs. H. Böttinger, M Delbrück, C. von Martius, E. A. Merck. The honorary vice-presidents, Moissan, Meldola, Piutti, and Christomanos, were appointed by acclamation.

The second plenary meeting on Friday morning was devoted to lectures. H. Moissan demonstrated some of the properties of the alkali hydrides which he has recently prepared. Potassium hydride is a snowy mass, which has to be kept in sealed tubes, and decomposes, when heated, into potassium and hydrogen; a tube was broken under water to exemplify this. Carbonic acid gas decomposes the mass, but the decomposition does not occur in the second of two tubes joined in series, because the presence of a trace of moisture in the CO_2 is necessary, nor does it occur below $-65°$ C. The KH_2 does not conduct the electric current, not even when fused, and the hydrogen in these alloys does not behave like a metal any more than it resembles metal in its liquid state.

Sir William Crookes then gave his discourse on modern views on matter: the realisation of a dream, dealing with speculations which the mysterious radioactive emanations suggest or support, and alluding to a fatal atomic dissociation which works when we brush a piece of glass with silk, and in sunshine and raindrops, in lightning and flames; protyle the formless mist, might once more reign supreme.

J. H. van 't Hoff then explained how the phase-law of Willard Gibbs enables us to understand the formation of natural salt deposits, referring to the influence of temperature, pressure, and time; the higher the basicity of the acid and the valency of the metal, the longer can a state of supersaturation exist, and when we have dibasic acids and bivalent metals, the addition of a solid crystal of the respective salt will no longer produce the crystallisation which is instantaneous in the case of Glauber salt.

The retrospective view of the ammonia-soda process, by E. Solvay (Brussels), did not enter into any detail. In the next lecture, on auto-oxidation, Carl Engler (Karlsruhe) went in a certain measure back to Schönbein's ozone and antozone. Oxygen does not appear to combine in single atoms, but always as a whole molecule, giving an unsaturated compound which yields a peroxide; this peroxide then, by giving off half of its oxygen, forms oxides, and we may distinguish two classes of bodies in this respect. The auto-oxidators bind the oxygen to peroxide and pass half of it on to the acceptor, which itself cannot bind the atmospheric oxygen. We have thus, in the animal and vegetable kingdoms, to which these arguments particularly apply, peculiar catalytic processes. Engler made reference to a paper, read by L. Woehler (Karlsruhe), who has extracted 18 per cent. of Pt from spongy platinum by hydrochloric acid, precipitated a protohydrate from the solution, and oxidised platinum, both as foil and sponge, by heating it in oxygen; a piece of foil absorbed 1.9 per cent. of oxygen in thirty-seven days.

The last general lecture was given by G. Kraemer, of Berlin, on coal tar researches.

The concluding plenary meeting had to pass or reject the sectional resolutions which are to be presented to the permanent committee of the International Congresses for Applied Chemistry, and also to select the place for the next meeting. Most of the numerous resolutions, concerning the drawing up of analytical reports, the undesirability of characterising reagents simply as pure, the specialisation of the Trauzl test (explosions within lead chambers), the transport of explosives, a uniform method of compiling statistics of accidents, the soda test of petroleum, the prohibition of additions of starch to press yeast, and other points were approved of without discussion. The electrochemical units, recommended by Nernst, Warburg, and Strecker, on behalf of the Bunsen Gesellschaft, the Physical Society, and the Elektrotechnische Verein of Berlin, for general use in publications, were adopted by the Congress, with an amendment by A. A. Noyes (Boston) that a committee of the Bunsen Gesellschaft should cooperate with other societies in order to make the system more comprehensive. The proposals of Section xi., legal and economical questions, however, met with opposition. It was not unreasonably complained that the resolutions were not in print before the meeting, though they had been published in the daily journals—not always in their final versions, however—and the meeting declined to sanction: that the registration as trade marks of words is not to be considered illegal for the reason that those words had previously been used in a definite sense. The assembly agreed to the general prohibition of white phosphorus matches, and recommended proper care of the employés in chemical works as a moral obligation the observance of which would serve the manufacturer's own interest. The two International Commissions, for analysis (created in 1900, chairman, Prof. Lunge) and for manures and fodders (created in 1898, chairman, Dr. von Grueber, of Malmö) were reappointed. The sugar chemists wished to settle their analytical methods for themselves. A new commission is to be elected for compiling a codex alimentarius.

The remarkable skill, tact, and firmness with which President Witt guided the assembly in these discussions were again called into requisition when the place of the next meeting was to be decided. On behalf of the Italian Government, the City of Rome, and the learned societies of Italy, Prof. Paterno di Sessa invited the congress to Rome. In accordance with a resolution unanimously passed by the British members of the Congress in a special meeting, at which thirty-eight members were present, Mr. I. Levinstein, president of the Society of Chemical Industry, asked the Congress to come to London in 1906, on behalf of that society and other societies interested; Dr. Tilden, the British delegate, supported the invitation. Both Italy and Great Britain had previously offered hospitality to the Congress, Italy, it would appear, twice, England once. The question was finally decided by a regular division, after the manner of the German Reichstag, when 294 members voted for Rome and 274 for London.

The sectional proceedings were conducted on the lines of the German Naturforscher-Versammlung. The presidents of the eleven sections and four subsections were almost all Berlin men. Their names are :—(1) Analytical chemistry, G. von Knorre; (2) inorganic chemical products, A. Heinecke, director of the Berlin porcelain manufacture; (3*a*) mining and metallurgy, G. Weeren; (3*b*) explosives, W. Will; (4*a*) organic products (including tar), H. Wichelhaus; (4*b*) dyes, A. Lehne; (5) sugar, A. Herzfeld; (6) fermentation and starch, M. Delbrück; (7) agricultural chemistry, O. Kellner; (8) Hygiene, E. A. Merck; subsections (*a*) foods, K. von Buchka; (*b*) pharmacy, H. Thoms; (*c*) hygiene, M. Rubner; (9) photochemistry, A. Miethe; (10) electro- and physical chemistry, H. Böttinger (of Elberfeld); (11) legal and economical questions, C. A. von Martius. Before adjourning each day, the sections, however, nominated the president and vice-presidents for the following meeting. As a result, the time limits, twenty minutes for the reading of a paper, five minutes for each speaker, were not well adhered to. Each speaker is at once presented with a slip of paper on which he is to condense his remarks for publication in the daily journal or later in the reports. Some sections gave brief abstracts of the proceedings in the daily journals, others merely stated titles of papers and names of authors and speakers. A not inconsiderable number of the 457 reports and papers announced were not read owing to the—frequently only momentary—absence of the authors. Brief abstracts of some of the most important papers will follow.

H. Borns.

NOTES.

The annual conversazione, or ladies' soirée, of the Royal Society will be held on Friday, June 19.

Prof. J. J. Thomson has had the honorary degree of doctor of science conferred upon him by the Columbia University, New York.

Sir Oliver Lodge delivered the Romanes lecture in the Sheldonian Theatre, Oxford, on Friday last, on the subject of "Modern Views of Matter."

A general meeting of the Institution of Mining Engineers will be held in London on Thursday, July 2, and the following day in the rooms of the Geological Society.

Mr. E. T. Whittaker, of Trinity College, Cambridge, will deliver an address before the Mathematical Society of University College, London, on Thursday, June 25, at 5.30 p.m., on "Some Present Aims and Prospects of Mathematical Research."

The *Moniteur Officiel du Commerce* of Paris announces that an International Exhibition of the Industrial Appliances of Alcohol will be held at Rio de Janeiro in August.

A Reuter telegram from Cape Town states that the *Gauss* expedition has disproved the existence of Termination Island, which is marked on maps, the expedition passing over the alleged site of the island.

That the Soufrière in St. Vincent is still in a state of slight agitation is recorded by Dr. E. O. Hovey (*Sentry*, Kingstown, March 13). Outbursts issue from time to time from the centre of the lake in the crater. The most impressive changes which have taken place are in the erosion of the lately-erupted volcanic material, and he estimates that twenty-five million tons have been carried to sea from the valley of the Wallibou.

We referred last week to the demonstration of the practical working of the Marconi long-distance wireless telegraphy given by Prof. Fleming during his lecture at the Royal Institution. Prof. Fleming has written to the *Times* complaining that the experiments were made particularly difficult to carry out towards the end of the lecture as the signals were being wilfully interfered with by an outside source. Mr. Nevil Maskelyne, in a reply to Prof. Fleming's letter, admits that he was the author of the interference, which was designed to demonstrate that the Marconi Company was not justified in its claim that it had solved the question of interference. A lecture at the Royal Institution scarcely seems a suitable occasion for settling commercial or semi-scientific disputes, nor can the result of the experiment be regarded as convincing. It shows, no doubt, that it is possible for an outsider to interrupt the signalling, but then it is also possible to throw stones at telegraph wires and break them; it does not demonstrate that two different systems working legitimately side by side would interfere with one another when the ordinary precautions necessary in commercial work were being taken.

Last week telephonic communication was opened between London and Brussels. The line is particularly interesting, as the submarine portion forms the longest submarine telephone cable yet laid. The total length from St. Margaret's Bay (Dover) to La Panne, Belgium, is a little more than forty-seven miles; this is rather more than double the length of the Dover-Calais cable (twenty-three miles), which forms part of the London-Paris telephone line. The cable was made by Henley's Telegraph Works, and was laid in three sections by the *Alert* and the *Monarch*, the two joints being made at sea. The *Alert* laid 16½ miles of cable, chiefly in the shallow water off the Belgian coast, the remaining 30½ miles being laid by the *Monarch*; the cable crosses one of the Anglo-Belgian telegraph cables in deep water at about one-third of the total distance from La Panne. The length of the whole line from London to Brussels is 210 miles, made up as follows:—83 miles overhead lines in England, 80 miles overhead lines in Belgium, and 47 miles submarine cable.

The promoters of the mono-rail high speed electric railway between Liverpool and Manchester hope to be able to start the work of construction this summer. When the railway is completed, a service of trains running at 110 miles an hour will be started; this will reduce the time taken over the journey from Liverpool to Manchester from forty to twenty minutes. Those interested in the scheme regard it as being the prelude to a reorganisation of express railway service throughout the country, and believe that once the possibility of working at these high speeds has been clearly demonstrated, the railway companies will be induced to build special mono-rail tracks alongside their existing lines for express services. It is already rumoured that the Great Western Railway is considering the advisability of constructing such a track for an express service between Bristol and London. In connection with high speed traction on railways, the experiments to be carried out in Germany during the next few weeks will be watched with interest. All the leading locomotive builders and electrical firms have been invited to submit designs, and trials will be made on the lines between Hamburg, Hanover and Berlin; it is hoped to attain speeds of 90 to 100 miles an hour with safety.

Mr. A. Meek informs us that a full-grown male beluga (*Delphinapterus leucas*) came ashore at the mouth of the Tyne on June 10, and was captured by the salmon fishermen. It measured 14 feet 2 inches. The specimen has already been cut up by the purchasers, so that it was possible to see that the teeth numbered eight on each side of each jaw, or thirty-two altogether, and that there were eleven ribs on each side. The skeleton is to be presented to the Hancock Museum or to the Durham College of Science. Mr. Meek states that, so far as he is aware, an example of this species has not before been caught south of the Forth.

THE establishment of an economic tripos in the University of Cambridge will mark an important step in the movement which it is to be hoped will ultimately break down the barrier at present existing between the university man and the man of business. The proposed tripos has been warmly approved by a number of leading representatives of the railway, ship-owning, financial, mercantile, and manufacturing interests, as well as by prominent members of the Government. The tripos as proposed will consist of two parts, of which the first is to be taken in the second year, and will not qualify for a degree except in conjunction with some other examination. The syllabus of the first part includes (1) an essay paper; (2) one paper on the existing British Constitution; (3) two papers on recent economic and general history; (4) three papers on the general principles of economics. The historical part leads up to part ii., where specialisation is encouraged. In both parts questions, not all of which are optional, may be set, including quotations from French or German writers, so that a knowledge of these languages is essential. Among the careers for which the proposed tripos will afford a valuable training are those of the country squire, the politician, the business man, and the administrator of charities. It is only by the study of the principles of economics and political science treated as exact sciences, but founded upon actual facts of business life, that our country can hold its own against the competition of other countries where these principles are so studied, and can thus maintain that supremacy which it was able to obtain under entirely different conditions by rule of thumb methods and by pure speculation.

THERE was little new in the narrative of the British Antarctic Expedition given by Sir Clements Markham at a special meeting of the Royal Geographical Society on June 10. Commander Scott's short record of the voyage of the *Discovery* and work of the expedition, brought back by the relief ship *Morning* at the end of last March, and printed in NATURE of April 2 (vol. lvii. p. 516), contained the substance of what has been achieved. Some of the results of explorations were summarised in a subsequent number (p. 12). The paper read by Sir Clements Markham confirmed the information given in these two messages. The description and discussion of the scientific results are left until Commander Scott and his fellow-explorers return to this country with details of their work. In proceeding along the ice-barrier, the furthest easterly point reached was 152° 30′ W., and at this extremity extensive land, to which the name King Edward VII. land has been given, was found, rising to heights of 2000 to 3000 feet. The ice-barrier was studied from this point to Cape Crozier, and its height was found to vary from 30 to 900 feet. The winter quarters of the ship were in lat. 77° 50′ S., which is more than 500 miles further south than any ship has wintered before. Meteorological observations made in this position over a period of two years will be of great value. The most southerly point reached by a sledge journey from the ship was lat. 82° 17′ S., long. 163° E., and from it a range of mountains was seen extending as far as visible in a south by east direction. The journey during which these observations were made occupied ninety-four days, and the explorers must have travelled more than 980 statute miles. Another journey was made to the west of the ship, the farthest point reached being in lat. 77° 21′ S., long. 157° 25′ E. The horizon to the west of this point was unbroken and clear. An altitude of 9000 feet was attained at a distance of 142 miles from the ship as the crow flies. Many interesting photographs were shown at the meeting, and judging from them and the brief messages brought back by the *Morning*, the expedition will contribute much to our knowledge of the physical and biological conditions of South Polar regions.

A SHORT account of one of the sections of the International Congress of History was given in NATURE of April 30 (vol. lxvii. p. 613). A memoir by Prof. Ernest Lebon, describing a plan for an analytical bibliography of contemporary works on the history of astronomy, was among the papers presented to the congress, and has since been laid before the Paris Academy of Sciences. At the meeting of the Academy at which the memoir was received, M. Paul Appell, Dean of the Faculty of Sciences of the University of Paris, spoke in favour of Prof. Lebon's plan, and said that the bibliography would not only be valuable to scientific historians, but would also be welcomed by all astronomers. The May number of the *Bulletin de la Société astronomique de France* contains the titles of the chapters of Prof. Lebon's work, and the names of the authors of books and papers which are summarised in it.

DURING a heavy thunderstorm at Heppner, Oregon, on Sunday last, a remarkable downpour of rain occurred, producing a destructive flood, which caused the death of more than three hundred people. Heppner is situated in a gulch through which a stream runs usually only a few feet in width. On Sunday a dense cloud suddenly covered the mountain overlooking the town, and the rain which followed produced a great mass of water which rushed down the mountain and carried everything before it, the little stream being quickly converted into a deep torrent about four hundred feet wide. The flood swept a clean path more than a mile long and two blocks wide through the town.

THE daily weather report issued by the Meteorological Office on Saturday morning, June 13, showed that the area of high barometric pressure lying outside our Atlantic coasts had to some extent given place to a disturbance of a very complex character which occupied the whole of England. By about midday heavy rain set in over a great part of the country, and continued persistently, especially over the southern districts, during the following days. In the neighbourhood of the metropolis rain continued with scarcely any intermission for a period of 59 hours, and the amount measured in the week was 4·82 inches, being nearly 3 inches in excess of the average for the month. In the north of London the fall was even heavier than in the south, and amounted to about 2¼ inches in the 24 hours ending 8h. a.m. on Monday, while the temperature, owing to the continuation of northerly winds, was about 20° below the average. To find such a heavy fall of rain in June we have to go back to 1860, when an amount of 5·8 inches was measured at Greenwich, but this was spread over twenty-three days. The average rainfall for the neighbourhood of London is 1·93 inches only for the month of June. The heavy rainfall was entirely due to the lingering of the low barometric pressure to the southward.

IN the *Quarterly Journal* of the Royal Meteorological Society for April last, Mr. W. Marriott contributed an interesting paper on the earliest *telegraphic* daily meteorological reports and weather maps. The paper refers specially to reports relating to this country, although mention is made of the maps compiled in the United States by the Smithsonian Institution by means of telegraphic reports, in 1849, and some years previously, from monthly returns, by Prof. Espy. The first telegraphic weather report in this country appears to be that published by the *Daily News* on August 31, 1848. The first printed daily weather map was that issued in August, 1851, at the great exhibition in Hyde Park. The first Government daily weather report was prepared by Admiral FitzRoy, and issued to London newspapers in 1860. In January, 1871, the *Shipping and Mercantile Gazette* published daily wind charts, prepared by the Meteorological Office, and in March, 1872, that office issued its first daily weather maps. The 6h. p.m. weather maps published by the *Times*, and prepared by the Meteorological Office, commenced on April 1, 1875. As Mr. Marriott has also quoted the weather maps prepared by Mr. Glaisher from July, 1849, which do not appear to have been entirely based on telegraphic reports, we may direct attention to one or two early English investigations of a somewhat similar nature. In the report of the Meteorological Department of the Board of Trade for the year 1857, Admiral FitzRoy directed attention to the desirability of collecting synchronous weather observations, and subsequently some hundreds of synchronous charts were prepared in the office, although not published, excepting for the time of the "Royal Charter" storm (October, 1859). Mr. Francis Galton discussed the daily weather for the month of December, 1861, and some 600 maps and diagrams were published in "Meteorographica" (Macmillan, 1862). With respect to work abroad, it may not be out of place to state that between 1816–20 H. W. Brandes apparently prepared synchronous weather charts for each day of the year 1783, from the Mannheim and other observations. Although the charts were not published, the data on which they were constructed were quoted in his "Beiträge zur Witterungskunde" (Leipzig, 1820), and one of the maps (for March 6, 1783) was reconstructed and published in "Les Bases de la Météorologie dynamique," by Dr. Hildebrandsson and M. Teisserenc de Bort (Paris, 1898).

At the recent flower show held in the Temple grounds, amongst the hardy shrubs there was displayed a profusion of maples, many of which hail from Japan. An interesting article on these and other Japanese trees which commend themselves by reason of their quick growth and free flowering habit is contributed by Mr. J. H. Veitch to the last number of the *Journal* of the Royal Horticultural Society. Amongst the more technical contributions to be found in the same publication, one of considerable importance is the account of manurial experiments with vegetable crops carried out by Dr. Dyer and Mr. Shrivell.

In the absence of the director, the annual report for 1902 of the Royal Botanic Gardens, Ceylon, has been issued by the assistant director, Mr. J. B. Carruthers. During the year an estate of 500 acres was acquired with the object of turning it into an agricultural experiment station, and was placed under the charge of Mr. H. Wright. The value of a special establishment for dealing with agricultural matters of economic importance is evident, and the presence of aggravated canker amongst the cacao trees growing on the land acquired for the purpose provided an opportunity for demonstrating the scientific treatment of this disease. In the ornamental lake of the Peradeniya Gardens an artificial island was constructed of mud taken from a depth of 8 to 10 feet below the water. It is expected that an instructive object lesson in the seed dispersal of terrestrial plants will be afforded by the systematic examination of the plants which develop on this area. A first attempt to raise worms and silk cocoons in the island is recorded by Mr. E. E. Green. In spite of untoward circumstances, of which the principal was a shortage of mulberry leaves or any other efficient substitute, the few cocoons raised were quite satisfactory, and it seems probable that the industry might with advantage be taken up by the natives.

Dr. Häcker, whose investigations on the cytology of Copepods are well known, has recently (*Jen. Zeitschr. f. Naturw.* 1902) reinvestigated the question as to the permanence of the maternal and paternal chromosomes in the germ cells of the offspring. The result has been not only to show that the parental chromosomes remain distinct in the nuclei of the germ tract of the young organisms, but that the processes associated with the "reduction-divisions" may prove to be even more complicated than had previously been supposed. It appears that in the early prophase of the heterotype mitosis, tetrads are formed in numbers equal to those of the *somatic* chromosomes. These are divided, during the first polar mitosis, by an "equal" division, twelve dyads travelling to the respective poles. These the dyads fuse longitudinally in pairs, thus giving rise to the reduced number (6) of chromosomes. The next mitosis divides these in such a way that the collaterally fused pairs are transversely split, and thus a true qualitative "reduction division" is brought about. It would thus appear that the first of the two divisions effects the mingling of the parental chromosomes, whilst the second ensures a qualitative distribution of those originating from the *penultimate* (grandparent) generation. This occurs in such a way that each of the six chromosomes ultimately passing to the daughter-nuclei consists of halves contributed by two different grandparents.

We have received the report (Aarsberetning) of the Bergen Museum for 1902.

No. xi. of the *Sitzungsberichte* of the Vienna Academy for the current year contains a *résumé* of the results of Dr. F. Steindachner's recent expedition to Brazil.

The "dragonets" (Callionymidæ) and allied fishes of Japan are described by Messrs. Jordan and Fowler in No. 1305 of the *Proceedings* of the U.S. Nat. Museum, several new forms being recorded.

Among the contents of the June number of the *Entomologist* we find a paper on the parasitic Hymenoptera and Tenthredinidæ collected by Mr. Whymper in the Andes of Ecuador, and a continuation of Miss Sharpe's list of butterflies from British East Africa.

The *Proceedings* of the South London Entomological and Natural History Society for 1902 is illustrated by two plates, devoted to the life-history of the crustacean *Argulus foliaceus*, which lives parasitically on sticklebacks. The council reports that the affairs of the Society continue to prosper, the number of members again showing a slight increase.

A revision of the American moths of the family Gelechiidæ, with descriptions of new species, by Mr. A. Busck, of the Department of Agriculture, appears in vol. xxv. (No. 1304) of the *Proceedings* of the U.S. Nat. Museum. No. 52 of the *Bulletin* of the U.S. Nat. Museum, comprising 723 pp., is devoted to a list of North American Lepidoptera, which will doubtless prove of great value to entomologists.

In their thirty-first annual report (for 1902) the directors of the Zoological Society of Philadelphia record a general satisfactory progress on the part of that institution. With the exception of a slight diminution, probably due to unfavourable weather, during three months, the number of admissions to the gardens shows a steady increase throughout the year. A number of species of animals have been exhibited for the first time in the menagerie during the year.

"SAWDUST AND FISH LIFE" is the title of an article in a recent issue of the *Transactions* of the Canadian Institute. From the result of experiments in aquariums, the author, Dr. A. P. Knight, gives reasons for the belief that the sawdust thrown in large quantities into the Canadian rivers is very harmful to fish; but from actual observations in the rivers themselves, it does not appear that the destruction is as great as might have been expected.

WE have received a copy of an "Outline of Special Course in Natural History for Training Colleges and King's Students," just issued by the Marischal College, Aberdeen. It contains outlines for demonstrations on classification, the adaptation of animals to their surroundings, and examples of the leading types of animal life, concluding with suggestions for seasonal studies in natural history. Although the illustrations are somewhat crude, the pamphlet seems well adapted to its purpose.

THE Liverpool Marine Biology Committee is to be congratulated on the issue of the tenth fasciculus of the well-known "L.M.B.C. Memoirs," this part, of which Prof. J. R. A. Davis and Mr. H. J. Fleure are the joint editors, being devoted to the common limpet (Patella). The mode of treatment of the subject follows the line of the earlier issues, and the illustrations are numerous. The authors believe that, although limpets are rightly included among the lower gastropods, yet that they form an isolated type, which has been specialised in connection with their adoption of the habit of adhering to exposed surfaces, and making limited excursions for the purpose of feeding.

THE report on the examination of food, drugs and public water supplies reviewing the work of the Laboratory of Hygiene of the State of New Jersey, U.S.A., has reached us. It deals especially with the analytical methods employed in testing foods and drugs; these are detailed, and should be of considerable service to public analysts in this country.

WE have received the "Year Book" of the Livingstone College. The College trains missionaries in the elements of medicine and hygiene, the curriculum extending over a period of nine months. During this time the students are systematically trained in the elements of anatomy and in hygiene, nursing, cooking, &c., suitable to tropical climates, as well as in the prevention and treatment of the ailments they are likely to meet.

A COPY of the report of the Medical Officer of Health for the City of London for 1902 has been received. It contains an account of the procedures adopted by the Corporation of London for the sanitary protection of its citizens, some of which have already been noticed in these columns, *e.g.* the prohibition of spitting, and condemnation of typhoid-contaminated shell-fish. A point of interest is that, though the *day* population of the City probably exceeds 359,000, only 339 births were registered during 1902.

THE geology of the country near Leicester is the title of a memoir, by Mr. C. Fox-Strangways, lately issued by the Geological Survey. It is accompanied by a colour-printed map of the area, which includes Mount Sorrel and Leicester on the west, and parts of Rutlandshire on the east. Excepting for the granite quarries at Mount Sorrel, numerous brick-yards, sand and gravel pits, and occasional lime-works, the country is essentially one of meadow and pasture, and a famous hunting ground, the subsoil being for the most part clay—Boulder-clay, Lias-clay, Keuper Marl, and Alluvium. As most of the area is drift-covered, this new map differs very largely from the old series geological survey map, on which only the "solid" geology was depicted. In addition this new map has alongside it a colour-printed section which gives an excellent and instructive view of the structure of the ground. In the memoir Mr. Strangways gives full particulars of the strata, a catalogue of the fossils from the Trias and Lias of Leicestershire and Rutland, and numerous records of borings and well-sections. A photographic plate shows the weathered crags of granite at Mount Sorrel, grooved by the erosive power of wind-drifted sand in Triassic times, as pointed out by Prof. Watts. The price of the memoir is 3*s.*, and of the map 1*s.* 6*d.*

A "Subject List of Works on Architecture and Building Construction, in the Library of the Patent Office," has been published in the Patent Office library series. The subject list consists of two parts, viz. a general alphabet of subject headings, with entries in chronological order of the works arranged under these headings; and a key or summary of these headings shown in class order. Copies of the publication can be obtained at the Patent Office, Chancery Lane, W.C., price sixpence.

A SECOND revised edition of the "Smithsonian Physical Tables," prepared by Prof. Thomas Gray, has been published by the Smithsonian Institution. This edition differs from that issued in 1897 in a few particulars only, the chief alteration being that the table of electrochemical equivalents now contains columns showing atomic weights with O=16 and H=1 based upon the report of the International Committee on Atomic Weights. The table giving values of the density and volume of water between −10° C. and 100° C. needs revision, the volumes from 46° to 100° being obviously wrong in the second decimal place. This, however, is a small point, and can be easily corrected by anyone using the tables. By issuing works of this kind, which are very valuable to teachers and investigators, but for which the demand is necessarily limited, the Smithsonian Institution is doing great service to science.

THE first number of the "Year Book" of the Carnegie Institution of Washington contains detailed information of what has already been accomplished for the encouragement of scientific research as the result of the munificence of Mr. Carnegie. Upwards of 38,000*l.* has been voted to assist a number of men of science in their investigations, but the fund, large as it is, has proved inadequate to meet all the requests for aid received by the trustees. As a consequence it has been found necessary to limit the activities of the institution—ground already occupied will be avoided, the systematic education of students will not be undertaken, and sites and buildings for other institutions will not be provided. It is to be understood, the "Year Book" states, that apparatus and materials purchased to assist investigators are to be regarded as the property of the Carnegie Institution. The persons assisted are expected to report upon the methods followed and the results obtained, and to state in the published results that aid was received from the Institution. Appropriations are to be made from time to time for the printing of papers of acknowledged importance To secure the counsel of experts, special advisers have been, and will be, invited from time to time for consultation. The first appendix, which runs to 238 pages of the "Year Book," consists of reports of eighteen advisory committees on the chief branches of scientific knowledge. Another appendix deals with the proposed explorations and investigations on a large scale, and is contributed to by several well-known American men of science.

A STRIKING illustration of the enormous advance that has taken place in chemical manipulation during the past two or three years is afforded by a paper, in a recent number of the *Berichte*, on the "Evaporation and Boiling of Metals in Quartz-glass and in the Electric Furnace in the Vacuum of the Kathode-light." Dr. F. Krafft there states that the quartz tubes could be safely heated to 1200°, and with care up to 1400° C., even when exhausted to the low pressure required for the production of the kathode-light in a vacuum tube, and that even when containing metals they could be safely taken from the furnace at 1200°, allowed to cool in the air without annealing, and then replaced in the furnace without any risk of fracture. By using an electric furnace it was possible not only to regulate the temperature within 2° or 3° between 18° and 1400° C., but also to connect the quartz tubes to the pump by means of a ground-glass joint made tight with wax, the wax remaining unmelted although within a few inches of the hottest part of the furnace.

THE results achieved by the methods described in the foregoing note were remarkable. The only vapour in the quartz tube was that of the metal, which extended from the surface of the liquid to the top of the furnace, above which condensation took place. Under this almost inconceivably low pressure cadmium boiled at 420°, *i.e.* below the boiling point of sulphur, zinc at 545°, and bismuth below 1000°, the temperature of the furnace being about 150° above that of the boiling metal. Lead could be rapidly distilled with a furnace temperature of 1180°, and antimony at 775–780°. Silver began to evaporate fairly rapidly at 1200°, but did not boil at 1340°; copper showed a distinct, though slight, evaporation at 1315°, but gold, even at 1375°, the highest temperature reached in the experiments, gave only a small mirror of silver, and below it a tiny distillate of gold weighing less than 2 mg. It is of interest to note that the boiling points in an absolute vacuum of these metals, which probably lie at about 1400°, 1600°, and 1800° respectively, are in the order of increasing valency, and not in the order of their atomic weights.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*), a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. C. S. Birch; a Two-spotted Paradoxure (*Nandinia binotata*), two Senegal Touracous (*Turacus persa*) from West Africa, presented by Mr. James Drew; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by the Hon. Sibyl Edwards; a Patagonian Cavy (*Dolichotis patachonica*) from Patagonia, presented by Sir E. G. Loder; a Common Quail (*Coturnix communis*), British, presented by Mr. J. Woodward; an Adanson's Sternothere (*Sternothoerus adansoni*) from West Africa, a Pale Lizard (*Agama pallida*), an Egyptian Eryx (*Eryx jaculus*), a Blunt-nosed Snake (*Tarbophis obtusus*), a Schokari Sand Snake (*Psammophis schokari*), a Diademed Sand Snake (*Lytohynchus diadema*) from North Africa, presented by Captain Stanley Flower; a Stair's Monkey (*Cercopithecus stairsi*) from British East Africa, a Green Monkey (*Cercopithecus callitrichus*), an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Black-headed Lemur (*Lemur brunneus*), a Grey Lemur (*Hapalemur griseus*) from Madagascar, five Grey Monitors (*Varanus griseus*), five Spiny-tailed Mastigures (*Uromastix acanthinurus*), eight Ocellated Sand Skinks, a Corais Snake (*Coluber corais*) from South America, a King Snake (*Coronella getula*), a Mocassin Snake (*Tropidonotus fasciatus*) from North America, a Carpet Python (*Python variegata*) from Queensland, a Rhesus Monkey (*Macacus rhesus*, var.), two Indian Rat Snakes (*Zamenis mucosa*) from India, deposited; a Burrhel Wild Sheep (*Ovis burrhel*), an Axis Deer (*Cervus axis*), born in the Gardens.

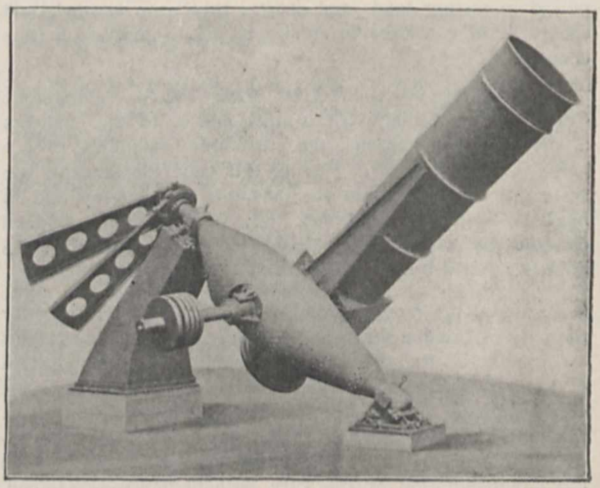
OUR ASTRONOMICAL COLUMN.

CONNECTION BETWEEN SUN-SPOTS AND ATMOSPHERIC TEMPERATURE.—M. Charles Nordmann has recently completed a discussion of the effect of sun-spots on the mean annual temperature of the earth's atmosphere in tropical regions. The period under discussion extends from 1870 to 1900, and the method of discussion is analogous to that published by Köppen in 1873, which dealt with the period 1830 to 1870.

M. Nordmann has compared the mean annual variations of temperature from the normal, as obtained from the observations made at thirteen tropical stations situated in various longitudes, with Wolf's numbers for sun-spot frequencies during the same period, and from the two curves obtained by plotting the two sets of numbers he has arrived at the following conclusion:—"The mean terrestrial temperature follows a period sensibly equal to that of solar spots; the effect of spots is to diminish the mean temperature, *i.e.* the curve which represents the variations of temperature is parallel to the inverse curve of sun-spot frequencies (*Comptes rendus*, No. 18).

THE CROSSLEY REFLECTOR OF THE LICK OBSERVATORY.—This reflector, it will be remembered, was presented to the Lick Observatory by Mr. Crossley, of Halifax, Yorks, and contains one of the splendid mirrors made by the late Dr. Common. It has an aperture of 3 feet, and a focal length of 17 feet 6 inches. When remounted and used at Lick it was found that the instrument was unsuitable for long exposures on account of flexure and other defects, therefore a new mounting has been devised and constructed by Messrs. Harron, Rickard and McCune, of San Francisco, and is found to work satisfactorily.

The polar axis is 14 feet long, and is so raised as to allow the instrument to be used in all positions. As shown in the accompanying illustration, this axis rests on two piers, the northern one consisting of an inclined steel



pillar, 8 feet high, resting on a concrete and brick foundation which is 6 feet high, whilst the bearing for the southern end, carrying the altitude and azimuth adjustments, rests directly on the brick and concrete foundation, the downward thrust being borne by hardened steel balls. The telescope tube is carried by the strong steel declination axis, and the mirror is contained by a cast-iron cell in the lower cylindrical section of the steel tube, whilst the photographic plate holder, with the usual adjustments, is placed at the focus of the mirror and in the optical axis of the same.

The driving motion of the clock is transmitted to the telescope by two sectors, one of which is being run back ready to be put into gear again whilst the other is being used; each sector allows of one hour's exposure being made. The "following" is performed by means of an auxiliary telescope rigidly attached to the plate holder (*Scientific American*, May 16).

THE RELATIONSHIPS BETWEEN ARC AND SPARK SPECTRA.—In No. 4, vol. xvii. of the *Astrophysical Journal* there appears an advance translation, by the author, of a paper on the above subject recently communicated to the K. Akademie der Wiss. zu Berlin by Prof. J. Hartmann.

In his experiments on the arc spectrum of magnesium, using metallic poles, he found that the line at λ 4481, which is generally regarded as essentially a "spark" line, appears in the arc spectrum, and actually increases in intensity as the current strength becomes *less*: this is plainly shown in a table which accompanies the paper. From this and similar results the author arrives at the conclusion that the *higher* temperature of the spark, as compared with that of the arc, is open to question.

Further experiments showed that a high voltage was not necessary for the production of "spark" lines in the arc, for when a current of 20 volts and 4 amperes was used the line 4481 was about thirty times more intense than when 120 volts and 4 amperes were used.

Prof. Hartmann arrives at the conclusion that the energy of the electric discharge and of the chemical changes may play a more important part in the production of "spark" lines than temperature does, and in his experiments, in which the arc was formed in an atmosphere of hydrogen, he has shown that the dielectric is also an important factor in determining the nature of the spectrum obtained.

RADIO-ACTIVE PROCESSES.[1]

THERE are three distinct types of radiation spontaneously emitted from radio-active bodies, which may be called the α, β, and γ rays. The α-rays are prominent in causing the conductivity of a gas, they are easily absorbed by metals, and are projected bodies, not waves. These bodies are about the size of a hydrogen atom, they are positively charged, and travel with about one-tenth of the velocity of light. The β-rays are similar in all respects to the kathode rays produced in a vacuum-tube. The γ-rays are probably like Röntgen rays, but of very great penetrating power. The α-rays are by far the most important. In addition to these rays two of the radio-elements give off radio-active "emanations," which are in all respects like gases. The radiations from these emanations are not permanent, but fall off in a geometrical progression with the time. The radiation of the thorium emanation falls to half value in one minute, that from radium in four days. They have all the properties of gaseous matter in infinitesimal quantity. Their coefficients of diffusion can be measured, the order of their molecular weights is 100, they are occluded by solid compounds producing them, and may be condensed at low temperatures. The radium emanation condenses sharply at $-150°$ C., the thorium emanation between $-120°$ C. and $-150°$ C. The two emanations excite on objects with which they come in contact two kinds of temporary radio-activity, that from the radium emanation decaying much faster than that from the thorium emanation. The latter decays in a G.P. with the time falling to half value in eleven hours. These effects appear to be produced by solid matter in invisible and unweighable quantity, which can be dissolved off in some acids but not in others. On evaporating the solutions, the radio-activity is obtained unchanged in the residue. The experiments of Crookes and Becquerel in separating by chemical treatment the matter responsible for the activity of uranium, called uranium X, were referred to, together with the latter's observation that the separated activity had completely decayed after the lapse of a year, by which time the uranium itself had completely recovered its activity. The work of Rutherford and Soddy on thorium was then discussed in detail. Thorium precipitated in solution by ammonia retains only 25 per cent. of its activity. If the solution is evaporated and ignited the remaining 75 per cent. is found in the extremely small residue left, which by reason of its separation is different chemically from thorium, and was called thorium X. Left to themselves, the thorium gradually recovers its activity, and the ThX loses it. The activity of the latter falls in a G.P. with the time, the half value being reached after four days. At any time the sum total of the two activities is a constant. This would occur if the ThX were being continually produced by the thorium, and this was shown to be the case by precipitating thorium at definite intervals after its separation from ThX. The ThX, and not thorium, produces the thorium emanation. The production of ThX by thorium, of the emanation by ThX, and of the matter causing the excited activity by the emanation, are all changes of the same type, although the rates of change are distinct in each case. The change of uranium into uranium X is also similar, being the slowest of all. Twenty-two days elapse before uranium freed from ThX recovers one-half of its activity. In radium the radium emanation is the first product produced, and since this in a solid is almost completely occluded, the activity of a radium salt after it has been obtained from its solution rises after precipitation to several times its original value, due to the occlusion of the emanation. In all three radio-elements a part of the radio-activity is non-separable, and this part consists only of α-rays. The β-rays only result at the last stages of the process that can be experimentally traced. In all cases the radiation, from any type of active matter, is a measure of the amount of the next type produced. Thus the radio-activity of ThX at any period throughout its life is always a measure of the amount of emanation it produces. These results find their explanation if it is supposed that the α-particles projected form integral portions of the atom of the radio-active element. Thus ThX is thorium minus one or more projected α-particles. The emanation similarly is ThX less a further α-particle, and so on. The non-separable activity is due to the atoms of the original radio-element disintegrating at a constant rate. The whole of the processes take place unaltered in velocity, apparently under all conditions of temperature, state of aggregation, and chemical combination. This is to be expected of a subatomic change in which one system only is involved at each change. On this view the spontaneous heat-emission of solid radium salts, discovered by Curie, is explained by the internal bombardment by the α-particles shot off and absorbed in the mass of the substance. The amount of energy given out in these sub-atomic changes is enormous, and from Curie's experiments it can be deduced that each gram of radium gives out 10^9 gram-calories during its life, which is sufficient to raise 500 tons a mile high. It seems probable that the internal energy of atoms in general is of a similar high order of magnitude.

[1] Abstract of paper read before the Physical Society on June 5, by Prof. E. Rutherford, F.R.S.

SOME UNSOLVED PROBLEMS IN ENGINEERING.[1]

THE present lecture is devoted to the indication of some of the directions in which the further aid of the physicist is more immediately required by the engineer, while it is hoped that in future lectures each branch of inquiry thus pointed out will be dealt with in detail by someone who has made that particular subject his special study.

In view of the great interests—monetary and otherwise—involved, it appears to me that the whole question of steam-jacketing, and particularly the application of such jackets to compound or multiple-expansion engines of modern types and of large power, using steam at high pressures, deserves a much more thorough and systematic investigation than it has hitherto received.

The action of steam-jackets is, however, only one of several important problems relating to steam-engine economy at present remaining unsolved. Another is the

[1] Abridged from the eleventh "James Forrest" lecture delivered by Mr. W. H. Maw to an Engineering Conference on June 16, at the Institution of Civil Engineers.

economic effect of interheaters, through which the steam is passed on its way from one cylinder to another, of a compound or triple-expansion engine. During the past half-century, numerous types of interheaters have been designed and applied more or less spasmodically; while, in recent years, the use of such appliances has become a prominent feature in certain branches of American practice. The data on which the use of such heaters is founded, however, are far from being of a satisfying character, and they present discrepancies which certainly require clearing up.

What is really required is accurate information as to the extent to which our most advanced steam-engine practice can—especially in the case of large power units—be improved by the use of superheated steam, and as to the manner in which such improvement can best be realised. In connection with this matter, I may point out that we are much in want of a thorough determination of the physical properties of superheated steam, extending over the range of temperatures and pressures likely to be employed in practice. Such a determination may, I hope, soon be undertaken. Equally desirable also is the thorough investigation of the action of steam—both saturated and superheated—in the various types of turbine motors, a matter which has, as yet, been by no means dealt with so exhaustively as its great, and rapidly growing, practical importance deserves, and respecting which many lessons undoubtedly remain to be learnt.

In addition to the various points already mentioned, the question of the economy to be secured by the use of still higher pressures of steam than are now used requires investigation. We are without any direct determination of the latent heat, volume, and temperature corresponding to pressure in the case of steam of pressures exceeding 350 lbs. per square inch. The published data relating to steam of higher pressures have been obtained by extrapolation, and are by no means strictly to be relied upon.

The thorough investigation of the theory and practical working of internal-combustion engines presents for solution problems at once so numerous and so varied as to tax to the utmost the skill and ingenuity of the experimenter. There appears to be good ground for believing that with an increase of temperature there is a very substantial increase in the specific heats of such gases. While, however, the general fact may be regarded as proved, the numerical data necessary to enable that conclusion to be turned to practical account are far from having been fixed with certainty, and further determinations are greatly wanted.

The value of experiments on internal-combustion engines depends in a most important degree upon the accuracy with which variations of temperature can be observed, both in the cylinder before and during explosion, and in the walls of the chamber in which the explosion occurs. As Prof. Callendar has pointed out, the temperature assumed by the platinum wire of an electric resistance thermometer exposed to such gases must necessarily be less than that of the gases themselves. Moreover, the rate at which heat is communicated from the gases to the wire is dependent not only upon the difference of temperature, but also on the pressure, in a way not yet accurately known; and thus the accurate determination of the results of explosions in internal-combustion engines means not merely the skilful use of known appliances, but the determination of certain physical constants involving much expenditure of time and labour. Then, again, the effect of the injection of water or water-vapour into the cylinder in itself offers much scope for investigation, as does also the influence of the quality and quantity of the lubricating oils on the gaseous mixture. The governing of internal-combustion engines and the regulation of the powers developed by them at various speeds and under varying conditions are also matters which present many unsolved problems.

In the case of large bridges, roofs, and structural work of that class, there is ample scope for aid to be given by the better determination of the amount and effect of wind-pressure—a branch of experimental inquiry which is at present far from being in a satisfactory state. What is greatly required is a thorough investigation of the action of the wind on surfaces of different areas and shapes, and particularly its effect on partially shielded areas. Amongst other points requiring settlement is the action of wind on the lee-side of roofs—a matter on which the experiments of Irminger have thrown much light, but which still requires further investigation.

In the determination of the stresses induced in the elements of a structure by the forces applied to that structure, there still remain many problems of importance imperfectly solved. The theory of the plate-web girder, for instance, is in a far from satisfactory state, particularly as regards the action of web stiffeners, the stresses on the web itself, and those on the connections between the web and the flanges. The whole subject of resistance to compound stresses—such, for instance, as those existing in the web of a plate girder or a flat stayed plate, forming part of a steam boiler—is one urgently requiring further experimental investigation.

Then, again, we are now largely using hollow shafts for marine and other purposes, and the relation of these to solid shafts of the same nominal strength, as regards the power of resisting repetitions of varying or alternating stress, has not yet been systematically investigated. Another point is the effect of oil-tempering and different modes of annealing on the endurance of fatigue, a matter which, in view of the effect of similar treatments on the ultimate strength and limit of elasticity of steel, is one of much importance.

The great problem we have still to face—and it is a problem which will tax to the utmost our powers of research—is the determination of what the change which we call elastic fatigue really is. The indications of ordinary testing machines do not reveal any change in the behaviour of a material which has certainly exhausted a large proportion of its "life" under repeated applications of stress, and we must evidently, to solve the problem, have recourse to other modes of inquiry. What is the change of structure produced by fatigue, and in the case of any but pure metals is this change accompanied by any rearrangement of the constituents? How is this change of structure affected by variations of treatments, by annealing, or, in the case of steel, by tempering?

It is sometimes of considerable importance to ascertain whether a certain object, as, for instance, a propeller shaft, or a portion of a bridge structure, or a steel rail, has or has not been injured by the repeated applications of stress to which it has been subjected; and at present the only method of determining this is the testing to destruction of the object respecting which the information is desired. But if we knew accurately in what part of the object the stresses to which it had been subjected would first cause injury, and if we further knew in what way the existence of such injury would be indicated by change of structure, it would follow that the microscopic examination of a small portion, cut from the most sensitive part of the object, would afford a valuable indication of what was going on.

There are other questions which appeal directly to the users of steel. Amongst such questions are the oil-tempering of mild steel forgings and of steel castings; the investigation of the treatment during manufacture and hardening of spring steel; the examination of the qualities of special steel alloys, suitable for the construction of engine or machine details, in which exceptional strength and lightness are essential; and the production of alloys capable of resisting corrosion and withstanding great changes of temperature, and thus specially suitable for the construction of superheaters and other apparatus in which such changes occur.

We have in new steels a series of materials which promise to revolutionise a very important percentage of our machine work, and to necessitate very material alterations in the proportions of our machine tools, involving very heavy outlay, if we wish to advance with the times. Now these are facts pointing to the necessity for extensive research conducted in a thoroughly systematic way.

I have endeavoured to show how desirable it is that the engineer and the physicist should work together in dealing with certain investigations which I have enumerated, and I have done so because, although engineers generally now fully appreciate the aid which physical science can afford, there has not hitherto been such an intimate association of the two classes of workers as is really desirable. But with electrical engineering the case is quite different. We are accustomed to speak of the extraordinarily rapid development of electrical engineering, and the marvellous way in which it is assuming such a paramount position in civilised life, but I do not remember ever hearing this wonderful growth attributed to what I believe to be its real cause, namely, that from the moment that the practical application of electricity became one of the branches of our profession, engineers and physicists have worked closely hand in hand to overcome its difficulties, and to elucidate the questions to which it gives rise. The growth of electrical engineering thus constitutes a great object-lesson, sufficient in itself abundantly to emphasise the fact that the future progress of engineering is indissolubly bound up with the progress of physical research.

THE SOUTH AFRICAN ASSOCIATION.

REVIEWING the brief history of the events which culminated in the first annual meeting of the South African Association for the Advancement of Science, the early proceedings of which were described in our issue for May 21, Sir David Gill, the president, announced some of the facilities which had been offered to induce the British Association to visit South Africa in 1905. The president read a letter he had received from Sir Gordon Sprigg, the Prime Minister of Cape Colony, stating that free railway passes will be granted over the Cape Railway system for all officials of the British Association, and a limited number of invited guests; and that a sum not exceeding 6000*l.* will be guaranteed towards the cost of passages to and from the Cape for the above-mentioned officials and visitors. This amount will be shared by the Governments of the Transvaal, Natal and the Cape. Sir David Gill went on to say that the other Governments had undertaken to share one-half of this responsibility, and to grant similar free use of their railways. There will be no lack of private hospitality, and the council of the British Association will recommend to the general committee of the Association at the Southport meeting next September that the invitation to hold the annual meeting in 1905 in South Africa be accepted.

Reference was also made to the value of a closer alliance between the results of scientific research and everyday practice in commercial pursuits, the classical works of several of the earlier investigators being mentioned as examples of the far-reaching effects of thorough and precise researches into common everyday phenomena. Sir David Gill then proceeded to enlarge upon the practical value of scientific research, and the reasons for its encouragement in the universities and colleges, and mentioned the unselfish work of Profs. Beattie and Morrison in undertaking the magnetic survey of South Africa, during 1897 and subsequent years, entirely at their own cost. He strongly urged that facilities should now be granted to them for completing this most important work, which fills a gap in the observations that are now being carried out in various parts of the world simultaneously with those being made by the various Antarctic expeditions in the South Polar regions.

Two papers read before Section A of the South African Association contained interesting statistics as to different aspects of the mining industries of the new colonies. In a paper on "Nitro-Glycerine Explosives: their Influence on Industrial Development," Mr. William Cullen, of the Modderfontein Dynamite Factory, stated that by means of explosives alone above 12,000,000 tons of ore had been milled in the Transvaal in the year prior to the war, but no estimate could be formed of the many million additional tons removed in developing shaft-sinking and so on. The old dynamite is rapidly becoming a thing of the past, and the more modern blasting gelatin has gradually supplanted everything else. Perhaps the most interesting part of the paper was that where the final triumph of nitro-glycerine in cordite and many similar powders was demonstrated, proving it to be not only the strongest disruptive agent, but also the mildest and easiest managed impellent.

Mr. W. A. Caldecott, in a paper on the "Cyanide Process from its Introduction into the Rand to the Present Day," said the immense importance of the process was shown by the fact that just before the war half the gold from the Rand was obtained by the cyanide process. By way of comparison, the writer stated that the Rand gold output in 1890 was 494,523 ounces milled, and only 286 ounces obtained by cyanide process. In three years the proportion grew to 1,147,960 ounces milled, and 330,510 ounces by cyanidation.

The records of meteorological observations made at the dynamite factory of Modderfontein, which extend over a large number of years, and form probably the most complete Transvaal meteorological record available, were discussed by Mr. William Cullen in Section A. Rainfall, barometric pressure, temperature (maximum, minimum and average), atmospheric moisture, wind velocity and wind direction were some of the meteorological data passed in review. All were illustrated by diagrams. The rainfall for the various years was analysed, and it was pointed out where a departure from the normal had great influence on the agricultural interests of the Transvaal, and on the prevalence of cattle diseases. The average rainfall for the past five years was 25 inches, the highest being 30·6, and the lowest 20·1, and the observations seemed to show that it was on the increase. The barometric readings showed a very slight variation all through the year, the maximum difference of about 14 generally coming in June, but every twenty-four hours the maximum and the minimum records always occurred at the same time.

Prof. S. Schönland, in a paper to Section B on stone implements in the Albany Museum, emphasised the persistence of the Palæolithic age in South Africa as compared with other countries. While, he said, the manufacturers of stone implements in South Africa were not devoid of skill which must excite our admiration, while their arrowheads of perforated stone, their rolling-pins, their stone rings, indicated that there was not only skill, but an inheritance of trade tricks handed down from generation to generation, which were faithfully adhered to by the masters of the craft, it was astonishing that so far it had been impossible to find any evidence of progress in the manufacture of stone implements in South Africa, such as we knew had taken place in other countries from Palæolithic times to the time when stone implements were given up. Generally speaking, it could be seen that not only had the Stone age persisted in South Africa until comparatively recent times, but that the Palæolithic age had persisted there to the same extent. This was especially shown in the entire absence of polished stone implements.

Dr. J. D. F. Gilchrist dealt in the same section with the development of some South African fishes. It has been commonly alleged that the practice of netting, as carried on in the Zwartkops, the Buffalo, and other tidal rivers of South Africa, has proved destructive to the eggs and spawn of fish. On the commencement of trawling by the Government steamer in False Bay and on the Agulhas Bank, it was urged that the dragging of the net along the bottom of the sea caused the destruction of great quantities of the eggs and young of food fishes. The evidence obtained by an inquiry held by a Parliamentary Commission seems to indicate that many of the common fishes may deposit their eggs on the bottom of the sea. On the other hand, in all the instances where the mature eggs had been procured and successfully fertilised on the Government steamer *Pieter Faure*, they were found to float on the surface of the water, and only after the larvæ had been hatched out some time did they begin to sink to the bottom. It was also brought to the notice of the Commission that it had already been demonstrated in northern waters that there was only one fish of practical economic importance depositing its eggs on the bottom—the herring—and only a small species of herring of little value to the present fishermen occurs in the Cape seas. Recently facilities have been afforded by Government for more careful examination on shore of the eggs and larvæ procured by means of fine nets and from the mature fish. The eggs and larvæ were described of the white stumpnose, red stumpnose, silver fish, sand fish, zeverrim or zee-basje, kabeljaauw, horse fish, red gurnard, klip-fish (two species), sole (two species), and the blaasop, and the ova and larvæ of fish as yet unknown. The general effect of the investigations so far carried out was to confirm that the trawling did not interfere with the eggs of fishes that were of practical commercial value.

At a concluding general meeting of the Association on the last day of the proceedings, the council of the Association for the present year was elected in accordance with nominations received from the chief centres in Cape Colony, Rhodesia, Transvaal, Natal, and Orange River Colony.

At a subsequent meeting of the newly-formed council, Sir Charles Metcalfe was unanimously elected president for the ensuing year and the 1904 meeting to be held at Johannesburg.

The following officers were also elected:—vice-presidents, Mr. Sidney J. Jennings, Dr. Muir, Mr. Gardner F. Williams, and Mr. J. Fletcher (Natal); hon. secretaries, Dr. Gilchrist (Cape Town), and Mr. Theodore Reunert (Johannesburg); hon. treasurer, Mr. W. Westhofen (Cape Town).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Prof. Darwin and Prof. Larmor have informed the Vice-Chancellor that certain donors desire to contribute a sum of 400*l*. a year, for five years, for the purpose of augmenting the stipends of two university lecturers in mathematics. The object is to enable the lecturers, whose present stipend is 50*l*. a year each, to devote themselves by study and research to the advancement of mathematical science. The donors hope that by additional contributions a sum may be procured which will enable the arrangement to be continued, should it prove successful in the first instance. The general board recommends that the offer should be gratefully accepted, and it proposes that it should be authorised to appoint in October two lecturers in mathematics, who, for the sake of distinction, and to commemorate two of the most eminent of Cambridge mathematicians, shall bear the title of the Stokes lecturer and the Cayley lecturer respectively. The new offices are to be tenable with university and college lectureships.

The general board has been in communication with the council of the Royal Geographical Society respecting the reorganisation of geographical studies within the University. It suggests that a board of geographical studies should be appointed, on which the Society should have representatives; that this board should arrange courses of instruction and administer funds; and that a special examination in geography for the ordinary B.A. degree should be instituted. The council of the Society has agreed to contribute 200*l*. a year for five years, to be met by a corresponding grant from the University, for the expenses of the scheme, and it is hoped that other contributions to the geographical fund may be received. The tenure of the present reader in geography expires at Midsummer, but the general board has postponed making fresh arrangements until the Michaelmas term, when a complete scheme is promised.

The annual reports of the Botanic Garden Syndicate and of the antiquarian committee have been published in the *University Reporter* for June 13. They record a large number of gifts to the collections from many sources.

The professorship of surgery and the new lectureships in electrical and mechanical engineering were duly established by the Senate on June 11. An election to the former will be made during the summer. The latter will be held by Mr. Lamb and Mr. Peace, the present demonstrators of applied mechanics.

At the same congregation the grace which brings to an end the long reign of Euclid, as the sole arbiter of geometry in the pass examinations, was passed without a dissentient voice.

Dissertations and memoirs, constituting records of original research, and qualifying for the B.A. degree, have been approved in the case of Mr. J. C. Simpson, Caius (pathology), and of Messrs. R. K. McClung and J. J. E. Durack, Trinity, Mr. F. Horton, St. John's, and Mr. M. Varley, Emmanuel (physics).

In the mathematical tripos, part i., Messrs. Bateman and Marrack, Trinity, divide the senior wranglership. For the third place four candidates are bracketed, Messrs. Gold and Phillips, St. John's, and Messrs. Barnes and Hills, Trinity. Miss P. H. Hudson, Newnham, is bracketed seventh wrangler. She is the daughter of Prof. Hudson, of King's College, London, and the sister of the senior wrangler of 1898. Her sister was bracketed eighth wrangler in 1900. Six men and one woman obtain first classes in part ii. of the tripos. In the mechanical sciences tripos, part i., thirty men obtain honours.

The department of psychology and education of the University of Colorado publishes from time to time booklets dealing with the investigations carried out by its staff. The most recently published number is concerned with certain aspects of educational progress, and includes five original articles dealing with subjects as different as the function of habits and the English Education Act, 1902. Under the title "Miscellanea" are given extracts from educational papers published in different parts of the world, and amongst them are two from Nature.

An instructive example of the close connection maintained between the needs of the American commercial community and the technical colleges of the United States is provided by a recent announcement from Chicago. In response to requests from insurance companies, architects, and contractors, the Armour Institute of Technology of Chicago is now offering a four years' course in fire protection engineering, leading to the degree of bachelor of science. This course will be inaugurated in September next under the direction of Prof. Fitzhugh Taylor, formerly engineer of the Underwriters' Laboratories. The requirements for admission are to be identical with those for the mechanical, electrical, civil, and chemical engineering courses. A special feature of the course will be a series of lectures by prominent insurance officials, architects, and contractors upon the practical features of their work. The technical laboratory work of this course will be given at the Underwriters' Laboratories of Chicago. These laboratories, maintained by the stock fire insurance companies, are well fitted for the work, because all new devices, appliances, and materials that enter into the question of fire protection, or have a bearing on fire risk, are taken there to be tested.

The papers relating to the appointment and resignation of Mr. M. E. Sadler, Director of Special Inquiries and Reports on Education, have been published in a Blue-book (Cd. 1602). It is evident from the documents that Mr. Sadler was anxious to secure that education should have an open-minded and impartial intelligence office as much as the War Office or the Admiralty. With this object in view, and the desire to obtain increased efficiency, Mr. Sadler asked for increased facilities for his work, including "the creation of a new post of scientific assistant in the office of the Director of Special Inquiries and Reports of the Board of Education. The increase in the number of cases, referred to the office of Special Inquiries and Reports, in the consideration of which an expert knowledge of scientific terminology and a general acquaintance with scientific investigation and discovery are indispensable, renders it desirable that one of the officers attached to the staff of the Director of Special Inquiries should be specially charged with the duties of scientific assistant." This was in 1900, but objection was raised to the proposal by the vice-president. An inquiry into the nature of the demands was then asked for by Mr. Sadler, but was not approved. The result of this and other suggestions showed that there was no desire to develop the work of the Special Inquiries Office, but rather to limit it. Matters came to a climax early in this year, when a request for permission to prepare certain reports was made, but was met with objections. Subsequently, the Director framed a memorandum setting forth further needs of the Office of Special Inquiries, and stating that without additional assistance he could not continue to hold himself responsible for the collection and supply of accurate and well-digested information on educational work at home and abroad. The Board of Education failed to agree with the proposals made, and laid down certain new conditions for the conduct of the Special Inquiries Office. The result was that on May 9 Mr. Sadler wrote:—"The arrangements which have been proposed to me for the future conduct of the Special Inquiries Office would, in my judgment, gravely impair the scientific thoroughness and independence of the work of the office, and prove incompatible with future efficiency," and on this account he resigned his post.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 28.—"On the Theory of Refraction in Gases." By George W. **Walker**, M.A., A.R.C.Sc., Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

The present theories of refraction in gases lead to the formula $\mu^2 - 1 = Nf(p)$, where N is the number of molecules per unit volume, and $f(p)$ is a function of the frequencies of the waves and independent of temperature. The measured variation of μ with temperature does not agree with this formula. There are several cases where $\mu^2 - 1$ is much less than $K - 1$, where K is the dielectric constant, and in such cases we find that, although $\mu^2 - 1$ is approximately proportional to N, $K - 1$ is nearly proportional to N/θ, where θ is the absolute temperature.

The present theories are thus inadequate to explain the actual facts.

The view adopted in the present paper is that instead of having free periods of vibrations, the molecules move in constrained motion. Regarding the atom as consisting of a positively charged particle united with a large number of small negatively charged particles, it is supposed that the negative particles roll on the surface of the positive one, but do not vibrate radially. The control on transmitted waves is thus the rotational energy of motion of the particles, and it must be proportional to the absolute temperature.

When, by collisions or otherwise, the rotational motion becomes so great that the electric attraction is overcome by the centrifugal force, ionisation occurs. The frequency or frequencies of rotation at which this occurs are determined by the electrical attractions, and are independent of temperature, although, of course, the higher the temperature the greater will be the amount of ionisation. These frequencies are regarded as corresponding to the spectral lines; this view explains the ionisation produced by ultra-violet light, and also agrees with the fact that luminosity is probably always connected with ionisation, *e.g.* the characteristic lines come out in the electrical discharge through the gas.

Regarded simply as obstacles, the molecules must contribute a term to $\mu^2 - 1$, which is proportional to N and practically independent of the frequency. The final formula obtained is

$$\mu^2 - 1 = k_1 N + k_2 N/\theta \, f(p,\theta),$$

where k_1 and k_2 are constants, and $f(p,\theta)$ is a function of p and θ. The function is fully discussed in the paper.

The formula is shown to be capable of accounting for all the known facts connected with the dielectric constant and the refractive index, while the absorption of ultra-violet light and apparent absorption, due to selective reflection in the infra-red, is also explained.

Notwithstanding the very complex and varied facts in air, hydrogen, carbon dioxide, ammonia and sulphur dioxide, complete numerical agreement between the measurements of $K - 1$ and $\mu^2 - 1$, as regards both absolute magnitude and dependence on pressure, temperature and frequency, has been established.

Chemical Society, June 4.—Dr. W. H. Perkin, sen., F.R.S., vice-president, in the chair.—The following papers were read:—Formation of an anhydride of camphoryloxime, by Dr. **Lowry**. This anhydride is formed when nitrocamphor is boiled with concentrated hydrochloric acid.—Mutarotation of glucose, as influenced by acids, bases and salts, by Dr. **Lowry**. The mutarotation of glucose is greatly accelerated by the presence of alkalis, less so by acids, and is not influenced by the presence of salts.—The solubility of dynamic isomerides, by Dr. **Lowry**. It is shown that in some cases the determination of solubility may be applied to the study of dynamic isomerides, thus the solubility of *pseudo*-β-bromonitrocamphor in benzene at 10° increases from 2·3 to 9·3 per cent., whilst a mixture of this with its isomeride dissolves to the extent of 14 per cent.—The rusting of iron, by Dr. **Moody**. It is stated that the rusting of iron is brought about by the initial production of ferrous carbonate by the action of atmospheric carbon dioxide on the metal, this salt being subsequently oxidised. The non-production of rust in presence of agents which destroy hydrogen peroxide is regarded as due, not as Dunstan suggested, to the destruction of hydrogen peroxide, but to the insolubility of carbon dioxide in solutions of these substances. In the discussion it was pointed out that the presence of impurities in the iron or in the reagents employed would materially affect the production of rust by inducing electrolytic changes, and that Dunstan had already pointed out that carbon dioxide exercised an accelerating influence in the production of iron rust.—Iminoethers corresponding with ortho-substituted benzenoid amides, by G. D. **Lander** and F. T. **Jewson**. The authors find that they get better yields of iminoethers by alkylation in an ethereal solution than in an alcoholic one, but even there nitriles are formed. They also find that whilst *o*-toluamide gives a yield of only 13·6 per cent., *p*-toluamide gives 70 per cent. of iminoether.—The hydrolysis of ethyl mandelate by lipase, by H. D. **Dakin**. It is shown that *i*-ethyl mandelate is unequally hydrolysed by this enzyme, the product being *d*-mandelic acid.—Isomeric change in benzene derivatives. The conditions influencing the interchange of halogen and hydroxyl in benzene diazonium hydroxides, by Dr. **Orton**.—The synthesis of $\alpha\alpha\gamma$-trimethylglutaric acid and its derivatives, by Dr. W. H. **Perkin**, jun., and Miss A. E. **Smith**.—Hexamethyleneoctocarboxylic acid and the *cis*- and *trans*-modifications of hexamethylenetetracarboxylic acid, by Messrs. **Gregory** and **Perkin**.—The bases contained in Scottish shale oil, part ii., by Messrs. **Garrett** and **Smythe**.—A direct method for determining latent heat of evaporation, by Dr. J. Campbell **Brown**. The weight of liquid evaporated by a determinate amount of heat, applied at the boiling temperature of the substance, is determined in a special apparatus.—The four isomeric hydrindamine-*d*-chlorocamphorsulphonates and isomeric compounds of the type $NR_1R_2H_3$, by Dr. **Kipping**. The isolation of the isomeric hydrindamine salts referred to in the previous paper affords conclusive evidence of the occurrence of isomerism among quinquevalent nitrogen compounds of this type. The author accounts for this isomerism by the assumption that the five valencies of the nitrogen atom are directed from the centre to the angles of a square pyramid.

PARIS.

Academy of Sciences, June 8.—M. Albert Gaudry in the chair.—On a new general relation between electromotive forces of saline solutions, by M. **Berthelot**. If an element formed by two saline solutions separated by a porous partition A and B has an electromotive force E, the element A+AB, formed by the two solutions A and AB, with electromotive force ϵ_1, and the element B and AB, with electromotive force ϵ_2, then the relation $E = \epsilon_1 + \epsilon_2$ is found to hold good. The relation concerning the union of acids and bases, established by earlier experimenters, is a corollary to this more general case.—The formation of alcohol in the fermentation of plant juices containing sugar, by M. Armand **Gautier**. An attempt to distinguish analytically between a naturally fermented wine and a liquid artificially fortified with alcohol. Attention was paid especially to the various forms in which nitrogen compounds were present; estimations of glycerol and acidity were also made. It was found that the best characteristics of a really fermented liquid were the amount of volatile acid and the complete absence of ammoniacal nitrogen.—On the propagation of waves in a perfectly elastic medium affected by finite deformations, by M. P. **Duhem**.—Prof. Lorentz was nominated a correspondant for the section of physics in the place of M. Amagat.—On the results obtained by cannonading against hail storms, by M. E. **Vidal**.—On the integrals of the equation $s = f(x, y, z, p, q)$, by M. E. **Goursat**.—On differential equations of the third order which admit of a continuous group of transformations, by M. A. **Boulanger**.—The motion of a solid in a gaseous medium, by M. L. **Jacob**.—An examination of the conditions which determine the sign and the magnitude of electrical osmosis and of electrification by contact, by M. Jean **Perrin**. Electrical osmosis is intense only for ionising liquids; thus a marked effect was produced with water, methyl, ethyl, and propyl alcohols, acetone and nitrobenzene, but was absent with benzene, ether and turpentine.—On the external thermal conductivity of silver wires plunged in water, by M. E. **Ragovsky**. The wires were heated electrically, and a steady current of water passed at a measured rate through the tube surrounding the wire, observations being made when a stationary state was attained.—Hypothesis on the nature of radio-active bodies, by M. Fillipo **Re**. An extension of the nebular theory to the formation of atoms. It follows from the hypothesis that radio-active bodies should possess a high atomic weight, and should give out energy owing to the contraction of their atoms.—Dissociation curves, by M. A. **Bouzat**. From an examination of thirty-five experimental results the following law is deduced :—in a group of univariant systems in which a solid body gives rise by dissociation to another solid body and a gas, the ratio of the temperatures corresponding to a given dissociation pressure in any two systems of the group is constant, whatever the pressure may be. The law has been verified for a range of temperature from 238° to 1065° (absolute), and of pressures from 300mm. to 1600mm.—On the action of arsenic on copper, by M. Albert **Granger**. When copper is heated with arsenic in an inert gas at 440° for a sufficient length of time, a definite crystallised copper arsenide is produced, having the composition Cu_5As_2. Phosphorus gives a corresponding compound.—On the qualitative and quantitative analysis of osmiridium alloys, by MM. **Leidié** and **Quennessen**. The alloy is attacked by fused caustic soda and sodium peroxide, the osmium and ruthenium separated in the form of the volatile peroxides, and the iridium as the double nitrite of iridium and sodium.—On the nutrition of plants deprived of their cotyledons, by M. G. **André**. The assimilation of organic material is lessened by the removal of the cotyledons, but the ratio of phosphoric acid to nitrogen is practically unaffected.—On the mechanism of the saccharification of the mannanes of *corrozo* by the seminase of lucerne, by MM. Ed. **Bourquelot** and H. **Hérissey**. The extract from *Phytelephas macrocarpa* contains a soluble ferment the hydrolysing action of which is complementary to that of seminase.—Research on indoxyl in certain pathological urines, by M. Julius **Gnezda**.—The mechanism of the emission of larvæ in the female of the European lobster, by MM. **Fabre-Domergue** and E. **Biétrix**.—On the iron ore of Troïtsk, by MM. L. **Duparc** and L. **Mrazec**.—Castration in man, and the modifications which result from it, by M. Eug. **Pittard**.—On the kinematography of barometric movements, by M. P. **Garrigou-Lagrange**. A series of charts of isobars, mapped out for equal intervals of time, has been studied by means of the kinematograph. The examination of the American charts has clearly shown that, in spite of their apparent complication in detail, there are in reality but two general movements of the atmosphere. These two movements have the effect of alternately opening and closing the two routes followed by American depressions. A study of European charts leads to similar conclusions, although the regularity is less marked than in America.—On the conflagration of balloons during landing, by M. **de Fonvielle**. The disaster of the *Pannewitz* was probably caused by the electrification of the balloon giving rise to a spark.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii. for 1903, contains the following memoirs communicated to the Society :—

February 21.—E. **Riecke** : Contributions to the theory of atmospheric electricity, iii., on the mass of the ions contained in the air.

F. **Krüger** : The theory of polarisation-capacity.

March 7.—W. **Nernst** : The determination of molecular weights at very high temperatures.

F. **Bernstein** : On the associated domains (Hilbert's *Klassenkörper*) of an algebraical domain (*Zahlkörper*).

E. **Riecke** : Contributions to the theory of atmospheric electricity, iv., on the "adsorption" of ions at the earth's surface.

DIARY OF SOCIETIES.

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—(1) Surface Flow in Crystalline Solids under Mechanical Disturbance: (2) The Effects of Heat and of Solvents on Thin Films of Metal: G. Beilby.—The Forces Acting on a Charged Electric Condenser Moving through Space: Prof. Trouton, F.R.S., and H. R. Noble.—On the Discharge of Electricity from Hot Platinum: Dr. H. A. Wilson.—The Bionomics of *Convoluta Roscoffensis*, with Special Reference to its Green Cells: Dr. F. W. Gamble and F. W. Keeble.—New Investigations into the Reduction Phenomena of Animals and Plants; Preliminary Communication: Prof. J. B. Farmer, F.R.S., and J. E. S. Moore.—The Action of Choline, Neurine, Muscarine and Betaine on Isolated Nerve, and on the Excised Heart: Dr. A. D. Waller, F.R.S., and Miss S. C. M. Sowton.—The Physiological Action of Betaine Extracted from Raw Beet Sugar: Dr. A. D. Waller, F.R.S., and Dr. R. H. Aders Plimmer.—On the Physiological Action of the Poison of the Hydrophidæ; Part II. Action on the Circulatory, Respiratory and Nervous Systems: Dr. L. Rogers.—The Spectra of Neon, Krypton and Xenon: E. C. C. Baly.—And other Papers.

LINNEAN SOCIETY, at 8.—Descriptions of New Chinese Plants: S. T. Dunn.—On the Life-history of a New Indian Species of Monophlebus: E. P. Stebbing.—On the Anatomy of Leaves of British Grasses: L. Lewton-Brain.—Scottish Freshwater Plankton.

FRIDAY, JUNE 19.

ROYAL INSTITUTION, at 9.—Radium: Prof. Pierre Curie (in French).

MONDAY, JUNE 22.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in Bolivia: Dr. Evans.

WEDNESDAY, JUNE 24.

GEOLOGICAL SOCIETY, at 8.—On a Transported Mass of Ampthill Clay in the Boulder-clay at Biggleswade: Henry Home.—The Rhætic and Lower Lias of Sedbury Cliff, near Chepstow: L. Richardson.—Notes on the Lowest Beds of the Lower Lias at Sedbury Cliff: A. Vaughan.

THURSDAY, JUNE 25.

UNIVERSITY COLLEGE MATHEMATICAL SOCIETY, at 5.30.—Some Present Aims and Prospects of Mathematical Research: E. T. Whittaker.

FRIDAY, JUNE 26.

PHYSICAL SOCIETY, at 5. (University of London, South Kensington).—(1) Electrical Effects of Light upon Green Leaves; (2) Blaze-Currents, (*a*) of a Vegetable Tissue, (*b*) of an Animal Tissue; (3) Quantitative Estimation of Chloroform Vapour in Air by (*a*) Oil Absorption, (*b*) Densimetry: Dr. Waller.—The Temperature Limits of Nerve-Action in Cold-blooded and in Warm-blooded Animals: Dr. Alcock.—(1) On the Movement of Unionised Bodies in Solution in an Electric Field; (2) On the Passage of Nervous Impulses through the Central Nervous System: Dr. Hardy.

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