THURSDAY, JUNE 15, 1893.

APPLIED CHEMISTRY.

Dictionary of Applied Chemistry. By Prof. T. E. Thorpe, F.R.S., assisted by eminent contributors. Vol. iii., completing the work. (London: Longmans, 1893.)

THE completion of Dr. Thorpe's Dictionary, upon which both men of science and of practice may with truth congratulate him and his contributors, opens out the question how far such a work, however well done, can or cannot supply the needs at once of the layman, of the scientific man, and of the manufacturer. Perhaps this standard may be too high a one to apply to any single work, and yet I think that in many respects these three volumes will be found satisfactorily to fulfil the above requirements. That in some instances this cannot be said to be the case is not only not to be wondered at but almost to be expected, when we remember the extent of the ground covered, the complexity of the questions considered, and, above all, the difficulty which persons not actually engaged in the various industries experience in obtaining the latest details of new and improved methods and processes. In looking through this volume one is struck with the care which the editor has taken to carry out the condition that the articles on special manufactures ought to be written by scientific men who are themselves engaged in conducting the industry, rather than by those who can only look on those questions from outside. To give examples of this is easy. Take the article on Borax (Sodium Borate) written by Mr. E. L. Fleming. The reader will at once see, by comparing this with any descriptions of the process of preparing borax given in the text-books, that this article is full of data which have hitherto been either ignored or incorrectly given. Again "Sugar," written by Messrs. Newlands, extending over twenty-two pages, is a typical case of descriptions of processes written by persons well acquainted with the details of the operations and able to describe them clearly, and, what is important, care has been taken to illustrate the article by excellent figures of plant. Closely connected with this subject, and also admirably treated by Mr. Heron, a practical authority, to whom we likewise owe an exhaustive article on saccharimetry not to be equalled in any work of the kind, is a description of starch manufacture, in which the newest processes are described and the construction of the most recent apparatus well shown. Then the articles, "Pottery" and "Porcelain," written by Mr. Burton, of Wedgwoods, is another example of processes described by one who knows what he is writing about. Another remarkable instance of the same thing is that of the article, "Phosphorus," by Dr. J. B. Readman. Hitherto the detail of phosphorus manufacture has been a *mare clausum* to the scientific world—and so well have the secrets of the trade been kept, that in no treatise, whether purely scientific or otherwise, have the particulars of the production of phosphorus been hitherto made known. Now for the first time we have, from the pen of one who was himself engaged in the industry, a complete description not only of the methods adopted for making both white and red phosphorus, but likewise the manufacturing details as to yield, which are invaluable. It seems that the explanation given in the books as to the preparation of this important element has been altogether wrong. It has been generally supposed that only so much sulphuric acid is added to the bone-phosphate as will form the acid phosphate, $CaH_4(PO_4)_2$, and that this yields metaphosphate, $Ca(PO_3)_2$, when heated to redness, so that when this latter is distilled with charcoal only two-thirds of the phosphorus are reduced, and one-third remains behind as tricalcium phosphate. This view turns out to be wholly incorrect. In practice enough sulphuric acid is added to convert all the lime present into sulphate, so that it is metaphosphoric acid, (HPO_3), and not calcium metaphosphate, which on distillation with charcoal gives phosphorus, and the yield amounts to about 68 per cent. of the theoretical.

In a notice like the present it is not possible to do more than to run through a few of the most interesting articles in alphabetical order. I take first that on Oils, by Mr. A. H. Allen, of Sheffield, an authority on this somewhat difficult subject. No less than thirty-eight pages are devoted to the description of fixed oils and fats, especially with respect to their classification and identification by analysis, in which the newest and most improved methods are given. I fail, however, to find the name of Chevreul mentioned, to whom chemistry owes the first and still classical research on fats. Then I next take "Oxalic Acid and the Oxalates," a short article by the editor, whose valuable contributions, be it here said, form no inconsiderable fraction of the total 1058 pages. He has not stated the interesting fact quoted in the report published by Drs. Schunck, Smith, and myself in 1862, which, although ancient history, is still true, that from two pounds of sawdust no less than one pound of crystallised oxalic acid is obtained by Dale's process. Nor do I find any mention of manganese oxalate, which is now a marketable product, and is used as a drying agent for oils, and has the advantage over the other "driers," inasmuch as they colour the oil, whereas manganese oxalate can be used so as to yield an almost colourless drying oil. Omissions such as these are, as I have said, not to be wondered at, and I quote them with the object of pointing out that this Dictionary, admirable as it is, cannot replace such sources of information on applied chemistry as the journal of the Society of Chemical Industry, but that it must rather be considered as an introduction to such a mine of wealth as this journal—which I may call a child of my own—contains, and to add, as I feel bound to do, that some of the writers would have done well to refer more fully to its twelve volumes before completing their articles.

Next comes "Oxygen," written by Dr. L. T. Thorne, of Brin's Oxygen Company, and here I may notice a misprint on p. 83—and say that such misprints are singularly rare throughout the book, reflecting great credit on both editor and printer—which has puzzled me. In the description of Robbin's process a reference is given P.J. [2] 5. 436. I looked in vain through the *Journal für Praktische Chemie*, and only after some time discovered that P.J. should be Ph. (the *Pharmaceutical Journal*). A more important error remains to be noticed in this paragraph. How a mixture of 3 mols. of barium chloride and 1 mol of potassium bichromate, on treatment with sulphuric acid *in the cold*, can yield oxygen I could not understand but, on looking up the original paper, I find that for barium chloride, barium peroxide should have been printed. Here CrO_3 and H_2O_2 mutually decompose to Cr_2O_3 and water, whilst pure oxygen derived from both sources comes off. This interesting reaction is not a new one, as it was used by Brodie in 1851, and adverted to in a lecture by Faraday at the Royal Institution; nor does it appear to be capable of producing oxygen at a sufficiently low cost to be of practical value. Of course, Dr. Thorne gives an excellent description of Brin's well-known process by which oxygen is now manufactured on a large scale, but I do not find any statement of a process which bids fair to compete with Brin, viz. Fanta's improvement on Tessie du Motay's reaction, by which oxygen is evolved from manganate of soda by the action of steam. He does indeed refer to Du Motay, and gives the cost of oxygen prepared by his process at from £3 to £4 per 1000 cubic feet, whereas that by the Brin process is given as from 3*s.* to 7*s.* I cannot help thinking that this proportional cost is incorrect, as I know that Fanta's process, the patent of which appears to have superseded Bowman's, is now in practical operation at the Bradford Gas Works, and this would scarcely be the case if the cost were as great as Dr. Thorne states.

That pure oxygen can now be produced at so low a figure as 3*s.* per 1000 cubic feet is a great fact, and induces the hope that we may ere long see it at 1*s.* per 1000. In that case the use of oxygen to heighten the temperature of combustion would become general, especially for welding and riveting of steel and iron. Even now its uses are spreading, not only for the oxyhydrogen light, but for purifying coal-gas. The addition of from 0·5 to 1·0 per cent. of oxygen to crude coal-gas renders its purification more complete and easy, as thus the sulphur compounds are reduced to 12 grains per 1000 cubic feet, and lime alone suffices as a purifying agent. Moreover, the luminosity of the gas is said to be increased. This application of oxygen is on its trial at certain gasworks, but it has to be shown how far this plan of adding oxygen acts more satisfactorily than the much cheaper one of the addition of air, in spite of the small loss in illuminating power which the presence of atmospheric nitrogen entails.

Next I turn to "Paper," by Mr. E. J. Bevan, a short but good article, in which I find a description, in which one misses some illustrations, of the method of recovering the soda used in the preparation of the esparto and other fibres used in making paper. No example of the applications of science to the working up of waste products is more striking than this. Before the introduction of the Rivers Pollution Act of 1876, no paper-maker thought of recovering his soda—all the liquors went to pollute the streams on which the works are situated. Now most paper-mills recover their soda, and save thereby from 80 to 85 per cent. of this costly article, whilst at the same time they have diminished the nuisance which they caused to their neighbours on the stream below them. It is high time that every user of soda for disintegrating or bleaching fibres of all kinds should be prohibited from thus fouling the water, and that the application of the "best practicable means" clause were rigidly enforced by all local authorities interested in improving the quality of the water of our rivers.

The article on "Petroleum," by Mr. Boverton Redwood, is another instance of information given by a high authority. It extends over forty pages, is up to date, and abundantly illustrated. "Photography," by Prof. J. M. Thomson, gives a clear and concise account of the chief processes of the application of photography to lithography and mechanical printing, now becoming more and more perfect, and the article concludes by giving a list of the more important works on the subject.

The two longest articles in the volume are, as might be guessed, Sodium and its compounds, occupying 93 pages and Sulphuric Acid and its relatives, taking up 84. The manufacture of sodium is one of the most remarkable advances of the time; not long ago it could only be bought by the ounce, and at an exorbitantly high price, now an order for 100 tons will be executed by the Aluminium Company, of Oldbury, and the price is only a few shillings a pound. Castner's process for making sodium is fully described, but the excellent illustrations are only of historic interest, inasmuch as the process which they indicate has lately been superseded by a more economic one. The article on Sodium Chloride is of a most complete and trustworthy character, and has been written by Mr. J. I. Watts, of Messrs. Brunner, Mond, and Co., where he has had ample opportunities of making himself master of every detail of the processes he describes. Sulphur and Sulphuric Acid are interesting articles by Dr. Alder-Wright, who adds to his scientific knowledge practical experience of the manufacture. I cannot pretend to discuss the merits—which are great—of these articles. I will only remark that they contain information up to date, and I am glad to see that Dr. Wright has consulted the *Journal of Chemical Industry*, and has given the readers of the Dictionary an opportunity of becoming acquainted with Dr. Hurter's researches on the chemistry of the leaden chamber, published in that journal.

The important article "Water" is contributed, as it should be, by Prof. Percy Frankland. With regard to this able article, extending over fifty-five pages, I have to remark that the author, whilst giving an excellent account of the chemistry of water, seems to have forgotten that he is writing an article in a dictionary of applied and not in one of pure chemistry. Why, for example, should two pages of valuable space be taken up by a long table of the tension of aqueous vapour? Nor is it clear that so many analyses of mineral waters need be quoted, no less than fifteen pages being taken up by tabular matter. On the other hand, greater prominence might well have been given to more technical details of the various methods of water purification. Here I think that the author might have given some extracts from the volumes of the Chemical Industry Society with profit, where, as he well knows, much new and important information is to be found. There is not a single diagram or illustration in this article showing the arrangements proposed for filtration or other means of purifying water; thus, whilst the author refers to the "Stanhope" purifier, he gives no drawing to explain its construction. Prof. Tilden's important experiments on the corrosive action of water on brass and copper are not referred to, a classical subject originally investigated by Davy in 1824, and reported upon by him to the Admiralty of that day. Nor is the paper of Mr. V. C. Driffield on the practical details on the use of carbonate of soda for softening water for boilers, important to every manufacturer, mentioned. Points such as these, which I might multiply, are needed by the practical man, and ought to have found a place in such a work.

Last, but not least, I will refer to the article on "Wine," written by Prof. Thorpe, which is of interest as giving a luminous account of vintage and vinification, and of the chemical changes which the vegetable acids present in the grape undergo during the process of wine-making. I miss, however, reference to the Pasteurisation of wine and to the classical researches of the great French chemist on the diseases of wine. Perhaps, however, the editor has rightly conceived that such matters, however important, do not quite come within the scope of "applied chemistry," and that the omission is intentional. I should have liked to refer to many other matters of interest with which this volume teems, but I have compassion on your space. Again I congratulate all concerned in the production of this Dictionary, which will, I feel sure, long continue as the standard work in our language.

H. E. ROSCOE.

A POPULAR ATLAS.

The Universal Atlas. Containing 117 Pages of Maps and an Alphabetical Index of 125,000 Names. (London, Paris, and Melbourne. Published for the Atlas Publishing Company, Limited, by Cassell and Company, Limited, 1893.)

THIS Atlas, published in a strong cloth binding at 30*s*. net, is certainly unique in the British Market, and in its serial form it has already obtained a deservedly wide circulation.

There is no kind of publication of which the British public is so ignorant as a map, and the fact that few purchasers can tell the difference between a good map and a bad one has produced its natural effects. One of these is that the reviews of atlases in literary journals and the daily press are usually characterised by a tone of forced praise, and rarely go beyond free quotation from the publisher's preface or prospectus. It is more difficult to review a map than a book on account of the immense amount of concentrated information it contains, and even those who are competent for the task are often inclined to shrink from the close study and careful comparison which are necessary. The quality and price of the *Universal Atlas* are so unusual that we feel justified in examining it with some care, and in offering a few suggestions for its further improvement.

The work is published for an unknown company by Messrs. Cassell. There is no hint as to who designed the atlas or drew the maps or engraved the plates, or produced the book. The only indication borne by each sheet is "Printed in Leipzig." German map-printers are good, but there are atlases made in London and Edinburgh which are much better than this; unfortunately they are also much more expensive. One effect of the present publication will, we hope, be to call forth native work designed so as to hold its own in cost as well as quality with that of Germany. Meanwhile the *Universal Atlas* deserves success as a pioneer. We strongly object, however, to the practice—not unknown to some British mapmakers—of issuing the work of trained scientific men without acknowledgment; and of republishing earlier maps without mentioning the fact. If Messrs. Cassell had bound up with the Atlas the "history," which they print as a separate advertisement, and if the name of the printer to whom the creditable appearance of the work is due appeared upon it, we would have almost unqualified praise to bestow on them. As it is, however, we must plainly say that they have not done justice either to the memory of Andree, who prepared the original maps, or to the skill of Mr. W. J. Turner, who so admirably translated them, or even to the enterprise of Mr. H. O. Arnold-Forster, the chairman and presumably the promoter of the publishing company. We regret also that Messrs. Cassell did not entrust the printing to some firm in this country; although the first cost might have been greater, we do not believe that the profit would ultimately prove less.

Not knowing who the editor of the English edition of the Atlas is, we must blame the publishers for failing to adjust the balance of representation to English requirements. Germany is treated with undue detail; the United Kingdom is not adequately shown. Large parts of Germany are given on the scale of 1:870,000; no part of Great Britain is shown larger than 1:1,000,000. No enlargements of English industrial regions, or the environs of British towns appear, although Andree's German edition contains two on the scale 1:750,000. Many of the Continental sheets, on the other hand, are crowded with valuable insets giving details of special districts. The Colonies are, on the whole, very well shown; Canada has a fair amount of space, Africa is lavishly treated, and India is clearly mapped, although the scale is comparatively small. But Queensland, New Zealand and Tasmania, British Guiana, and all the small Asiatic colonies, have been slighted. It is interesting, however, to find Fiji, Samoa, and the West Indies given on a scale making each island show as a visible disc, which displays some little topographical detail. We would suggest that the neglected parts of the empire, some of the more important South American States (the delineation of which is far too small), and the central part of the United States, should have more space devoted to them. Room might be provided by suppressing the large scale map of Alsace-Lorraine, and the rather blurred map of Hungary on p. 51 (also Bohemia, p. 52), which have the scale of 1:2,500,000, and show scarcely more detail than does the general map of Austria-Hungary, pp. 47, 48, which is on the very similar scale of 1:2,750,000.

It is undesirable to enter into a minute criticism of individual maps, for the best workers cannot avoid occasional mistakes, and the most diligent revision has hard work to keep pace with the unceasing changes of railways, populations, and boundaries. We may notice, however, that Aberdeen, Bolton, Cardiff, Croydon, Preston, and Reims have now populations exceeding 100,000, and should be designated by the special sign set apart for towns of the first magnitude. Ross and Cromarty have ceased to exist as separate counties, and the care bestowed on colouring and lettering the detached fragments of these and other counties in Scotland is consequently thrown away. The railways and telegraphs of South Africa are far behind the age, the Orange Free State being shown as if still undisturbed by the engine's whistle. The cable (p. 5) to the Cape by the west coast is only partly shown, though correctly given in the German original; and the Bermudas are now in electrical touch with the world, though this does not appear on the map. There are surprisingly few errors of spelling, and for the general purposes of the newspaper reader the atlas is eminently serviceable.

Only a few physical maps are given, including two pages of familiar and rather feeble astronomical diagrams, the use of which must be very slight. The world in hemispheres is shown with an attempt at orographical colouring on the land, and there are bathymetrical charts of the Atlantic and Pacific Oceans. The latter are somewhat remarkable. The contour lines of depth are given as 110, 1100, 2200, 2750, and 3300 fathoms, those odd numbers corresponding of course to even depths in metres, but the occasional soundings dotted over the surface are stated not in fathoms, but in feet. Similarly the one small climate map shows isotherms drawn to represent centigrade degrees, but lettered with the approximate Fahrenheit equivalents. The system of showing the winds on this map is arbitrary, and the arrangement it implies is unnatural. The physical maps might indeed be excised without serious loss.

The plan of printing the hill-shading—usually much generalised—in brown, throws out the black lettering, admirably, while the rivers and railways are very clearly shown in most cases. The importance of clear maps in following any movement or distribution cannot be overestimated, and the Switzerland (pp. 53, 54), Caucasus (p. 71), and Greece (p. 72), in this atlas are beautiful examples of artistic work, embodying ample detail without confusion.

OUR BOOK SHELF.

Types of Animal Life. By St. George Mivart, F.R.S. (London: Osgood, McIlvaine and Co., 1893.)

IT is reported of a negro preacher that, having omitted to note the source of his text, he counselled his hearers to search diligently for it, assuring them that in doing so they would find many other texts which would be for their souls' good. We are reminded of this anecdote in reading Prof. Mivart's new book on popular natural history. In our search for the types given in the table of contents we have been rewarded by finding a pleasing description of a goodly number of the higher animals. At the beginning of the fourth chapter we are told that the bull-frog has been selected as one type of animal life in order to introduce the group of *Batrachia*. Very little is said, however, about the bull-frog himself, though there is a figure of him in a deprecating attitude suggestive of some appreciation on the part of the artist of the somewhat shabby treatment this Batrachian elect has received. But there is much interesting matter concerning amphibians of all kinds, illustrated by reference to, or short descriptions of, some twenty genera. The first chapter is headed "Monkeys"; and similar headings would, we think, have been more appropriate throughout. As it is, the animal named is, in each case, merely a convenient starting-point for the consideration of the group to which it belongs. We do not know whether the chapters embodied in the book have already done service in any form in America, but the animals selected suggest that such may have been the case. We have the opossum, the turkey, the bull-frog, the rattlesnake, the Carolina bat, the American bison, the racoon, the sloth, and the sea-lion; while the chapter which deals with, or starts with, the last-named animal begins thus:—"The sea-lion is a beast the sight of which must be familiar to very many Americans." The term "animal life" of the title of the work is shown by the contents to be applied to the dactylate vertebrata only, three-fourths of the volume being devoted to mammals, or beasts as the author prefers to call them.

Unfortunately the proofs have been carelessly corrected, so that misprints (*e.g.* fleshating beasts, p. 209), errors of fact (*e.g.* that *Notoryctes* has recently been discovered in America, p. 60), grammatical errors (*e.g.* only two kinds of elephant now exists, p. 207); a redundant "and" before "which," p. 217), and inelegancies (*e.g.* python-like headed reptiles, p. 149: the blind worm is popularly reported as being deadly poison, p. 146) have been suffered to remain. Technical terms have, as far as possible, been avoided; but it is questionable whether the use of such a term as "wing-wedge bone" is advisable. Surely those who can take in such names of places as "Eschscholtz Bay," and such local names of animals as "Catamiztli," could swallow "alisphenoid" without serious mental indigestion

For the rest we have nothing but praise. A great deal of information is conveyed in a pleasant style. The illustrations, if not quite all that could be desired, are decidedly above the average. The reiterated allusion to the possibly independent origin of similar structures (or the independent origin of different structures, as it appears on p. 120) is, in our opinion, not out of place in such a book. Those who enjoy a smattering of knowledge, picked up from popular works, are apt to be so terribly dogmatic that it is well to urge them to keep their minds "free from prejudice and ready to receive all and any truth which may be demonstrable." C. LL. M.

Science Teaching in Schools. By Dr. Henry Dyer. (London: Blackie and Son, 1893.)

AN address given by Dr. Henry Dyer on science teaching in schools has been amplified and is now published in book form. The points dwelt upon appeal particularly to the managers and teachers of existing elementary schools, and of the secondary and technical schools now being organised in all parts of the country. In an appendix (which, by the way, is almost as long as the address itself) are given syllabuses of elementary science as taught under the London and Leicester School Boards, and the curricula of the evening classes of the Glasgow and West of Scotland Technical College. A commendable feature is the insertion of the courses of instruction at the Ecole de Commerce et de Tissage of Lyons and the Public Mercantile Educational Institute of Leipzig.

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.*]

Vectors and Quaternions.

PROF. MACFARLANE claims that his "fundamental rules for vectors are based on physical considerations, the principal one of which is that the square of a vector is essentially positive." His proof is virtually this:—The expression for the kinetic energy ($\frac{1}{2}mv^2$) is an essentially positive quantity. It contains one factor $\frac{1}{2}m$ evidently positive. Hence the other factor v^2 must also be positive. "But v denotes the velocity which is a directed quantity." Unfortunately for this argument v does not denote the velocity in its complete conception—it simply measures the speed. The physicist may think of velocity as being a vector quantity; but in ordinary analysis the vector is not symbolised. We deal only with tensors and scalars. It would be well, I think, if the strict meaning of vector were clearly borne in mind. A vector is a directed line in space, and may be used to symbolise all physical quantities which can be compounded according to the well-known parallelogram law. Displacement is perhaps the simplest conception that can be so symbolised. Velocities, concurrent forces, couples, &c., are in the same sense vector quantities. Now it can be proved rigorously that quadrantal versors are compounded according to this very addition law. On what grounds, then, are they refused admittance to the order of vectors? If a vector cannot be a versor in product combinations, what is the significance of the equation $ij = k$? Regarding this Dr. Macfarlane vouchsafes no remark, save that it is possible to get along without its use. As he himself has not done so, such a possibility lies altogether outside our consideration. Again, I fail to see what "physical considerations" have to do with mathematics of the fourth dimension.

Dr. Macfarlane says that the "*onus probandi* lies on the minus men." To my mind there is no question of proof at all. That the unit vector α should fulfil the equation $\alpha^2 = +1$ is a bare assertion on the part of Dr. Macfarlane and Mr. Heaviside supported by such words as "natural, simple, conventional," and the like. The equation $\alpha^2 = +1$ is a pure assumption, having no better physical basis than the assumption that $\alpha^2 = -1$. *But in quaternions this is not the assumption.* The assumption is—as Dr. Macfarlane admits—that products are to be associative. Hamilton, in fact, invented his calculus so as to have its rules differing *as little as possible* from the recognised rules of algebra. The commutative law had to go, but the others were kept (see *Preface to Lectures*, §§ 50—56). In the system he advocates, Dr. Macfarlane loses the associative principle, and—as I think I show in my paper—gains nothing but a positive sign and an undesirable complexity in transforming by permutations.

As a calculus, quaternions may be developed quite as readily from the conception of the product as from that of the quotient. But in my paper I was arguing against Prof. Gibbs's dictum that the quaternion *as a quantity* corresponded to nothing fundamental in geometry. The extremely simple geometrical conception of a quaternion as a quotient of two vectors sufficiently meets Dr. Macfarlane's query, "Is not the product always the simpler idea?" It is certain that the quotient of any two like quantities has always a meaning; the product is often meaningless.

In the particular geometrical development of quaternions which I indicate in my paper, it can be shown that the quaternion, originally defined as the quotient of two vectors, can also be represented as the *product* (Dr. Macfarlane inadvertently misquotes "quotient") of two quadrantal versors, and this quite independent of the truth that quadrantal versors obey the vector law.

Dr. Macfarlane evidently grudges Prof. Tait (properly, Kelvin and Tait) the use of any but quaternion symbolism. Of course, when $\nabla^2 v$ occurs in ordinary non-quaternion analysis, it is used in the sense of the *tensor*, for only as such can it come in. This surely hardly needed to be pointed out. In quaternions there is no doubt whatever that $\nabla(\nabla\omega) = (\nabla\nabla)\omega = \nabla^2\omega$; and therein, as in all the higher physical applications, the flexibility and power of Hamilton's calculus are at once apparent.

In conclusion, let me say that no reasonable man can possibly object to investigators using any innovations in analysis they may find useful. But in the present case there is a very serious objection to the innovators condemning the system, from which they have one and all drawn inspiration, as "unnatural" and "weak," without in any way showing it so to be. That they can re-cast many quaternion investigations into their own mould does not prove their mould to be superior or even comparable to the original. Yet, in so far as they possess much in common with quaternions, the modified systems used by Gibbs, Heaviside, and Macfarlane cannot fail to have many virtues.

"His form had not yet lost
All her original brightness, nor appeared
Less than Archangel ruined."

Edinburgh University, May 29. C. G. KNOTT.

The Fundamental Axioms of Dynamics.

MY reasons for holding that the fact that potential energy belongs to a system rather than a particle is hostile to the idea of the identity of energy, are briefly these. If two pieces of kinetic energy, are successively transformed and added to a system as potential energy, and then some of the potential energy is retransformed into kinetic, we cannot say *which* of the original kinetic energies thus makes its reappearance; for while both were potential they had no local habitation within the system, and so could not be distinguished from each other.

The objections to including the ether as one of the "bodies" between which contact actions occur, without further explanations, are admirably stated by Prof. Rücker; but I should like to go even further than he does, and point out that if "contact action" means only "action at constant distance" it has not yet been shown how, by such action, kinetic energy comes to be transferred from one body to another. For if the bodies "move over the same distance," and have at any moment the same velocity, their kinetic energies are both increased or decreased *together*; whereas what we wish to show is how that of the one body may increase while that of the other decreases, and why the increase in the one case is equal to the decrease in the other. For example, it may be that in a perfect fluid such transference of kinetic energy actually takes place; but the question is, has Prof. Lodge explained this as a case of "contact action" or "action at constant distance"? What are the things or "bodies" which in this case are actually in contact, and which move over equal distances while the action is going on? Or between what points is the "constant distance" to be measured? Prof. Lodge has not shown in his last paper or in those in the *Phil. Mag.* how "potential energy" can be explained by contact action, nor how kinetic energy can be transferred by contact action alone. But perhaps the answers to these questions are included in the "something more definite" which Prof. Lodge now realises that he has "to say concerning the functions of the ether as regards stress"?

The third paragraph of Prof. Lodge's letter is evidently a joke. I certainly suppose that the denial of action at a distance means that material particles are without *direct* influence upon one another until they touch; *i.e.* that any influence they do exert is *indirect*, and takes place through their both touching something else. Indeed I indicated this in my last letter; but Prof. Lodge apparently hoped I would overlook his omission of the word "direct," and that so the joke would go against me!

EDWARD T. DIXON.

Trinity College, Cambridge, June 10.

Chemical Change.

IN the current number of the Proceedings of the Chemical Society, Prof. H. E. Armstrong publishes two articles on (1) the conditions determinative of chemical change, and (2) the nature of depolarisers. The former deals mainly with the presence of water as a necessary condition of chemical change, the latter with the question of the solution of metals in acids. For some time past I have been engaged with work on the former subject, upon terms of mutual understanding, with my friend Mr. H. B. Baker, whose experiments, following upon those of Prof. H. B. Dixon, have revolutionised our conceptions of chemical change. In the last four years I have also carried on investigations upon the reactions of metals with acids, especially nitric and sulphuric. I should, therefore, propose to deal more fully in a separate publication with the interesting speculations raised by Prof. Armstrong in the articles quoted above. For it has become apparent that after a century of work in chemical science we have no answer to the questions, (1) What is the nature of chemical change? and (2) What is the cause of its commencement? It is probable that both questions resolve themselves, in the long run, into the first. Of facts there is no end, but no interpretation thereof.

The subject is, therefore, ripe for discussion, not only for chemists among themselves, but also, as Prof. Armstrong aptly remarks, for physicists.

Such a discussion might be brought forward at the Chemical Section of the British Association, at Nottingham, in the current year, or, more appropriately, next year in Oxford, the home of Robert Boyle, Mayow, and other earlier chemists.

V. H. VELEY.

The University Museum, Oxford.

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

REFERRING to my former note (*supra*, p. 101) I cannot find that I have been guilty of even "a slight confusion of dates," as Mr. Forbes says (*supra*, p. 126). On his last visit to Cambridge he told me he had forgotten the name I had before written, and asked me to renew my suggestion. I thank him for the kind terms in which he speaks of me, but I must be allowed to disclaim the opinion "that the Chatham Island form was nearer to *Aphanapteryx* than the latter was to *Erythromachus*."

ALFRED NEWTON.

Magdalene College, Cambridge, June 10.

Linnean Society Procedure.

AT the anniversary meeting of the Linnean Society complaint was made that the attendances at the evening meetings were greatly falling off, and fellows were urged to remedy this. The bad attendance is, I think, largely attributable to the lamentably unbusinesslike routine into which the Society's proceedings have fallen, and is not likely to be remedied until *that* is first remedied. Permit me to indicate what appear to me four primary defects in the Society's proceedings.

(1) The actual scientific business of the evening is frequently disposed of in an hour; so that fellows, who attend, sacrifice their evening for very inadequate reward.

(2) In the agenda no intimation is given as to whether the papers to be read will be *really read* by their authors, or whether merely a few sentences will be rattled through by the secretary in order that the paper can be marked as "read." It may thus happen that fellows who attend specially to hear some particular paper read and *discussed* get nothing for their pains. For instance, a short time since, some of us came up specially to hear a paper by Dr. Plowright on the *Aecidiomycetes*, but instead of being treated to a biological paper, followed by a discussion, all that we heard was a few sentences from the introduction read by the secretary! Naturally this sort of thing militates against regular attendances.

(3) Even when an important paper is intended to be read, it may not be reached at all, or if reached may be hurried over and not discussed for want of time. Why is this? Simply because the Society allows "exhibitions" to be intercalated between the formal business and the papers. These exhibitions are often of much interest, often, again, very trivial, but anyhow are quite secondary in importance to the papers, and clearly should be deferred *until the papers* have been disposed of, instead of taking precedence. These exhibitions are not advertised in the diaries of Societies; and it is rather hard that fellows, who have attended to hear an important paper on some new discovery, should go away disappointed because some inconsiderate visitor possibly is allowed to prose about a trifling exhibition for half an hour!

(4) A very grave defect is the confusion of heterogeneous subjects in one evening. If, for instance, alternate meetings were devoted entirely to botanical and zoological papers respectively, probably the attendances would be increased; but the botanists cannot be expected to display much interest in a new genus of earthworms, nor the zoologists in a monograph of *Dianthus*.

If the Council could see their way to adopting these simple reforms that I have suggested, I believe that the attendances would be much increased.

F. H. P. C.

THE GERMAN MATHEMATICAL ASSOCIATION.[1]

THIS is the Catalogue of the Exhibition that was to have been held last year in the picturesque old town of Nürnberg; but in consequence of the state of health in Germany, the meeting of the German Mathematical Association and the exhibition were postponed; and they are now to be carried out this year at Munich, in the month of September.

The last exhibition of a similar kind was that held in London in 1876, the catalogue of which shows that a large collection of apparatus, much of it of a great historical interest, was brought together.

[1] "Catalogue of Mathematical and Mathematico-physical Models, Apparatus, and Instruments." Edited, in conjunction with numerous colleagues, by Walther Dyck. Munich, 1892.

In the present collection the objects of historical interest are comparatively few in number; but, on the other hand, the various models and apparatus intended to illustrate mathematical principles and ideas show what great advances have been made in this branch, so much neglected in our own country.

Prof. Armstrong has recently described in these columns the superiority of the systematic manner in which chemical science is carried out in Germany; and the present Catalogue will show how much we have to learn in the principles of object teaching and illustration in Mathematics.

The Catalogue is divided into two parts. The first part consists of a collection of short and interesting articles.

I. "Geometrical enumeration of the real roots of algebraical equations," by F. Klein, in connection with which No. 47, the plaster model of Sylvester's Amphigenous Surface (constructed by Prof. Henrici) for showing the relations for a quintic equation, may be considered.

II. "Equidistant curve-systems on surfaces," by A. Voss.

III. "Elementary discrimination of singularities of algebraical curves," by A Brill; illustrated by instructive diagrams.

IV. "On the constructive postulates of geometry of space, in their relation to the methods of descriptive geometry," by G. Hauck; an article of great interest to students of Euclid's axioms, and of their modern developments.

V. "Historical studies on the organic description of plane curves, from the earliest times to the end of the eighteenth century," by A. v. Braunmühl; in this article the mechanical methods of the construction of curves, which are perpetually being re-invented, are traced back to their original sources, with interesting historical references.

VI. "On the methods of theoretical Physics," by L. Boltzmann, is a humorous article, describing the former antiquated methods of teaching Natural Philosophy in Germany, apparently not very different to what many of us remember in this country, until Maxwell's vivifying influence made itself felt.

Prof. Boltzmann gives with wonderful clearness Maxwell's ideas about the use of models in Physics; contrasting the views introduced by him with those held before. This article of Prof. Boltzmann is in course of translation and publication by the Physical Society.

VII. "Mechanical integration," by A. Amsler; this gives a complete account of the theoretical principles which underlie the action of Planimeters; it is illustrated with carefully-drawn diagrams.

VIII. "Instruments for Harmonic Analysis," by O. Henrici.

The Catalogue proper begins with the second part; this again is divided into three sections.

The first section contains instruments relating to Arithmetic, Algebra, Theory of Functions, and Integral Calculus, such as Arithmometers, of which the collection and illustrations appear very complete; Galton's Quicunx, illustrating the laws of probability of error; instruments for the solution of equations, Galton's Trace-computer, models of Riemann sheets by Prof. Schwarz, of functions of a complex variable by Prof. Dyck, and a very complete and profusely illustrated collection of Planimeters and Harmonic Analysers of all descriptions. The Rev. F. Bashforth's pioneering description of a Harmonic Analyser, read before the British Association in 1845, deserves especial attention. The elegant little planimeter of Messrs. Hine and Robertson, of New York, might well find a place in the exhibition. In this instrument the record of area is made by the sidelong movement of a sharp-edged wheel on its axle, and not by the rolling motion, so that all slipping of the wheel on the paper is done away with.

The great number of slide-rules is surprising. Mr. Stanley alone has sent more than a dozen.

Among the Arithmometers is the circular form of Mr. Edmondson, and one of great novelty by Prof. Selling, in which the *carrying* is performed continuously and without jerks. The instrument works in consequence with great smoothness and rapidity.

The same section contains instruments and models referring to Geometry, such as angle dividers, ellipsographs, Galton's pantograph, and several perspectographs. Pepys writes in his diary, April 30, 1669:—"This morning I did visit Mr. Oldenburgh, and did see the instrument for perspective made by Dr. Wren, of which I have one making by Browne; and the sight of this do please me mightily." If this instrument can be found it would be welcome at Munich; perhaps Mr. Penrose could help in this matter.

The models for instruction in elementary geometry are very complete, and there are interesting illustrations of polyhedra and space dissection, the subject to which Prof. Alexander Herschel has devoted considerable attention. No. 150 is a collection of six tables on the "Lines of Beauty," to which Hogarth gave great attention; this exhibit should be of interest to artists.

Under the head of Algebraical Surfaces we find among familiar models a pair of Prof. Henrici's confocal deformable hyperboloids, constructed of a number of straight sticks, tied together at the crossings. Darboux's application of these linked bars to the description of spheres and planes, and the mechanical illustration of the motion of a body under no forces, *à la Poinsot*, noted on p. 327 of the Catalogue, may be instanced here.

The plaster models of the confocal quadric surfaces designed and carried out by Prof. H. A. Schwarz and E. R. Neovius with mathematical accuracy should now form part of the apparatus of every teacher of solid geometry; the complete series are obtainable for a moderate price through Brill, of Darmstadt.

Surfaces of the third, fourth, and higher degree, Kummer's and Steiner's surfaces, minimum and deformable surfaces, and others too numerous to mention here, are profusely illustrated in the catalogue.

Prof. Dyck's models of surfaces representing the real and imaginary parts of a function of a complex variable at and near a singular value should be studied by every reader of Mr. Forsyth's new book on the Theory of Functions. Of the curious complexity of even the simplest kinds of *essential singularities* a clearer idea is obtained by a glance at these models than by a long study of the analytical expressions.

The third section is devoted to Applied Mathematics, including Mechanics, Mathematical Physics, and instruments required in geodesy and navigation.

The mechanical models illustrate the parallelogram of forces; the laws of falling bodies, including an arrangement exhibited by Mr. F. R. Barrell of University College, Bristol; models of Saint Venant's torsion prisms, and so forth.

Mr. A. B. Kempe has supplied a complete account of his Linkages; and Prof. Reuleaux's well-known collection of kinematical models is profusely illustrated here.

In mathematical physics we find apparatus for the illustration of wave motion and sound vibrations, refraction of light, interference, Mr. Boys's bullet photographs, and Mr. Bashforth's chronograph. Prof. Alexander Herschel's models are given under the head of models of crystalline structure.

Under thermodynamics are found the thermodynamic surfaces of Gibbs and Van der Waals; and Profs. Oliver Lodge and Fitzgerald exhibit their mechanical illustrations of the laws of electrodynamical action.

Some interesting apparatus are described and illustrated in the last section on geodetic, nautical, and meteorological instruments, including General Strachey's apparatus for the determination of the height and velocity of the clouds.

It would be impossible to give within reasonable limits a detailed account of all the novel and interesting objects described in this catalogue; but it is hoped that the present short sketch will show that the catalogue itself, apart from the exhibition, is a valuable work of reference, which should be in the hands of all interested in mathematical and mathematico-physical science.

It is expected that the postponement of the meeting to the coming September will give time for the collection of other objects of interest, which can be described and catalogued in an appendix.

A fresh manifesto has been issued by the German Mathematical Association inviting further contributions. Intending exhibitors in this country requiring information and advice, and instructions concerning packing and transport of instruments, are requested to communicate with:—

Prof. O. Henrici, Central Institution, Exhibition Road, W.; or Prof. A. G. Greenhill, Artillery College, Woolwich.

At the meeting of the Deutsche Mathematiker-Vereinigung at Halle, it was concluded to arrange for an exhibition of models, drawings, apparatus, and instruments, used in pure and applied mathematics, for the occasion of the proposed conference in Nürnberg in the autumn of 1892.

The proposal enjoyed, from the beginning, the support of the Royal Bavarian Government, by which, through special material assistance, as by increased funds which the Imperial Ministry of the Interior liberally provided, the undertaking was assured.

The proposal of the undertaking was received with universal interest in scientific circles, and so the plan of the exhibition seems to be a natural one. A large number of mathematical, physical, mechanical, and geodetic institutes of our own universities and technic high schools, and those outside of Germany, placed the models in the institutes, as well as those of historical interest, to the disposal of the project. Announcements of participation were received from museums, private collections, and individual men of science, at home and abroad.

Besides Germany, America, France, Italy, Austria-Hungary, Holland, Norway, Russia, and Switzerland joined in the project, and especially in Great Britain a committee was composed, with Profs. Lord Kelvin, Greenhill, and Henrici at the head, to send to the exhibition the most prominent articles from the Government, as well as from private collections. Practically all the more important mechanical workshops that are particularly engaged in the production of mathematical apparatus and instruments, and also publishing-houses interested, agreed to share in the scheme.

All initial steps were taken and preparations made. An extensive catalogue was compiled, through the cooperation of numerous men of science, with a minute description and numerous illustrations of the particular objects, together with a series of comprehensive sketches of its contents; this shows to what extent the various preparations were made.

The condition of the public health of Germany made the postponement of the meeting of the Deutsche Mathematiker-Vereinigung, and consequently the exhibition, which was almost in readiness, inevitable. The directors of the Deutsche Mathematiker-Vereinigung, however, at once concluded to realise their project in 1893.

In Munich, the place selected for the next meeting of the Deutsche Mathematiker-Vereinigung, the extensive rooms of the Polytechnic have already been kindly placed at the disposal of the directors. On account of the proportions that the exhibition has assumed, is will last longer than at first proposed. It will be open from September 1 to 30, as the session of the Mathematical Society, which lasts from September 4 to 10, will be immediately followed by that of the Society of Natural Science in Nürnberg, from September 11 to 15.

In this case, too, we rejoice in the support of the Royal Government, and hearty assurances of intentions to participate in the exhibition have been given by various scientific circles.

Again, therefore, and with confidence, do we turn to our fellow scientific men, to the various mathematical institutes in this and other countries, to publishing-houses and mechanical workshops, with the wish that, through their hearty cooperation, the project may be furthered. We add the plan and more minute information, for the successful realisation of the exhibition.

The exhibition lasts from September 1 to 30, 1893, inclusive, and comprises models, drawings, apparatus, and instruments used in pure and applied mathematics, either for purposes of instruction or investigation.[1]

The Deutsche Mathematiker-Vereinigung will take charge (free of cost) of the fitting of the rooms, the providing of tables, putting in of partitions, &c., as well as the unpacking and repacking of all articles intended for the exhibition. Moreover, the society will assume control of the articles while on exhibition, and will take particular care to preserve them, and will carry an insurance against fire. However, it can assume no responsibility against injury or loss.

Exhibitors who desire their various displays to be exhibited under closed cases must provide them at their own expense.

The expense of shipment to Munich, and, if desired, insurance, must be borne by the exhibitor. For the return the same inducements are held out as last year, viz. free freight over the chief German lines.

A comprehensive detailed catalogue of the mathematical exhibition, according to the announcement made last year, has appeared.[2]

The first part (142 pages) contains a number of essays, of general nature, having reference to problems, results, and methods of presenting geometrical concepts.

The second part (300 pages) contains, according to the suggestion given below, the enumeration and exact description of the articles intended for the Nürnberg exhibition, and gives, with numerous illustrations, a comprehensive view of the general plan of the undertaking, and a statement of what has already been accomplished.

The catalogue will also give the plan of the preparations of the present year; a detailed supplement will be added, in which we hope to perfect the non-completed parts of last year's catalogue.

As far as possible all technical explanations of the articles will be undertaken by the committee.

The committee will attend to all sales and buyings (which are in view by various mathematical institutes of our Hochschulen), and give all desired information.

During the exhibition the sold articles must not be removed from the exhibition rooms, except with special permission of the committee.

The intention to participate in the exhibition may be given by the use of the "Exhibition Announcement" until July 1.

Address: "Herrn Prof. Dr. Walther Dyck,
München, Polytechnicum."

At the same time all papers and scientific notices for the catalogue respecting woodcuts (clichés) for illustration must be sent to the same address.

The editors reserve the right of all abbreviation and change in the notes of Part II. of the catalogue that uniformity may require.

All articles proposed for exhibition must be forwarded from August 15 to 31 under the address: "Mathematische Ausstellung in München (Polytechnicum) zu Handen Herrn Prof. Dr. W. Dyck."

The return of all articles will be effected within two weeks after the close of the exhibition.

In order to more minutely define the extent of the exhibition, we give, in accordance with the arrangement of the catalogue which has already appeared, the following division of groups:—

I.—ANALYSIS.

Calculating apparatus (calculating machines, slide rules); apparatus for the solution of equations and construction of functional relations; models and drawings in algebra and theory of functions; curvometers, planimeters; other instruments for mechanical integration.

[1] From the field of applied mathematics only those models, apparatus, &c., will be accepted whose chief interest lies in the field of pure mathematics.

[2] The catalogue can be obtained direct from Prof. W. Dyck (München, Polytechnicum) at the price of M. 9.80 (including postage).

II.—GEOMETRY.

Drawing apparatus; models for elementary instruction in plane and solid geometry, trigonometry, and descriptive geometry; polyhedra (division of surfaces and spaces in polygons and polyhedra); analysis situs; plane curves; algebraic surfaces; transcendental surfaces; curves in space and developable surfaces; models in line geometry; models to illustrate theory of curvature; singularities of curves and surfaces.

III.—APPLIED MATHEMATICS.

Mechanics.

Models used in elementary instruction; apparatus and models for the demonstration of the laws and principles of dynamics (equilibrium and movement of a material point; Poinsot motion of a rigid body; apparatus for representing precession and nutation; dynamical tops; gyroscopes; models and articles showing the effect of tension, compression, flexion and torsion of solids; representation of various phenomena in hydro-dynamics); models and apparatus in kinematics with regard to their application in practice.

Mathematical Physics.

Apparatus and models to illustrate the laws of the propagation of waves; models for the explanation of crystal structure; models to illustrate the optical, elastic, and electric properties of crystals; drawings and models in thermodynamics; models and apparatus for the mechanical illustration of electro-dynamic phenomena.

Various Technical Applications.

It is to be understood that exhibitors must declare their willingness to submit to the present rules and further dispositions ordered by the committee for the interest of the exhibition.

For all further information please address the undersigned delegate of the committee. PROF. DR. WALTHER DYCK.

RELATIONS BETWEEN THE SURFACE-TENSION AND RELATIVE CONTAMINATION OF WATER SURFACES.

IN a recent paper (NATURE, vol. xlvi., p. 419) I have suggested a method for measuring the relative contamination of an anomalous water-surface in my adjustable trough without fearing an error caused by incomplete separation of the surfaces by the partition. It consists in observing not the displacement of the partition itself, but that of a floating wire laid across the surface, which follows every motion of the superficial water particles.

By this method I have now tried to find a relation between the relative contamination and the decrease of tension which begins at that relative contamination, which we will call unit.

The surface-tension was measured by the separating weight of a ring of thin wire, which had a circumference of 114 mm. and was cleaned by ignition, so that it could be afterwards entirely moistened with water. The ring was attached to a balance with a sliding weight. In this manner the normal surface-tension of water was determined to be 80 mg. per cm. at a temperature of 15° C. The values obtained by experimenters on this subject differing considerably from each other, I shall express the tensions not in absolute measure, but in fractions of the normal surface-tension of water taken as unit. Thus, I found the surface-tension of a saturated solution of camphor 0·72, and that of a strong solution of soap 0·37.

On several occasions, when fast working was required, the tension was not observed directly with the wire-ring, but with the small balance used in my former experiments, the tension corresponding to each separating weight being previously determined by comparison with the large balance.

The observations were made as follows:—A slight trace of oil was communicated to the surface of the trough by means of a wire previously heated to redness, the water-surface still remaining normal. If tallow was to be tried, I left several fragments floating on the water for a short time. When the anomalous surface had reached a sufficient length, the floating wire was put upon it about halfway between the partition and the end of the trough. Then the sliding weight of the balance was displaced successively along intervals of the scale, corresponding to equal differences of tension, and after each displacement one determined the length of surface, at which, under continued contraction, the disk or ring broke off. From these lengths the relative contaminations were afterwards calculated.

Thus I obtained the following results, T denoting relative surface tension and R relative contamination :—

Provence Oil.				Tallow.	
Interval of T. 0·05.		Interval of T. 0·06.			
T.	R.	T.	R.	T.	R.
1·00	0· 1	1·00	0· 1	1·00	0· 1
0·95	1·11	0·94	1·13	0·95	1·12
0·90	1·20	0·88	1·24	0·90	1·22
0·85	1·29	0·82	1·32	0·85	1·31
0·80	4	0·76	10	0·80	1·39
0·75	13	...	...	0·75	6
				0·72	12

It did not influence the results if I used poppy-oil instead of olive-oil, or tallow of various provenience.

The decrease of tension was rapid, and nearly proportional to the increase of relative contamination, till the value 0·82 in the case of oil,[1] or 0·79 in the case of tallow, was attained. At this point a sudden change occurred, and the further sinking took place very slowly. At the same time the "solution current" of floating tallow fragments showed a sudden lessening.

Under continued contraction the water surface at last appeared turbid, and the lowest tension I could attain in this way was about 0·63 with oil and 0·68 with tallow.

The method described is still somewhat imperfect, inasmuch as the water particles in close proximity to the sides of the trough did not participate in the movement of the rest of the surface, indicated by the displacement of the wire-mark. Therefore the results were checked by another method.

The whole surface of the trough was rendered anomalous by means of weak solutions of oil or tallow in benzol, for which purpose 23 drops of the oil solution, or 13 of the stronger tallow solution were required. If the contamination be a little too great, the normal tension may be easily restored by immersing small strips of paper. Then part of the surface was cleansed by shifting the partition from the end towards the middle of the trough about 10 cm., and one drop of the solution being evaporated on the newly-formed surface, the partition was removed and the tension measured. The increase of relative contamination thus added by each drop was respectively $\frac{1}{23}$ and $\frac{1}{13}$. The means of all observations made in this manner were as follows :—

Provence Oil.		Tallow.	
R.	T.	R.	T.
0·0000	1·000	0·000	1·000
1·0000	1·000	1·000	1·000
0·0434	0·973	1·077	0·963
1·0868	0·945	1·154	0·924
1·1321	0·916	1·231	0·879
1·1736	0·891	1·308	0·832
1·2170	0·860	1·385	0·790
1·2604	0·834	1·462	0·790
1·3038	0·815	...	...
1·3472	0·815	2	0·782
...	...	4	0·760
2	0·805		
4	0·795		
12	0·760		

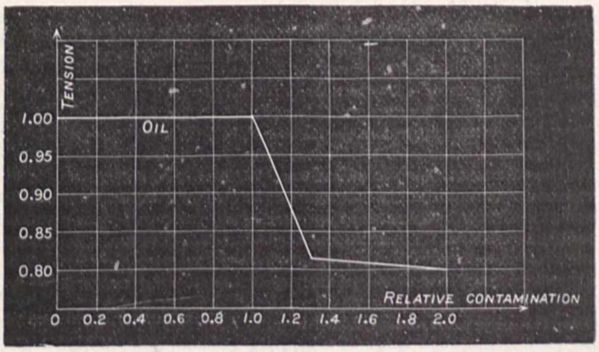
[1] When ordinary olive-oil was used the value in question was 0·78.

The results agree tolerably well with those obtained by the first method, and show still more clearly, that the tension in the beginning of the anomalous state may be approximately expressed by

$$T_0 - T = k (R - 1),$$

T_0 denoting the normal surface-tension and k a constant which is, in the case of oil, 0·60, and in the case of tallow, 0·54.

The course of the tension of a surface contaminated by oil may be more clearly seen from the following curve :

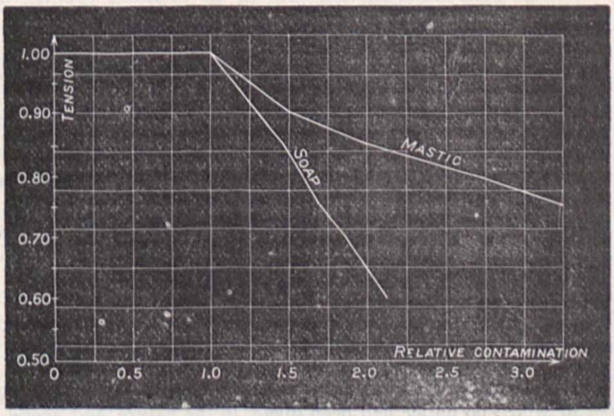


When the water-surface is not contaminated by pure grease, but by any other substance, as soap, resin, palmitic acid, the tension behaves quite differently.

If the justly anomalous surface be contracted, the tension at first sinks rapidly, but gradually begins to rise again, while the area of the surface remains constant; the latter being re-extended, the normal condition is attained at a shorter surface than before contraction. When the surface then is left for some time in the normal state, the length of the anomalous surface increases again.

Therefore the difference of tension produced by varying the area in a given ratio depends very much upon the time required for the contraction or extension.

The deeper the tension is lowered the stronger becomes its tendency to rise, till at last a further sinking



only can be observed during the motion of the partition, and this even is the case with grease at higher degrees of contamination. A sudden change of direction at a certain lowered tension I could perceive in no other curve than that of pure grease. As an example may be exhibited the curves of soap and mastic, when the contraction was as quick as possible. Mastic was introduced by means of benzol, soap directly by contact.

On strongly contracted surfaces, every substance gives a stiff, visible pellicle, composed, as it appears, of small incoherent particles.

Certain peculiarities of some substances still must be mentioned.

(1) The contamination due to colophony and palmitic acid continually diminishes, and at last seems to disappear altogether on standing, which is not the case with mastic.

(2) On the other hand, if the surface has been for a moment in contact with a piece of soap, the contamination continues to increase after the removal of the soap.

(3) Stearic acid renders the water surface stiff as soon as the tension begins to sink.

(4) A surface made anomalous by olive-oil in the course of twenty-four hours undergoes a change, by which the curve of tension is totally altered.

On the whole the phenomena are rather complicated, the tension by no means being determined by the quantity of contaminating substance in the unit of area; but depending considerably upon conditions that are still to be investigated. Especially in the experiments relative to the final tensions attainable by the various substances in the state of utmost concentration I could not succeed in getting definite results.

AGNES POCKELS.

NOTES.

A BRONZE statue of Arago, erected in the grounds behind the Paris Observatory, was unveiled by M. Poincaré on Sunday last in the presence of several members of the Institute, the observatory officials, and a few spectators. This is the third monument that has been erected to the memory of that renowned astronomer.

PROF. MAX MÜLLER has had the order of Medjidieh conferred on him by the Sultan of Turkey. This is a graceful recognition of Prof. Müller's scientific researches.

BARON VON NORDENSKJÖLD, of Stockholm, has been elected a Foreign Member of the Paris Academy of Sciences.

DR. E. B. TYLER, Curator of the Oxford University Museum, has been elected an Associate of the Brussels Academy of Sciences.

THE announcement that Mr. E. B. Poulton, F.R.S., has been appointed Hope Professor in succession to the late Prof. Westwood will be received with satisfaction by all naturalists who are familiar with this author's work. For more than ten years Mr. Poulton has displayed the greatest activity as an original investigator, more especially in connection with the subject of insect colouration, which he has advanced by many important discoveries. His contributions to insect morphology are sufficient guarantee that the purely systematic side of entomology will not be neglected at Oxford. All who are interested in the status of the University as a centre of biological research will recognise the wisdom of the electors in making their selection.

IN the House of Commons on June 8 Mr. Rentoul asked the Secretary of State for War whether he was aware that at the recent Staff College examination there was a striking change, of which no notice had been given, in the nature and scope of the mathematical examination; and whether steps would be taken to prevent any of the officers who were candidates at the examination being disqualified in consequence of this unusual procedure. Mr. Campbell-Bannerman replied that the change was due to the appointment of a new examiner, and said that, as the examination is competitive, the candidates would not be put to any disadvantage by the greater difficulty of the questions. This may be a sufficient explanation of the circumstance, but, in many cases, candidates for Government appointments have found upon reading the question paper, that important changes have been made in the character of the examination without any intimation whatever having been given to them.

A *conversazione* of the Institution of Electrical Engineers will be held in the galleries of the Royal Institute of Painters in Water Colours on Friday evening, June 23.

THE Selborne Society have made arrangements for a visit to Selborne, the home of Gilbert White, on Saturday, June 24. Lord Selborne will occupy the chair at lunch, and be supported by Lord Northbrook, the Earl of Stamford, and Sir John Lubbock, Bart. Tickets for the excursion can be had from the Secretary, 9, Adam Street, Adelphi, W.C.

THE fourth annual meeting of the Museums' Association will be held in the rooms of the Zoological Society during the first week in July. The formal proceedings will commence on Monday, July 3, at 8.30 p.m., when Sir W. H. Flower, F.R.S., the President-Elect, will deliver an address. It is proposed to devote mornings to the reading and discussion of papers bearing upon the subject of museums, and in the afternoons and evenings visits will be made to various Metropolitan museums. The arrangements of the meeting will be greatly facilitated if those who propose to attend will give early notice to Mr. F. W. Rudler, 28, Jermyn Street, S.W.

THE fifth summer assembly of the National Home Reading Union will be held at Ilkley, Yorkshire, from July 1 to July 8. The inaugural address will be delivered by the Master of Trinity College, Cambridge, and there will be lectures by Mrs. Henry Fawcett, Prof. Michael Foster, Sir Robert Ball, Mr. W. G. Collingwood, Mr. Churton Collins, and others. Short lectures on archæology, botany, and geology will be given each day, and will be followed by excursions to places of interest in the neighbourhood. There could hardly be a more pleasant road to knowledge than that afforded by such a meeting as this.

VARIOUS learned and scientific bodies of Liverpool and the district, being desirous of inviting the British Association to meet at Liverpool in 1896, sent representatives to the Mayor on June 5 for the purpose of soliciting his aid in the furtherance of their object. The Mayor would not pledge himself to any course of action, but said he would consult the Corporation upon the matter.

THE Permanent Committee of the International Congress of Zoology propose, as the subject for the S. A. I. le Tsarévitch prize, the study of the fauna of one of the great regions of the globe and the relations between this fauna and that of neighbouring regions. The award will be made at the Leyden Congress in 1895. By the rules of the Congress this prize cannot be given to a Dutch man of science. The jury will accept works bearing upon a branch or a class of the animal kingdom. Manuscripts or printed papers should be written in French and sent, before May 1, 1895, to M. le Président du Comité permanent, Société Zoologique de France, 7 Rue des Grands-Augustins, Paris.

WITH the exception of heavy thunderstorms which occurred in the central part of Ireland during the night of Friday, the 9th inst., in which 1·2 inch of rain fell, and in Merioneth the next day, the weather, as represented by the stations reporting to the Meteorological Office, has been practically rainless over nearly the whole of the British Islands. These conditions were owing to the persistence of an anticyclone over Scandinavia, the North Sea and our own area. The temperature has been somewhat high for the time of year, the highest daily maxima in the south and west having at times exceeded 75°; but in the north, and especially on the east coast, owing to the continuance of easterly winds, many of the maximum readings have been below 60°. During the early part of the present week the anticyclone decreased in intensity and began to move slowly eastward, while a depression which lay over the south-west of France moved northward, causing the barometer to fall generally over our islands, and on Tuesday night, the 13th inst., a thunderstorm occurred at Jersey, while a further rise of temperature occurred over the southern portion of the kingdom, the maximum at Cambridge reaching 81°. The *Weekly Weather Report* of the 10th inst. showed that the greatest excess of temperature occurred in Ireland and the Channel Islands, where it was 5° above the mean. The rainfall just equalled the mean in the east of Scotland and the north of Ireland only. Bright sunshine was above the usual amount everywhere; the percentage of duration ranged from 29 to 38 in Scotland, from 36 to 40 in Ireland, and from 40 to 67 over England, while in the Channel Islands the percentage was as high as 75 of the possible amount.

WE are indebted to Dr. A. Buchan for the discussion and publication (in vol. ix. of the Journal of the Scottish Meteorological Society) of a very valuable series of mean monthly and yearly temperatures for London and vicinity for 130 years, from 1763 to 1892. The only interruptions of the continuity of this long series occurred in May 1777 and July 1780, and the means for these months have been interpolated. For the 130 years the mean temperature of London is 50°·2. The highest mean temperature of any month was 74°·1 in July 1783, and the lowest 25°·9 in January 1795, the difference being 48°·2. The warmest seasons were, winter, 1779, 8°·3 above the normal value; spring, 1811, +5°·2; summer, 1783, +8°·2; and autumn, 1777, +5°·1. The coldest seasons were, winter, 1814, 6°·5 below the normal; spring, 1837, −6°·7; summer, 1816, −4°·6; and autumn, 1877, −4°·1. The year 1783 had the highest mean annual temperature, being 5°·2 above the normal for the year; and 1816, the lowest, being 3°·5 under the normal. Dr. Buchan states that much labour has been spent in searching for evidence of cycles, but that it cannot be said that the results show more than highly interesting resemblances and contrasts among the months, and that in whatever way the periods are viewed, they suggest no appearance of a cycle. But a tendency is shown of types of high and low temperature to prolong themselves during months, seasons, and years. Following this paper is an equally important discussion by the same author of the temperature of the north-east of Scotland for 129 years, from 1764 to 1892, from observations taken at Gordon Castle and other places.

AT the instance of Herr von Helmholtz, and with the support of the Berlin Academy of Sciences, Drs. Franz Richarz and Otto Krigar-Menzel have undertaken a remarkable series of experiments for the purpose of determining by weighing the diminution of gravity as we ascend from the surface of the earth. The method was theoretically the following:—To each pan of an ordinary balance is attached another pan by means of a rod about 2 m. long. Two sensibly equal masses are placed in the left upper and the right lower pan respectively. The gravitational attraction being stronger on the latter weight, a difference will be indicated by the balance. On removing the left weight from the upper to the lower pan, and the right weight from the lower to the upper, the difference acts in the opposite direction, and half the mean of the two differences gives the decrease of gravity with the height. It is almost needless to say that the experiment was one of very great delicacy and difficulty. It was performed in an earth-covered casemate of the citadel of Spandau, partly in order to utilise a mass of lead weighing about a hundred tons to determine the attraction exerted by it. The necessary preparations were begun in 1887, and the main part of the observations has only just been concluded. The difference between the values of g at two points, one 2·26 m. above the other, was found to be $6{\cdot}523 \times 10^{-6}$. The calculated value was $6{\cdot}970 \times 10^{-6}$. The difference may be due to a density of the strata below the station being less than the average.

A THERMOSTAT for the comparison of standard thermometers between the temperatures of 50° and 300° C. is described by Herr A. Mahlke in the current number of the *Zeitschrift für Instrumentenkunde*. It is used at the Physikalisch-Technische Reichsanstalt for the purpose of maintaining the thermometers to be compared at certain temperatures for which the boiling point of some substance is not available. It consists essentially of an oil-bath in a copper cylinder surrounded by another copper cylinder, the space between the two being filled with air. Heat is applied to the outer vessel. The heated air warms the inner vessel by circulating round it, there being a clearance of 2 or 3 cm. all round. Special precautions are taken to keep the level of the oil in the inner vessel constant, and the temperature of the oil uniform throughout. Both cylinders are closed with lids containing holes through which to insert the thermometers. The oil is kept circulating by means of two propellers enclosed in vertical copper cylinders open at both ends. Their axes project through the outer lid, and are provided with pulleys rotated by means of a small water motor. The whole arrangement is designed to keep the entire body of oil in motion, so as to prevent unequal heating. Surplus oil, due to expansion, and any oil-vapour that may be evolved, are drawn off through a siphon leading through the walls of the cylinders into a refrigerator. The apparatus has worked very well, the variations of temperature not exceeding the average errors in reading the thermometer scales.

THE extremely high cost of high resistances made of metallic wire causes the discovery of a cheap substitute to be a matter of considerable importance. Most of the substitutes hitherto proposed, such as liquid resistances, pencil marks on glass or ebonite, &c., are subject to the objection that they have an extremely high temperature coefficient, and in the case of the pencil mark, on account of the extreme thinness of the conducting material, the rubbing off of a few particles causes a great increase of resistance. These resistances also depend in a considerable degree on the electromotive force to which they are subjected. The *Elettricista* for May contains the description of a new material for the construction of high resistances, discovered by E. Jona which is said to be free from most of these defects. He uses an ebonite tube which is filled with a mixture of graphite and unvulcanised ebonite in suitable proportions. The mixture is then vulcanised, when it hardens and adheres to the containing tube. Metal cups fitted with binding screws are fixed to the ends. In this way a resistance of a megohm can easily be obtained in a tube 10 cm. long and of 15 mm. diameter.

IN a recently-published number of the proceedings of the Cambridge Philosophical Society there is an interesting paper by Messrs. Griffiths and Clark on the determination of low temperatures by means of platinum thermometers. Acting on the suggestion of Profs. Dewar and Fleming, that from observations on the resistance of certain pure metals (including platinum) at very low temperatures, it would appear as if the resistance vanished at absolute zero, the authors have calculated by means of Callendar and Griffiths' method the temperature at which the resistance of several platinum thermometers, whose accuracy had been severely tested, would be zero. The values obtained seemed to corroborate the conclusions arrived at by Profs. Dewar and Fleming as the mean value found for the temperature at which the resistance would be zero is −273°·96. This gives a convenient method of graduating a platinum thernometer, when a high order of accuracy is unnecessary, without the usual observation in sulphur vapour, which, in the absence of special apparatus, is a troublesome operation. For if the platinum is pure, it may be assumed that at absolute zero the resistance vanishes, and thus a measure of the resistance in steam and ice will allow of its constants being calculated.

WHILE making the observations mentioned in the previous note the authors were led to suspect that the heating effect of the small currents necessary to measure a resistance are of more importance than is usually supposed. During their determination of the value of the mechanical equivalent of heat by means of an electric current, they measured the temperature of the bath containing the wire under experiment, at which the resistance was the same, while the difference of potential at the ends was increased from one to ten volts. Hence they were able to calculate the change of resistance (δR), and the results seem to show that $\delta R = aC^2$ where a is a coefficient depending on the nature of the surroundings. Thus, by determining the resistance of a coil with two different electromotive forces, it would be possible to find the value of a, and hence calculate the value of the resistance when $C = 0$.

THE June number of the Journal of the Institution of Electrical Engineers contains a long paper by Mr. A. T. Snell on the distribution of power by alternate current motors. The paper is followed by a full report of the discussion which it raised when it was communicated to the Institution.

ACCORDING to the *Electrical Review* Messrs. Cross and Mansfield have recently contributed to the Massachusetts Institute of Technology some further experiments on the excursion of the diaphragms of telephones. They find that on increasing the magnetising current, the corresponding permanent deflection increases more and more rapidly in proportion up to about $\frac{8}{10}$ths of an ampère, after which the deflection is very nearly proportional to the current. Similarly the results show that as the strength of the magnet of the telephone increases, the amplitude of the vibration likewise increases up to a certain limit and then falls off. The maximum motion of the diaphragm for a given value of the alternating line current employed is attained before the core reaches half saturation. It also appears that, in general, the amplitude of vibration of the diaphragm increases less rapidly than the current actuating the telephone.

AGRICULTURE is rapidly becoming more scientific. In France the Société Nationale d'Agriculture lately charged a special commission to study the question of agronomic maps, designed to afford the farmer useful indications on the physical and chemical qualities of land, so that he may know how to improve it, what manures to apply, and in what quantity, &c. In an interesting report on behalf of this commission (summarised in *Rev. Gen. de Sciences*) M. Carnot represents that the time is now ripe for production of cantonal and communal agronomic maps, on a large scale; and a number of suggestions are offered as to how the work should be done.

THERE is now a general tendency in Russia to introduce some teaching in agriculture and horticulture into the primary schools. Both private persons and the Provincial authorities freely give grants of land to the schools and to the teachers' seminaries for their fields and orchards, and in many schools the plots of arable land and gardens attended to by the pupils become small centres of agricultural and horticultural education. In Caucasia the same tendency is even more pronounced, and no better idea can be given of the extent of this new movement than by giving the following facts relative to the primary schools of Kuban, a province of Northern Caucasia. This year ten schoolmasters have been invited to attend the lectures upon sericulture and bee-keeping at the schools of the Cossack villages, Armavir and Labinskaya. The inspector of the schools has acquired, with the modest grant of £35, thirty appliances for raising silkworms, and five arrangements for each school for pumping out honey from the beehives, and preparing the artificial wax honeycombs; in addition to which, ten schools have been supplied with apparatus for silkworm culture, while others have been supplied with seeds of plants of special use to bees. All schools which have gardens of silkworm trees have been supplied with seeds of the tree, and 20,000 young trees have been distributed among them. Fourteen schools are expected this year to carry on the silkworm culture, and ten other schools are already carrying on experiments relative to the same.

IN the current number of the *Entomologists' Monthly Magazine*, Mr. R. McLachlan, F.R.S., in an article on the extinction of several species of British butterflies within recent years, and the decadence that appears to be going on with respect to others, suggests the enforcement of a close-time to last continuously during the whole of a series of five or ten years.

IN a recent paper to a Christiania journal on the melting of inland ice (whereby glaciers are prevented from growing indefinitely in thickness, notwithstanding additions above the snow line), Herr Schiotz attempts to estimate the three factors concerned in the interior fusion, viz. earth heat, friction, and pressure, and arrives at the result that a more important agent than any of these (in hindering glacier growth) is solar heat melting the surface ice below the snow line (*Naturw. Rdsch.*, No. 21).

A PARAGRAPH describing a supposed earthquake felt in the Isle of Man on the afternoon of May 5 was published in several London and provincial papers. Mr. Charles Davison writes us to the effect that his inquiries show that the shocks were due, not to earthquakes, but to the firing of heavy guns from a battleship situated near the island.

DURING the cutting of a tunnel at the Notabile Terminus of the Malta Railway (writes Mr. N. Tagliaferro in the *Mediterranean Naturalist*) a piece of lignite, of dimensions about 11 by 4 by 1 inches, was found embedded in the blue variety of the upper globigerina limestone. The upper layers of this limestone appear to be contemporaneous with the Langhian series of the miocene beds of Italy, and were probably deposited on an ascending sea-floor at a depth of nearly 300 fathoms. The discovery of lignite in these beds is, therefore, of some importance.

WRITING in *Science* of May 5, Dr. Morris Gibbs says that the results of observations of the songs of fifty different species of birds shows that the notes do not change in quality as a result of change in emotion. After robbing nests he has waited and listened, allowing ample time for the male to learn of the spoliation. In each instance the male, upon returning to the empty nest, at once burst into song, and though it is possible that the song expressed much sorrow or complaint, Dr. Gibbs could never distinguish any difference between it and the warbling he was accustomed to hear.

IN the *Lancet* of June 10, Dr. Edwin Haward calls attention to a point with respect to proofs of death, which, in consequence of the growth of opinion in favour of cremation, is of great importance. Sir B. W. Richardson and himself had to decide in a particular case whether life was or was not extinct. Of ten tests applied to the body, eight indicated that death was complete. These were (1) heart sounds and motion entirely absent, together with all pulse movement; (2) respiratory sounds and movements entirely absent; (3) temperature of the body the same as that of the surrounding air in the room; (4) a bright needle plunged into the body of the biceps muscle and left there showed no sign of oxidation on withdrawal; (5) intermittent shocks of electricity passed through various muscles and groups of muscles gave no indication whatever of irritability;

(6) the fillet test applied to the veins of the arm caused no filling of veins on the distal side of the fillet; (7) the subcutaneous injection of ammonia caused the dirty brown stain indicative of dissolution; (8) rigor mortis was detected on making careful movements of the joints of the extremities and of the lower jaw. Two tests, however, indicated that life was not extinct. The opening of a vein to ascertain whether the blood had undergone coagulation showed that the blood was fluid. This is not very important, because under abnormal conditions the blood may remain fluid after death has occurred. But a criterion which has been believed to afford sure evidence of life or death was found to fail. It is known as the diaphanous test, and consists in holding the fingers of the supposed dead person in front of a strong light, and looking through the narrow spaces between two fingers just touching one another. The belief has been that if the person is alive a line of scarlet colour will be seen, and that the absence of the colour indicates death. In the case investigated, however, the scarlet line of light between the fingers was clearly visible, though death was assured by the fact that decomposition set in. Further, Sir B. W. Richardson records a case in which the test, applied to the hand of a lady who had simply fainted, gave no evidence of the scarlet line; so that, on that test alone, she would have been declared dead. Thus the diaphanous test, which has been considered by many as infallible, has been proved to be untrustworthy.

HERRN FRIEDLÄNDER UND SOHN, of Berlin, have issued their *Natural History News*, Nos. 3-9. The lists contain advertisements of recent literature on natural history.

THE Technical Instruction Committee of the Essex County Council have just issued a prospectus containing syllabuses of lectures on chemistry and biology—sciences which are specially applicable to the industries of the county.

Iron has ceased to exist as an independent journal, after living for twenty years under that title and fifty years as the *Mechanics' Magazine*. It has been amalgamated with *Industries*, and the combined journal will in future be issued under the title of *Industries and Iron*.

THE life of Sir Richard Francis Burton, by Lady Burton, will shortly be published by Messrs. Chapman and Hall. The work will recount Sir Richard's life from his birth to his death, and will comprise two volumes of about 600 pages each. A large amount of space is devoted to a description of his explorations.

WE have received the New South Wales Statistical Register for 1891 and previous years, compiled from official returns by Mr. T. A. Coghlan. The volume is a collection of eight parts which have already been issued separately. It is wholly devoted to statistics.

FROM Felix Alcan, of Paris, comes a work on the "Conquête du Monde Végétal," by Louis Bourdeau. The arrangement of the matter in the book is very good. After discussing the general theory of the growth of plants, the author passes to the study of various groups of plants of economic and of ornamental value. This branch of the subject is divided into seven parts. The operations of culture furnish matter for a special chapter, and the book is concluded with an account of the creation and preservation of artificial varieties of some types of plants. To a large extent the subject is treated historically.

THE Life Saving Society has for its chief object the development of instruction in such swimming arts as would be of assistance to a person endeavouring to save life. They have just issued a revised edition of an excellent little handbook in which an account is given of the methods recommended by the society for the rescue of the drowning and the resuscitation of the apparently drowned. It is hoped that the issue of this course of instruction will lead to the subject of life-saving and resuscitation being included in the curriculum of every school.

THE decomposition of steam by means of heated magnesium makes, according to Herr Rosenfeld (*Berichte*), a pretty lecture experiment. A short piece of a combustion tube is furnished at one end with a stopper and tube for escape of gas, and connected at the other with a vessel containing water. A little powdered magnesium (0·5 to 1 gramme) is put in the tube, and cautiously heated; then, by gently heating the water, steam passes over, and the metal merely glows. In this way is obtained a steady current of hydrogen, which can be collected over water. But if a rapid current of steam is sent over the heated metal, the latter burns with dazzling light, and the heat breaks the tube. This occurs, however, only after some time, when a good deal of hydrogen has been collected in the bell-jar.

AN interesting compound of aluminium chloride with benzoyl chloride, the chloride of the benzoic acid radicle, has been obtained in large crystals by M. Perrier, and an account of it is contributed to the current number of the *Comptes Rendus*. Such compounds are of particular importance in view of the remarkable *rôle* which aluminium chloride has been found to play in synthetical chemistry, as affording some insight into the nature of the intermediate reactions upon which the apparently catalytic action of this useful salt depends. The new compound now described is represented by the formula $C_6H_5COCl.AlCl_3$, or, if aluminium chloride is considered as represented by the usual double formula, $(C_6H_5COCl)_2.Al_2Cl_6$. It is readily prepared by heating about ten grams of benzoyl chloride dissolved in 150 c.c. of carbon bisulphide with nine grams of anhydrous aluminium chloride in a flask fitted with a reflux condenser. After three hours' ebullition and subsequent cooling a large yield of the colourless tabular crystals of the new compound is obtained. The crystals decompose somewhat rapidly in moist air, and they are instantly decomposed by water, forming an aqueous solution of aluminium chloride, hydrochloric acid, and benzoic acid. They are readily soluble, however, without decomposition, in carbon bisulphide. The formation of compounds of this nature is not confined to the chloride of benzoic acid, but would appear to be general throughout the aromatic series, and M. Perrier has already isolated in a pure state the corresponding compound containing the chloride of phthalic acid. Moreover, in the fatty series the chloride of butyric acid is found to combine readily with aluminium chloride, in carbon bisulphide solution, to form a compound of the same definite nature.

THESE compounds are not the first of the kind that have been prepared. Last year MM. Perrier and Louise described a considerable number containing the aromatic ketones, ethers, and phenols. They were all constituted upon the same type, $M_2.Al_2Cl_6$, where M represents a molecule of a ketone, ether, or phenol. The compound containing acetophenone, for instance, $(C_6H_5.CO.CH_3)_2.Al_2Cl_6$, may be obtained in good crystals by cooling the liquid formed by heating acetophenone dissolved in carbon bisulphide with aluminium chloride to 40°. Similarly the compound with phenyl benzoate, $(C_6H_5.COOC_6H_5)_2.Al_2Cl_6$, crystallises from the liquid obtained by heating the components in carbon bisulphide solution. They are all of the same character, permanent in carbon bisulphide solution or in dry air, but decomposed rapidly by moisture.

THE formation of the above compounds explains at once the important synthetical method introduced by MM. Friedel and Crafts for the preparation of the aromatic ketones by the action of the hydrocarbons upon the chlorides of the acid radicles in presence of aluminium chloride. It is most probable that a compound of aluminium chloride with the chloride of the acid radicle, $(R.COCl)_2.Al_2Cl_6$, is first formed, and that this is subsequently converted by the hydrocarbon into the compound of aluminium chloride and the ketone, $(R.CO.R)_2.Al_2Cl_6$, with elimination of hydrochloric acid. Under the conditions of the experiment this latter compound is dissociated into free aluminium chloride and the free ketone. That this explanation is very near the truth is demonstrated by the fact that by working in carbon bisulphide solution, M. Perrier has actually converted his new compound with benzoyl chloride, $(C_6H_5COCl)_2.Al_2Cl_6$, directly into the ketone compound, $(C_6H_5.CO.C_6H_5)_2.Al_2Cl_6$, by reacting upon it with benzene. The crystals of the ketone compound obtained were identical with those prepared from benzophenone itself.

WE regret that in announcing the birthday honours last week the name of Mr. Daniel Morris was printed "Mr. David Morris."

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Actinian *Chitonactis coronata*, the Polychæta *Glycera capitata* and *Proceræa picta*, the Opisthobranchs *Candiella plebeia* and *Triopa claviger*, the Schizopod *Leptomysis mediterranea*, the Ascidian *Pycnoclavella aurilucens* and a number of *Amphioxus lanceolatus*. The character of the floating fauna has exhibited little change since the preceding week, Ctenophora and Leptomedusæ having been especially abundant. The following animals are now breeding: Various Serpulidæ, the Schizopoda *Schistomysis arenosa* and *Leptomysis mediterranea*, the Decapod *Crangon sculptus*, and the Ascidian *Botryllus violaceus*. The majority of *Amphioxus* also are full-grown and mature.

THE additions to the Zoological Society's Gardens during the past week include a Stair's Monkey (*Cercopithecus stairsi*, ♂) from East Africa, presented by Mr. F. Hintze; a Himalayan Bear (*Ursus tibetanus*, ♂) from Northern India, presented by Capt. Michael Hughes, 2nd Life Guards; a Maugé's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. Robert Hoade; four South Island Robins (*Miro albifrons*) from New Zealand, presented by Capt. Edgar J. Evans; two Carrion Crows (*Corvus corone*), British, presented by the Hon. Wm. Edwardes; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, presented by Mr. J. B. Sutherland; a Herring Gull (*Larus argentatus*) British, presented by Miss M. A. Croxford; a Long-eared Owl (*Asio otus*), a Tawny Owl (*Syrnium aluco*), British, presented by Mr. Alan F. Crossman; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. A. E. Jamrach; a Red-handed Tamarin (*Midas rufimanus*) from Surinam, a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*, ♂) from South Australia, fourteen Horned Lizards (*Phrynosoma cornutum*) from Texas, four Tuberculated Iguanas (*Iguana tuberculata*) from the West Indies, deposited; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, four Bronze-winged Pigeons (*Phaps chalcoptera*), two Australian Sheldrakes (*Tadorna tadornoides*, ♂ ♀) from Australia, four Green Waxbills (*Estrelda formosa*) from India, purchased; a Vervet Monkey (*Cercopithecus lalandii*), a Japanese Deer (*Cervus sika*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

FINLAY'S COMET (1886 VII.).—The ephemeris of Finlay's comet for this week is as follows:—

12h. *M.T. Paris.*

1893.		R.A. (app.) h. m. s.		Decl. (app.) ° ′
June 15	...	1 45 47	...	+ 8 2·9
16	...	50 31	...	8 31·2
17	...	1 55 15	...	8 59·1
18	...	2 0 0	...	9 26·8
19	...	4 45	...	9 54·2
20	...	9 30	...	10 21·3
21	...	14 16	...	10 48·1
22	...	2 19 1	...	+11 14·5

DETERMINATIONS OF GRAVITY.—The Appendix (No. 15) of the report of the "United States Coast and Geodetic Survey for 1891" contains a set of determinations of gravity made with half-second pendulums on the Pacific coast, in Alaska, and at Washington, D.C., and Hoboken, N.J., under the superintendence of Mr. T. C. Mendenhall. On account of the difficulty and cost of a previous undertaking, the apparatus in the present determinations has been greatly reduced both in magnitude and complexity by using a pendulum vibrating to half a second and a chronometer in place of a clock. The pendulum apparatus consisted of a set of three-quarter metre pendulums, a dummy or temperature pendulum, an air-tight receiver in which the pendulums were swung, a flash apparatus, wherein an electromagnet in the circuit of a chronometer moves a shutter and throws out a flash of light each second, a telescope for observing, mounted above the flash-light apparatus and various accessories. The pendulums themselves constituted a set of three, so that discrepancies in any one of them, if they appeared, could easily be detected. Each was composed of an alloy of aluminium 10 per cent. and copper 90 per cent., a composition highly resistible to corrosion. The base station adopted was at the Smithsonian Institution in Washington, and the value assumed there for g was 980·10 dynes.

The following are the values of g as obtained at five places, a table given here including several other determinations:—

Station.	Lat. N. ° ′	Long. W. of Greenw. ° ′	Elev. above sea-level. Feet.	g at station. Dynes.	g reduced to sea-level. Dynes.
Washington, D.C.	38 53	77 02	34	[980·1000]	980·1020
San Francisco, Cal.	37 47	122 26	375	979·9507	979·9727
Seattle, Wash.	47 36	121 20	243	980·7116	980·7258
Mount Hamilton, Cal. Lick Observatory	37 20	121 39	4205	979·6456	979·8920
Hoboken, N.J.	40 44	74 02	35	980·2555	980·2576

SOLAR OBSERVATIONS AT THE ROYAL COLLEGE, ROME.—In the *Memorie della Società degli Spettroscopisti Italiani* Prof. Tachini communicates the observations of the sun made at the Royal College Observatory during the first trimestre of this year. The records of the protuberances during this period show that the monthly numbers were 138, 198, 264, a rapid increase, as will be noticed, the maxima heights being 1026″, 1149″, and 1650″ respectively for the same months. The mean altitudes increased also rather irregularly, 706″, 824″, and 1103″ being the numbers given. With regard to the spots, March contained the most numerous (358), being 94 more than January and 73 more than February. The number of groups for the first two months were, curiously enough, nearly equal (the numbers being 101 and 102), but the extensions were very different, 1968 and 2215 representing the numbers for the spots, and 870 and 1170 for the faculæ. The same number of these memoirs gives a summation of the solar observations made at the Royal Observatory at Palermo during the year 1892 by M. T. Lona and A. Mascari, and M. Abetti's observations of the conjunction of Mars with v Tauri, and of Saturn with γ Virginis.

L'ASTRONOMIE FOR JUNE.—The opening article in this month's number contains a description of a very remarkable observation on Jupiter made by M. Lumsden on September 20, 1891. It seems that he has seen the shadow of the first satellite of Jupiter on the planet's surface, accompanied and followed by a second shadow, not so dark and sharp as the original satellite, but nevertheless very distinct and incontestable. This second shadow is said to have moved uniformly with the real one, following it at an equal distance. The observer seems to be very certain that it was not a spot, so the question is—How can this secondary shadow be explained? It was thought at first that as the other satellites were all on the same side of the primary it might have been one of their shadows, but the facts show that that was not the case. M. Lumsden suggested that perhaps it was the shadow of Satellite 1 cast by the light emitted by Satellite 4, assuming the fourth satellite to be self-luminous, but M. Flammarion's explanation is perhaps more simple, it being that since the atmosphere of Jupiter is very deep, the clouds would be at various depths, and at great distances from one another, so that sometimes the shadow of a satellite would fall either on the upper or on the lower clouds, or even on the disc itself. It is true that the distance between these shadows would be very small as seen from the earth, and in the actual observation here mentioned the distance between the shadows is comparatively large. Among other communications in the same journal we may mention M. Cornu's address on the discovery of minor planets by photography, M. Flammarion on the spring of 1893, some notes on the late total solar eclipse, and a brief reference to a proposed new astronomical station on Mount Mounier, at an altitude of 2800 metres.

GEOGRAPHICAL NOTES.

MR. F. G. JACKSON, whose proposed attempt on the North Pole by Franz Josef Land has been announced, has altered his plans. He now proposes to spend next winter in Nova Zembla, in order to familiarise himself with the conditions of Arctic life, and to test his sledges and other appliances for travelling over the ice. His more serious journey in Franz Josef Land has been postponed for a year, and will have a greatly increased chance of success.

VITA HASSAN, well known as Emin Pasha's apothecary in the Equatorial province, died recently. He had published a book on affairs in the Sudan, which throws some new light on the history of the Egyptian provinces before Stanley's expedition reached the Albert Nyanza.

A LADY traveller, Miss Taylor, of the China Inland Mission' has made a somewhat remarkable journey in Eastern Tibet' details of which will be looked for with much interest. Miss Taylor, who travelled alone, is expected soon to arrive in this country.

A GEOGRAPHICAL Club has recently been established in Philadelphia, which practically constitutes a new geographical society. It has published the first number of a bulletin containing a paper by Mr. E. S. Balch on mountain exploration, in which he endeavours to redeem mountaineering from the charge of being only a dangerous pastime.

THE coral reefs of Dar-es-Salaam, on the east coast of Africa, have been carefully studied by Dr. Ortmann, whose observations extend considerably our knowledge of fringing reefs.

THE ROYAL SOCIETY SOIRÉE.

THE President of the Royal Society received a brilliant company at the Society's rooms on the occasion of the annual ladies' *soirée* on June 7. Many of the exhibits were shown at the *conversazione* of May 10, and were noted in NATURE of May 18. Other exhibits are described in the following account:—

Mr. C. J. Woodward exhibited a bar over a resonance chamber illustrating sound interference. When a ventral segment is over the box a loud deep tone is heard. When the bar is placed so that a node is near the centre of the opening to the box no sound is heard, owing to opposite movements of the bar on either side of the node.

The Karakoram Mountain Survey Expedition exhibited Water-colour Drawings of the scenery of the Karakoram Mountains, Kashmir, India, by Mr. A. D. McCormick. These drawings were made at altitudes of from 15,000 to 20,000 feet, during the Expedition in 1892.

Prof. Osborne Reynolds, F.R.S., exhibited an illustration of vortex motion showing motion analogous to vortex rings in fluids.

Prof. Thorpe, F.R.S., exhibited autotype enlargements from photographs taken by himself, illustrative of the recent African Eclipse Expedition. The enlargements portrayed—(1) the eclipse party; (2) the observing party at Fundium, Senegal—taken immediately after the eclipse; (3) the duplex coronagraph; (4) the prismatic camera; (5) the integrating photometer; (6) the equatorial photometer.

Capt. McEvoy exhibited the hydrophone. This, in connection with a new instrument named a kinesiscope, is intended to be used at night, or in foggy weather; it has for its object the prevention of surprise attacks from torpedo-boats, or other hostile vessels, approaching anchorages, or mine-fields. It will give warning of their movements when they are several miles distant by ringing bells, flashing lights, &c. These signals in every case are verified by telephones in the circuit. The apparatus, which is electrical, may also be employed to warn vessels off dangerous points of the coast.

Dr. John Gorham exhibited a reflecting kaleidoscope, which is a new instrument adapted to produce not merely symmetric patterns of beauty, but to exemplify many of the theories in optics connected with the reflections of light. To do this changes in its construction are required to adapt it to its novel uses. The two mirrors, for instance, must be thrown open to admit the light upon them and the objects. The objects themselves must have a definite shape to cause them to reflect oblique rays of light only, while the light again must fall upon them from above, instead of being transmitted through them from below. These objects consist of strips of card bent backwards and forwards into hollows and elevations, upon which the light falls obliquely. It is then received upon the mirrors and reflected from them to the eye. Experiments were made to show:—(1) Gray tones from oblique white surfaces; (2) tints and shades of colour from oblique coloured surfaces; (3) depth, intensity, and brilliancy by repeated reflections; (4) the choice lustre, &c.

Mr. Edwin Edser exhibited an apparatus to illustrate Prof. Michelson's method of producing interference bands. Light is allowed to fall on a mirror thinly silvered, so that about half of the light is reflected and half transmitted. The two rays pursue paths which are mutually perpendicular, are reflected back by two ordinary mirrors, and on meeting interfere. The interference bands can be projected on a screen, and this fact together with the simplicity of the arrangements will make the method very useful for lecture illustration.

Mr. W. A. Shenstone and Mr. M. Priest exhibited an apparatus used for studying the action of the electric discharge on oxygen. A known volume of oxygen at known temperature and pressure is exposed to the "glow" discharge at known difference of potential. The change of pressure is read by a mercury manometer, and from this the proportion of ozone is calculated. The use of the mercury manometer, hitherto impossible, makes this method very accurate, and by means of it our knowledge of the influence of various conditions (such as difference of potential, rapidity of discharge) has been considerably extended. It is found that under equal conditions a coil is more effective than a "Wimshurst" or "Voss" machine. The using of mercury in the manometer is made possible by protecting it from the ozone by placing a rod of silver in the tube connecting the ozone generator and the manometer.

Mr. Percy E. Newberry was in charge of an exhibit by the Egypt Exploration Fund (Archæological Survey). The exhibit included water-colour drawings executed by the artists of the survey—Mr. Percy Buckman, Mr. John E. Newberry, and Mr. Howard Carter—during the past season, 1892–3. (1) Sketches of various sites visited by the officers of the survey, including views of Tell el Amarna, Sheikh Said and Dêr el Gebrawi. (2) Specimens of facsimile drawings of wall paintings from ancient tombs in the provinces of Minieh and Assiut (VI. and XII. dynasties, B.C. 3800 and B.C. 2500).

Lord Kelvin, Pres. R.S., exhibited illustrations of the molecular tactics of a crystal. (1) Bravais homogeneous assemblage of 512 single points. (2) Two homogeneous equilateral assemblages of points, red and green, with stretched springs between each point of the green assemblage and its nearest neighbour, and four struts between each of the reds and its nearest neighbour of the green assemblage; showing how any degree of resistance to compression with given rigidity can be provided for by Boscovich's theory. (3) Three-dimensional netting, analogous to the ordinary hexagonal netting of two dimensions. The stretched cords of this model are exactly in the positions of the struts of model No. 2. (4) Twelve nearest and eight next-nearest neighbours of an ideal particle at the centre of a cube, placed to show the cubic arrangement of an equilateral assemblage. (5) Cubic cluster of fourteen balls, being the least number which can show cubic form in an equilateral assemblage. (6) Probable molecular structure of Iceland spar. (7) Illustrating the molecular movement in the twinning of Iceland spar by knife according to Baumhauer. (8) Illustrating Baumhauer's artificial twinning of Iceland spar by knife. (9) Tetrahedron with adjustable edges (six independent variables). (10) Two geometrical models of:—(*a*) A dextro-chiral crystal. (*b*) A levo-chiral crystal. (11) Special tetrahedron, with perpendiculars from corners to faces, meeting in one point; to illustrate engineering of Boscovich's theory for an incompressible elastic crystal with 12 arbitrarily given rigidity moduluses.

Dr. G. H. Fowler exhibited specimens of oyster shells. The specimens illustrate:—(1) The rate of growth of the oyster. (2) Natural varieties of the shells. (3) Modifications of a variety bred under new conditions.

Prof. T. McKenny Hughes, F.R.S., exhibited abnormal and normal forms of oyster shells. The collection included oyster shells, showing the great variety of abnormal forms produced by accidental change in the position of the shells during growth, and also a selection of oyster shells, showing that among recent shells of *O. edulis* most of the forms occur which are considered of specific value in fossils.

The Joint Eclipse Committee exhibited the following photographs taken during the recent Eclipse Expeditions to West Africa and Brazil. (1) Photographs of the corona, taken in West Africa. (2) Photographs of the spectra of the corona and prominences, taken in West Africa. (3) Photographs of the corona, taken in Brazil. (4) Photographs of the spectra of the corona, and prominences, taken with the objective prism in Brazil. (5) Photographs of the stations.

Mr. W. H. Preece, F.R.S., exhibited submarine borers and specimens of submarine cables damaged by them. The *Xylophaga* and *Limnoria terebrans* have proved serious and expensive depredators in tropical seas, but while twenty years ago limnoria was practically unknown in our English waters, it has now gradually spread all around our coasts, and cables have to be served with brass tape to be protected from its attacks. Some stones pierced by *Saxicava rugosa* were also shown. They came from the Plymouth Breakwater. Several specimens of damaged cables from different parts of the world were exhibited.

The Zoological Society of London exhibited (1) a series of living Canadian walking-stick insects (*Diapheromera femorata*), hatched from eggs laid in the Society's insect-house in 1892. The "Walking-sticks" are orthopterous insects of the family Phasmidæ, so-called from their resemblance to sticks. They are strictly herbivorous, and closely imitate the plants upon which they feed, changing colour as the foliage turns in autumn. In North America the present species is said to do great injury to the oaks. These specimens are fed on hazel-leaves. (2) Living specimens of the Hornet Clearwing Moth of the Osier (*Sesia bembiciformis*), reared from pupæ in the Society's Insect-house. This moth affords one of the best known examples of "*mimicry*." Although belonging to quite a different order of insects, it resembles a hornet so closely as to deceive a casual observer, especially when it is on the wing.

Col. Swinhoe exhibited some species of butterflies, illustrating protective mimicry. Mimetic forms of the nymphalid genus Hypolimnas in India, Malayana and Africa, showing the various phases of development of mimicry in two widespread species of the same genus; also mimetic resemblances to different protected species in the females of *Euripus halitherses*, &c.

Prof. H. G. Seeley, F.R.S., exhibited fossil skulls from the Karoo Rocks of Cape Colony. These specimens were brought from Cape Colony by the exhibitor in 1889. They include examples of the chief types of fossil reptiles included in the Anomodont and Theriodont groups, preferable to the genera Dicynodon and Tapinocephalus.

Mr. Edward Whymper exhibited the Corry "protected" aneroid, a new form of aneroid, specially designed for use in mountain-travel, or for aeronauts. This form of mountain aneroid is designed to avoid the inaccuracies which result from continued exposure to low atmospheric pressure. It is enclosed in a perfectly air-tight outer case, and the internal atmosphere is kept at about a normal pressure at all times, except when an observation is to be taken, and then the cock is opened, and communication with the external atmosphere is established. After taking a reading, the pressure is restored to the normal by means of a small force pump. The conditions thus correspond to those which originally obtained, when the aneroid was graduated under the air-pump receiver.

Mr. J. W. Swan exhibited specimens of electrolytic copper, deposited bright. A series of electrolytic copper deposits, showing the great change produced in the character of the deposited metal by the addition of a minute quantity of colloid matter to an acid solution of sulphate of copper. The deposits produced from the solution containing the colloid are not only bright instead of being dull, but they are also very much harder and more elastic than ordinary electrolytic copper.

Prof. Henrici, F.R.S., exhibited (1) A harmonic analyser, constructed by G. Coradi, Zürich, according to instructions by Prof. Henrici and Mr. Sharpe. The instrument gives, on going once over a curve, the first five terms of the expansion in Fourier's series, and on going twice more over the curve, it gives five additional terms. The constant term is not given. (2) A calculating machine by Prof. Sellinger, constructed by Ott, Munich. This instrument is constructed on altogether new principles. The "carrying" is done continuously without jerks. It works very rapidly and smoothly.

In addition, Prof. J. Norman Lockyer, F.R.S., gave a lecture on the localities and instruments used during the eclipse of April 16, 1893, in West Africa and Brazil, with photographs showing some of the results obtained.

Mr. W. M. Conway also used the electric lantern to show photographic lantern slides, illustrating the scenery of the Baltoro Glacier in the Karakoram Mountains, Kashmir, India. The photographs were taken during Mr. Conway's climbing and survey expedition in 1892. Some of them were taken from the summit of the Pioneer Peak (22,500 ft.); the remainder represent the great mountains K2, Gusherbrum, Masherbrum, the Golden Throne, and others, probably the highest group of mountains in the world.

At intervals throughout the evening Mr. W. Bayley Marshall exhibited the lantern stereoscope (invented by Mr. John Anderton). The images of a pair of stereoscopic transparencies having been superposed on a 10-foot screen, the beams of light from the two lanterns were polarised in planes at right angles to each other. The picture was viewed through a pair of analysers, similar to a small opera glass, and a true stereoscopic effect was obtained.

THERMOMETER SOUNDINGS IN THE HIGH ATMOSPHERE.

THE project, which was suggested by Le Verrier in 1874, of sending small balloons into the upper atmosphere with registering apparatus has been executed recently by M. Hermite, in Paris, with remarkable success. No fewer than thirteen small balloons, constructed with paper and varnished with petroleum, were liberated during the last four months of 1892, and penetrated to an altitude of 9000 metres. A paper balloon of 60 cubic metres capacity was sent up on December 7, but exploded at a small distance from the earth. It was therefore resolved to build a balloon of 113 cubic metres capacity in gold-beaters' skin. The launching of this balloon took place on March 21 last, at Vaugirard, with the help of the Aerophytic Union of France, of which I have the honour to be the president. The balloon was filled with 113 cubic metres of coal-gas. Its weight with netting was about fourteen kilograms. It carried in a small basket a Richard registering apparatus for temperature and pressure, and about seven hundred postal-cards, to be liberated by the combustion of a cotton string specially prepared for the purpose. This part of the operation utterly failed. Although the fire was put to both extremities of the string, it was extinguished before all the cards had been sent down, and out of four hundred which were precipitated, no more than five or six were recovered. Thus, the hope of determining the path by dropping such objects from an immense height had proved futile. But the recovery of the balloon at 190 km. from Paris was very easy, and the registering apparatus was returned to its owner in excellent working order. The diagram, which had been traced on the revolving cylinder, has been submitted to a close inspection, of which the results have been published in the *Comptes Rendus* and *l'Aerophile*, a new periodical devoted to the study of aeronautics.

The registering of the pressure had been continued down to 95 mm. of mercury, which answers to something less than 17,000 metres, if Laplace's formula is valid even for this altitude. A temperature had been registered of $-51°$ C. $=60°$ below zero Fahr. at a level of about 14,000 metres, according to the same formula. The temperature on the ground being $+17°$, a diminution of $67°$ C. was thus found, which is about a degree for each 210 metres. The atmosphere being supposed to extend up to 180,000 metres, it is easy to see that these numbers are an indication that the cold of the upper regions is much greater than supposed according to Fourier's theory, which asserts that the greatest degree of cold observed at the surface of the earth, viz. 58° registered by Black in Northern America is about equal to the temperature of celestial space.

This remarkable observation is not however to remain long isolated, as Commander Renard, of Meudon, has built a set of registering apparatus, which were exhibited recently at the anniversary meeting of the *Société de Physique*, and will be sent up very shortly with a 113 c.m. balloon inflated with pure hydrogen. So a new departure may be said to have been taken for the scientific exploration of the air at an altitude where no human being can penetrate. The series of prizes proposed by M. Hodgkins for 1893 and 1894, and the creation of the Hodgkins medal by the Smithsonian Institution, certainly add new interest to these experiments.

M. Janssen intends to establish an apparatus for making pure hydrogen in the Meudon Observatory in order to help M. Hermite to send his sounding balloons to a higher level if possible. He will, moreover, try to measure by direct observation the altitude of the balloons sent, as long as they remain visible from his Observatory.

This last scheme was adopted by Le Verrier, who says in the *Bulletin de l'Association Scientifique de France* for October 1874: "La hauteur du ballon est toujours déduite de la mesure du baromètre et du thermomètre, au moyen d'hypothèses sur la repartition de la pression atmosphérique. Il s'agit d'écarter ces causes d'incertitude, et de mesurer directement par des opérations trigonométriques la hauteur même du ballon; ce qui permettra de vérifier les lois admises ou de les modifier. Les opérations trigonométriques à terre seront faites par les astronoms de l'observatoire sur le charge de cette partie des dépenses. La direction de l'aerostat fourni par l'observatoire est confiée à M. W. de Fonvielle." The protracted illness of the illustrious astronomer and his subsequent death, prevented the series of ascents from being tried as contemplated.

The experiments already tried by M. Hermite, namely, on March 3, prove that the balloon will remain long visible from an Observatory, if the ascent is executed on a clear and calm day with a considerable ascending force, which goldbeater's skin can support without being torn by the friction.

The ascent of March 21, when ordinary gas was employed, took place with such velocity that the balloon was seen always nearing the zenith, independently of the diverging direction of the air, the mean recorded velocity having been eight metres per second from the time of starting to the time of maximum, which was reached in three-quarters of an hour, according to the automatic barometer.

The inflating pipe (*appendice*) which the balloon carried with it, was 30 cm. diameter and 90 cm. long, and air took the place vacated by the retreating gas, when the balloon descended. Consequently it was found quite full when discovered, just the same as when the balloon was liberated. The only differenec was that the gas had been expelled and replaced by air.

Since the volume of the balloon remained quite constant during the whole of the operation, it would have been quite easy to determine the absolute distance from the observatory by measuring the apparent diameter with a micrometer. By taking simultaneously a reading of zenith distance and azimuth, it would have been quite easy, by a series of observations conducted from a single station, to ascertain the altitude of the balloon and every circumstance of its motion.

The principal object of M. Janssen will be to determine the absolute minimum of temperature at the maximum altitude, which can be done more or less precisely, and the direction or velocity of the winds blowing at different altitudes. Then the indications of the registering instruments can be submitted to the rational control which is necessary before coming to any definite conclusion.

It is interesting to notice that these preliminary results are in conformity with the Joule and Clausius theory, which asserts that celestial space is at the temperature of $-273°$ C., or even with the opinion that there is no limit to the refrigeration, as asserted by other natural philosophers.

Another question is raised by these experiments, when coupled with Dewar's and Cailletet's discoveries relating to the liquefaction or solidification of the elements of the air. If the temperature descends to such a degree it is necessary to admit that the air loses its gaseous condition and becomes changed into a series of minute crystals or drops, which follow the earth in its motion through space, and are constantly vapourised when falling in regions where the temperature is somewhat above their point of liquefaction or evaporation.

Such are some of the questions raised by this new exploration of elevated regions, rendered very easy by the unexpected facility with which balloons and instruments in working order are recovered. This has been rendered possible in France by the interest taken in the matter by public schoolmasters, who have been notified of the experiments by the newspapers, and have found special instructions printed on a paper pasted to the basket. It is certain that similar results may be obtained in every civilised country in the world, and we trust this new method will develop and improve so that unquestionable facts will be discovered with regard to the mysterious cosmical frontiers of our globe.

W. DE FONVIELLE.

DISINFECTANTS AND MICRO-ORGANISMS.

SOME important results have recently been obained by Heider, who has been experimenting with disinfectants at higher temperatures and testing the effect produced upon their bactericidal properties. The author's first contributions in this direction were published in 1891. In Heider's original communication, "Ueber die Wirksamkeit von Desinfektionsmitteln bei höherer Temperatur" (*Centralblatt für Backteriologie*, vol. ix. 1891, p. 221), temperatures of 55° and 75° C. were employed, and the spores of anthrax were selected for investigation. Although these spores, it was ascertained, survived an immersion during 36 days in a 5 per cent. solution of carbolic acid kept at the ordinary temperature of the room, they were destroyed in from one to two hours in a similar solution at 55° C. Weaker solutions of this acid (1 per cent. and 3 per cent.), even when maintained at the higher temperature for seven and eight hours, produced no effect upon the anthrax spores. On the temperature being raised to 75° C., however, three minutes' exposure to a 5 per cent. solution of carbolic acid, fifteen minutes to a 3 per cent. solution, from two to two and a half hours to a 1 per cent. solution sufficed to annihilate these spores. Other materials were also investigated at these high temperatures, and equally satisfactory results obtained. Heider has brought together all his researches on this interesting subject in an elaborate memoir, "Ueber die Wirksamkeit der Desinfectionsmittel bei erhöhter Temperatur," which has been published in the *Archiv. für Hygiene*, vol. xv. p. 341. It is pointed out how great an effect upon the powers of resistance possessed by micro organisms may be exercised by the nature of their surroundings, and that it may be taken that they are, as a rule, more refractory in their normal environment than when purposely introduced into various materials. This has been shown by Yersin, in respect to the tubercle bacillus, which succumbs more readily to certain temperatures when exposed in artificial cultures than in sputum. Heider also found that particular culture media had a remarkable effect in this respect upon bacteria, that, for example, those grown in sugar broth (3 per cent. cane sugar) proved far more capable of resisting exposure to a high temperature than those introduced into ordinary broth. In conclusion, it having been distinctly proved that the bactericidal action of the majority of disinfecting materials is markedly increased when they are employed at a higher temperature, the author recommends that in all those cases where the destruction of spores is required, instead of applying these materials in cold solutions, they should be employed hot, or even boiling. The advantages derived by so doing are not alone the greater security obtained and saving of time, but economy in the cost of material, inasmuch as effectual sterilisation may be accomplished by the use of less concentrated solutions.

THE NEW FLORA AND THE OLD IN AUSTRALIA.

A VERY interesting paper on the effect which settlement in Australia has produced upon indigenous vegetation, by Mr. A. G. Hamilton, appears in the new number (vol. xxvi.) of the "Journal and Proceedings of the Royal Society of New South Wales." Mr. Hamilton traces with great care the results which have sprung from the direct action of man. He then deals with the alteration of the flora by the introduction of a new fauna, and the modification of it by the destruction of the native fauna. Finally, he considers the introduction of a new flora, and the consequent modification of the indigenous flora through competition.

The following is the portion of the paper relating to the effects due to a new flora:—

The plants which have become naturalised in Australia naturally come under two headings, viz. those purposely introduced for use, ornament or sentiment, and those which accidentally found their way here.

Of those introduced for use or for ornamental purposes, a large number do not spread to any extent: they are children of civilisation and show no tendency to become feral. Many hardy annual garden flowers come up self-sown in gardens year after year and yet never gain a footing outside. Others again, which have the power of spreading rapidly, are never able to do so, as they are succulent feed, and cattle take care that they never multiply. Such are oats and other grains. Wheat never seems to spread at all away from the fields in which it is cultivated. But still there are numbers of useful plants which are able to hold their own and more. Among these may be mentioned the lemon, peach, Cape gooseberry, tomato, and passion fruit, all of which are wild in many parts of the Illawarra district, and continue to bear fruit. Another species of passion flower (*Passiflora alba?*) is common there and is even more plentiful than the edible species. It is bitter and nauseous, but has spread over large tracts of bush country, converting them into tangle of the densest description. The common bramble or blackberry has been introduced for the sake of its fruit, and is now beginning to be a troublesome tenant of unoccupied lands in the cooler parts of the Colony. It reaches a development far exceeding that attained in its native land.

Sweet-briar and Scotch thistles are said to have been introduced for the sake of the associations clustered round the plants in the mother country. The latter plant is reported to have been introduced into Tasmania by a patriotic Scotchman desirous of having his national plant growing near his new home. He appears by all accounts to have succeeded only too well.

But with regard to most introduced plants, there is much difficulty in discovering the method of introduction. The plants which habitually flourish in European cornfields are certainly easily accounted for—they came in the seeds imported to the Colonies. Such are corn marigold, corn spurrey, and many of the Caryophylleæ, the cornfield poppy and numerous others which will occur to every one. Then again, many noxious weeds growing among grain, were introduced to Australia in straw in packing cases. Such are the Centaureas and others. As an example of this I may note that *Bupleurum rotundifolium* first appeared in the Mudgee District in a yard where a box from England was unpacked.

But with many plants introduced, we can only reason by analogy as to the manner of their introduction. In an article on the weeds of Europe in the *Cornhill Magazine*, an anonymous writer states that a common English weed was introduced into an Antarctic island by the use of a spade which had some mould attached to the blade, and the plant has now spread all over the island. Darwin gives instances of seeds being found in balls of clay attached to the feet of birds, and even to the elytra of beetles. Still, the method of introduction of many foreign weeds must in the nature of things always remain more or less of a mystery. Many aliens have arrived in the colony attached to the wool of sheep or the hair of other animals as in the case of the Bathurst Burr—a species of vegetable stowaway.

As to the methods of spreading, they are various. Cultivation of the soil brings the weeds in its wake, and they manage to spread somehow. Some have specially constructed seeds to float through the air—any one who has seen thistle-infested country on a windy day will have a good idea how thistles spread. The Composites are especially rich in plants adopting this contrivance. Others stick to the wool and hair of animals by hooks, barbed hairs, or sticky glands. Others again have seeds so minute that a high wind will carry them, although they are not furnished with special apparatus for the purpose.

Railways and roads are active helpers in the dissemination of aliens, especially the former. The land being fenced in is protected from the depredations of stock, and thus protected the weeds flourish and spread rapidly. In 1887 I remember noticing on the Mudgee Railway near Lue that there were miles of the embankments one tangled mass of *Meliotus parviflorus*. And in the neighbourhood of Bowenfels the railway line enclosures are thickly covered with a species of *Hypochæris*: it is pretty plentiful outside but inside the land is a golden sheet of the yellow flowers. Rivers also act in the same way, and especially carry weeds when in flood and deposit them on the flooded lands. I first noticed *Ranunculus muricatus* and Fool's parsley on the river banks at Mudgee. The following year they had reached Cullenbone, and the next year had got as far as Guntawang, a distance of seventeen miles by road but at least twenty-five or thirty by the river. A curious instance of the spread of a plant from one locality to another was afforded me in 1886 and 1887. During a journey from Guntawang to Wellington, a distance of forty-two miles, I noticed at Wellington, on the river banks, great quantities of *Cassia sophora*. At that time none of the plant was found in the Mudgee District, but in the same year a mail coach commenced running from Wellington to Gulgong passing through Guntawang. The following year, two plants of the *Cassia* appeared at Guntawang, and soon after it began to be common in the district. The Rev. Dr. Woolls, at a meeting of the Linnean Society of N.S Wales, in September 1890 exhibited plants of *Calotis scapigera* and *C. hispidula* from Concord and Burwood. These are strictly denizens of the interior and were probably brought down by sheep travelling to the sale yards. Indeed I feel pretty sure that an examination in the neighbourhood of the Homebush sale yards would show that many western plants are brought down by the sheep, etc. In collecting introduced plants, I have always been most successful by roadsides, river-banks, and railway enclosures, and there can be no doubt but that they are the principal lines of travel for these plants.

The plants which have edible fruits containing indigestible seeds are for the most part dispersed by birds and mammals which eat the fruit and void the seeds in new localities. In this way passion fruit, blackberries, *Phytolacca*, tomatoes, solanums, Cape gooseberries, and many others are distributed.

It is a significant fact that horehound—*Marrubrium*—is always plentiful in the vicinity of a sheep station. Two other plants commonly found in the same situation are the introduced nettles, *Urtica urens* and *U. dioica*, whether from the plants being eaten by the sheep and the undigested seeds voided, or because that in sheep-manured land they find a congenial soil, I am unable to say.

Australian plants from their long isolation, and their having little competition of a severe kind, settled down into a state of balance or rather of slight oscillation, governed by a few causes, which themselves varied but little. In the older continents, however, from the intercommunication of the various nations, and from the fact that men continually add to their stock of cultivated plants, there is severe competition; the struggle for existence goes on continually and aided by natural selection and domestication some plants gain an advantage.

Among other, useful habits acquired by plants under competition is a certain plasticity of constitution which enables them to bear changes to different climates with equanimity. On this account the old world weeds when brought to Australia are able to beat the native plants. They are mostly plain dwellers, and as such accustomed to the heat of the sun in the open, and the bitter blasts of the winter, better than forest plants. When forests are cleared and brought under cultivation, the weeds soon beat the former occupants out of the field. Again many old world weeds are plants of wide range, and on this account have an advantage over those of more restricted habitat.

"Widely varying species abounding in individuals which have already triumphed over many competitors in their own widely extended homes, will have the best chance of seizing on new places when they spread into new countries. In their new homes they will be exposed to new conditions, and will frequently undergo further modification and improvement; and thus they will become still further victorious and produce groups of modified descendants." ("Origin of Species," 6th ed. p. 319.) As before remarked their success in competition implies a plasticity of organism which is an advantage to them also; on this subject Darwin says, "If a number of species, after having long competed with each other in their old home, were to migrate in a body into a new and afterwards isolated country, they would be little liable to modification or variation; for neither migration nor isolation in themselves effect anything." (*Op. cit.*, p. 319.) The isolated productions of Australia on the other hand, have had uniform conditions and comparatively small range and so they cannot make way against those that have had such competition and range.

"In the same manner at the present day, we see that very many European productions cover the ground in La Plata, New Zealand and to a lesser extent in Australia and have beaten the natives, whereas extremely few southern forms have come to be naturalised in any part of the northern hemisphere, though hides, wool and other objects likely to carry seeds have been largely imported into Europe during the last two or three centuries from La Plata, and during the last forty or fifty years from Australia." (*Op. cit.*, p. 340.) Wallace says, "There is good reason to believe that the most effective agent in the extinction of species is the pressure of other species, whether as enemies or merely as competitors." ("Island Life," p. 63)

It is well known that few Australian plants have found a footing in Europe notwithstanding the many facilities which commerce offers for their introduction, and the few American weeds which have found their way to Europe do well only in the Mediterranean region. Even in New Zealand but a few Australian plants have become naturalised, as is shown by Mr. T. F. Cheeseman's paper on the naturalised plants of Auckland (read before the Auckland Institute, November 1892).

In America, the majority of introduced weeds are European, though at first they completely beat the natives, it is noteworthy that now the natives are holding their own, and even beating the strangers, thus showing that competition has gone on long enough for some advantage to be gained by the natives. It is remarkable too that the plants of Eastern America immigrated westward with man, and conquered the western plants at first; but from a consideration of the facts the great American botanist Prof. Asa Gray was led to prophesy a return wave of western plants, and that is now actually coming.

The theory that insulated floras are less able to resist the influx of foreign plants is supported by the fact that only in the Neilgherrie Mountains in India have Australian plants been able to compete with others to any extent. It is, I believe, considered that that part of India long existed as an insular region. Therefore we see that the Australian flora, which though isolated, had a large range, is able to get an advantage over the Neilgherrie flora which was for so long developed in a small centrum.

One cause of the power of spreading of what are commonly called weeds is that they are usually plants with inconspicuous flowers, and as such are generally self-fertilised and so can get along without specialised insects to fertilise them. It is manifest that in a new country where the local insect fauna is being destroyed to some extent, the plants which have not to depend on insects for fertilisation will be the more likely to win. And even cross-fertilised plants seem to manage sometimes to find insects to perform that office for them. Moseley points out an instance in the following passage:—"The orange, lemon, and lime, which grow wild all over Tahiti do not appear to deteriorate at all in quality or quantity of fruit, although in the ferine condition. The fruit almost appears finer for running wild. . . . . Some native insect must have adapted itself completely to the blossoms of the orange tribe as fertiliser, so abundant is the fruit." ("Notes of a Naturalist on the *Challenger*," p. 524.) The same is the case in Australia, for although the orange does not seem to grow wild to any extent, lemons have made themselves at home in the Illawarra district. The flowers of the lemon and the native plant *Synoum glandulosum* are much alike in structure, and it may be that the same insect or insects fertilise them. These plants would be on equal terms in this respect, but the lemon from its wide cultivation has gained a power of bearing diverse conditions, which gives it a better footing. I may remark that *Synoum* is a common plant in Illawarra.

Among wind-fertilised plants are the grasses. The introduced species so far are not beating the natives. They are equal as far as regards fertilisation, but most introduced species are from cool temperate regions, and so the Australian species being warm temperate, are able to hold their own. The dying out of some Australian grasses is attributable to over stocking and close feeding and not to competition.

In considering the introduction of weeds in Australia there is a great difficulty viz. that it is hard in some cases to say whether c rtain plants are indigenous or alien. It is considered a safe ul: to take all plants common in the colony in Robert Brown's time as truly indigenous, but as Brown only collected in the neighbourhood of Port Jackson, that course leaves some difficulty still. On this subject Baron von Mueller says in the preface to his "Census of Australian Plants" (1st Edit. 1882) —"The lines of demarcation between truly indigenous and recently immigrated can no longer in all cases be drawn with precision; but whereas *Alchemilla vulgaris*, and *Veronica serpillifolia* were found along with several European *Carices* in untrodden parts of the Australian Alps during the author's earliest explorations, *Alchemilla arvensis* and *Veronica peregrina* were at first only noticed near settlements. The occurrence of *Arabis glabra*, *Geum umbrosum*, *Agrimonia eupatoria*, *Eupatorium cannabinum*, *Carpesium cernuum*, and some others will readily be disputed as indigenous and some questions concerning the nativity of various of our plants will probably remain for ever involved in doubts." As will be seen from this, the origin of some plants will and must remain more or less a matter of personal opinion. And on referring to lists of plants of the various colonies it will be found that their authors differ in their placing of these doubtful plants. If we critically examine the Census of New South Wales plants by Mr. C. Moore, of Queensland plants by Mr. F. M. Bailey, of Victorian by Baron Von Mueller, and of New South Wales by Dr. Woolls, we shall find abundant evidence of diversity of views in this respect. But very many weeds present no difficulty at all, although the record of their plentiful occurrence in very early days may well surprise us. The Rev. J. E. Tenison-Woods ("Proc. Linn. Soc. of N.S. Wales," vol. iv., p. 133) remarks that Leichhardt found *Verbena bonariensis* so plentiful in the neighbourhood of Darling Downs, then only five or six years settled, that he named the place Vervain Plains.

The injury done by introduced weeds will be almost entirely by competition, but it is possible that in time, the Australian plants may begin to hold their own and even to some extent drive out the others. This will be more especially the case with the group of plants which are found on the barren and sandy tracts wherever the Hawkesbury Sandstone formation occurs. In such land few aliens get a footing. On the sandstone about Sydney as a rule, and in the Blue Mountains where the same soil occurs, the foreign weeds have no chance. But wherever the soil is fairly good, or where it has been broken up, there they triumph and exclude the indigenes.

To some extent however, the weeds will work their own destruction. They increase so rapidly that competition is most severe, not between them and the natives, but between individuals of the same alien species, or between distinct alien species. *Sisymbrium officinale* was once a pest near Mudgee, the fallow and unoccupied land being covered with a thick mass of it; but after the lapse of a few years it became quite rare, and *Erigeron canadense* took its place. I think that in some cases the fact of a heavy crop of weeds occurring in a locality one or more years is a reason for expecting its scarcity in the following years. The soil becomes exhausted of the particular constituents demanded by the plants, and they fail in consequence. I had often read doleful prophecies of the damage that might be expected when the Cape weed (*Cryptostemma calendulaceum*) became common. When I first saw it appear in Illawarra, I was therefore prepared to see much land infested by it in a short time. It spread to a great extent in certain spots for a couple of years and then almost disappeared. In my garden half-a-dozen vigorous plants came up, and as I left them for the purpose of observation, they flowered and seeded plentifully. I fully expected a large crop the following year, but to my surprise not a single plant was to be found, nor has there been on

Mr. T. Kirk, in a paper on the naturalised plants of Port Nicholson, N.Z., says:—"At length a turning point is reached, the invaders lose a portion of their vigour, and become less encroaching, while the indigenous plants find the struggle less severe and gradually recover a portion of their lost ground, the result being the gradual amalgamation of those kinds best adapted to hold their own in the struggle for existence with the introduced forms, and the restriction of those less favourably adapted to habitats which afford them special advantages." (Trans. N. Z. Inst., vol. x., p. 363) And Mr. T. F. Cheeseman, from whose paper on the "Naturalised plants of the Auckland District" I have quoted the above, coincides with this opinion to some extent and says, "Speaking generally I am inclined to believe that the struggle between the naturalised and the native floras will result in a limitation of the range of the native species rather than in their actual extermination. We must be prepared to see many plants once common become comparatively rare, and possibly a limited number—I should not estimate it at more than a score or two—may altogether disappear, to be only known to us in the future by the dried specimens in our museums."[1] If this is likely to be the case in a territory so limited as New Zealand how much more is it probable in Australia with the vast extent of area, diversified surface and various climates from tropical to cold temperate.

[1] Paper read before the Auckland Institute, November 1892.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"On the Geometrical Construction of the Oxygen Absorption Lines Great A, Great B, and α of the Solar Spectrum." By George Higgs. Communicated by R. T. Glazebrook, F.R.S.

In the early part of August, 1890, the photographic work of the normal solar spectrum which I had undertaken had been carried as far as great A, or the limit of visibility in the red, and to λ 8350, or beyond z, in the invisible regions.

During the two previous months of continuously dull weather, while classifying and comparing results, I was interested, on making a close examination of the head portion of the A line, to find, the rhythmical grouping, the harmonic order of sequence, and other characteristics of the B line repeated here in every detail.

These two bands, together with alpha, are composed of a number of doublets or pairs, which approach each other on the more refrangible side with uninterrupted regularity, finally crossing, and at the limiting edges of all three bands the three last pairs overlap each other.

The differences of wave-length between the components of pairs increase in the same order.

These and other properties, which will be referred to, are still more obvious in the trains or flutings.

From its holding an intermediate rank in each of its distinguishing characters I was induced to adopt B as a typical group in a geometrical representation, and to investigate the subject by means of rectangular co ordinates.

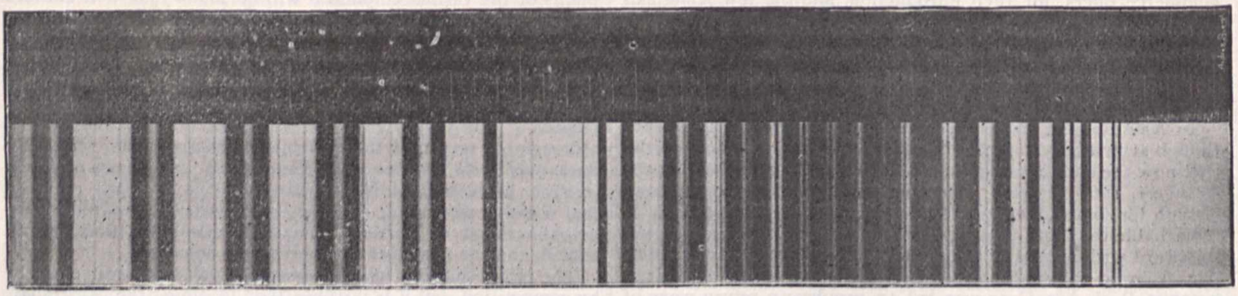


FIG. 1.

Before a complete analysis could be made out, a micrometer had to be completed. This consisted of a platform, serving as a plate holder, which was made to travel on runners between parallel ways by means of a screw of such a pitch as to move the negative from one division of the scale to the next, for one revolution of the divided plate on the screw head, this latter being divided into 100 parts.

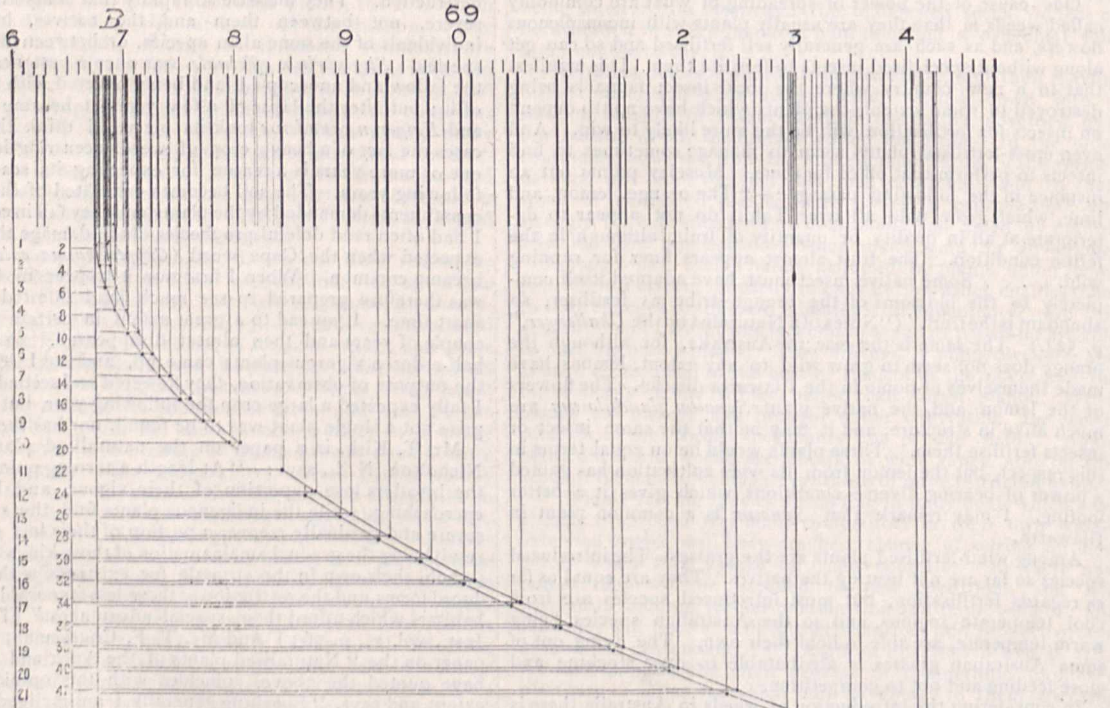


FIG. 2.

On and over the platform, a microscope is mounted with slide motions at right angles to each other; an index of glass fibre and reflector complete the apparatus.

Over 1000 measurements of nearly 200 lines have been made, 100 of which belong to great A, these together with the computed positions are contained in the Proc. Royal Soc.

In the analysis the axis of x is assumed to occupy a position coincident with, or parallel to, the scale of $1/10^{10}$ m. units, and the positions of the various lines are set off on this scale (see Fig. 2) for the group, which is divided into four series. Ordinates are then drawn in the position occupied by each line. The axis of y is divided into a number of equal parts, 1, 2, 3, n. Lines parallel to the axis of x, drawn from each of these divisions, intersect the respective ordinates. The continuous curve passing through the points of intersection is found to possess all the properties of a parabola.

Three points at least are selected to determine the position of the vertex and value of latus rectum. The distance from the origin along y is also found for an ordinate to the first line of a series.

Now, from the equation to the parabola $y^2 = px$, the formula $\lambda = V + \frac{(n+c)^2}{p}$ is derived, where V = the wave-length in $1/10^{10}$ m. units of a point in the spectrum coinciding with the vertex of the curve; p, the latus rectum; n, any number of units, reckoning from the origin; c, a constant.

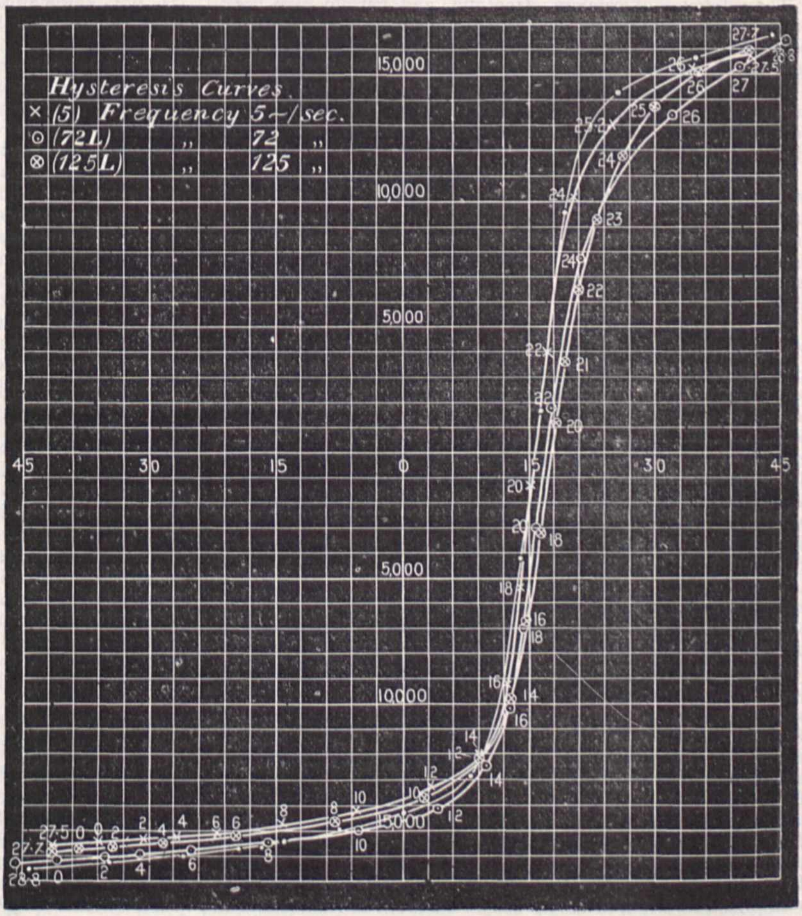
In practice a representation more suitable for lantern projection being desirable, two units are taken on y for each line of the series; the equation then becomes $\lambda = V + \frac{(2n+c)^2}{L}$, where $L = 4p$, and c has twice its former value.

April 20.—"Magnetic Viscosity." By J. Hopkinson, D.Sc., F.R.S., E. Wilson, and F. Lydall.

In some experiments carried out by Dr. J. Hopkinson and B. Hopkinson, an account of which appeared in the *Electrician* of September 9, 1892, it was found that when hysteresis curves were obtained for rings of soft iron and hard steel wire by means of alternate currents, and compared with curves taken with the ballistic galvanometer, in the cases where the induction was considerable, there was a marked difference which might be due to magnetic viscosity or to the ballistic galvanometer.

To settle this question the experiment was tried of completing the galvanometer circuit at known intervals of time after the magnetising force had been changed, and noting the deflection. The effect of the self-induction of the ring was approximately calculated, and found inadequate to account for the deflections obtained.

Next, the experiments previously alluded to were continued, and curves of hysteresis obtained with alternating currents of a frequency of 5, 72, and 125 v per second, the method of procedure being exactly the same. In all the curves thus obtained it was seen that the more rapid the change of magnetising force, the greater was the deviation from the curve taken with the ballistic galvanometer. The accompanying figure gives the hysteresis curves actually obtained, and show this point very clearly.



Similar experiments were carried out on hardened chromium steel, and the same effect was observed but was not so marked.

The following conclusions are drawn from the experiments:—(1) As Prof. Ewing has already observed, after sudden change of magnetising force the induction does not at once attain to its full value, but there is a slight increase going on for some seconds. (2) The small difference between the ballistic curve of magnetisation with complete cycles, and the curve determined with a considerable frequency which has already been observed is a true time effect, the difference being greater between a frequency of 72 v per second and 5 v per second, than between 5 v per second and the ballistic curve.

June 1.—"On the Metallurgy of Lead." By J. B. Hannay. Communicated by Sir G. G. Stokes, F.R.S.

In this paper the author deals with the result of seven years' researches on the metallurgy of lead.

It is shown that by repeated crystallisation any subsulphide of lead may be fractionated into metallic lead, and its monosulphide. The sp.gr. of pure monosulphide is found to be 7·766, and the methods of analysis are reviewed and corrected.

The reaction, $PbS + PbSO_4 = 2Pb + 2SO_2$, which was supposed to explain lead smelting, is shown to have no existence, as when lead sulphate and sulphide react upon each other, a volatile compound, PbS_2O_2 or $PbS.SO_2$, is formed which introduces complications, and being unknown to chemists was the cause of the errors in the accepted furnace reactions of lead.

This substance is formed whenever its constituents PbS, and SO_2, meet at high temperature, and is the cause of lead fume. Similar volatile compounds are formed by the gases CO_2, CO and H_2O. These bodies dissociate on cooling, but form colourless gases at a red heat.

All the furnace reactions of lead compounds are examined and corrected in the light of these discoveries, and the fact applied to explain the metallurgy of lead.

A new metallurgy is mapped out by which galena is treated in a Bessemer converter, and made into pig-lead, litharge, or sulphate of lead, in any proportions as may be desired, while all the silver is eliminated.

"Flame Spectra at High Temperatures. Part I. Oxyhydrogen Blowpipe Spectra." By W. N. Hartley, F.R.S.

The substances examined are supported in the oxyhydrogen flame on small plates of kyanite. This mineral contains ninety-six per cent. of aluminium silicate, and is practically infusible. The spectra were all photographed. The dispersion of the instrument being that of one quartz prism of 60°.

The spectra of a large majority of the metals and their compounds all terminate somewhere about the strongest series of water vapour lines in the ultraviolet. Typical non-metallic spectra are sulphur, selenium, and tellurium; the first yields a continuous spectrum with a series of beautiful fluted bands, the second a series of fine bands, occurring at closer intervals, and the third is characterised by bands still closer together and near the more refrangible termination of which four lines occurring in Hartley and Adeney's spark spectrum of tellurium are visible. Increase in atomic mass causes shorter periods of recurrence of bands. In line spectra it is the reverse; increase in atomic mass causes greater periods in the recurrence of lines. Charcoal and carbon monoxide yield chiefly continuous spectra; the latter, however, exhibits some carbon lines. The hydrocarbons yield the well-known spectrum of carbon bands with also those attributed to cyanogen. Of metallic elements, nickel, chromium, and cobalt yield purely line spectra; antimony, bismuth, silver, tin, lead, and gold beautiful banded spectra (spectra of the first order) accompanied by some few lines.

Iron and copper exhibit lines, and, less prominently, bands. Manganese has a beautiful series of bands and a group of three very closely adjacent lines. Aluminium gives a fine continuous spectrum with three lines, origin uncertain, zinc a continuous spectrum without lines, and cadmium a spectrum consisting of one single line only, λ 3260·2.

Of compounds, chromic trioxide yields a continuous spectrum with six lines belonging to the metal, copper oxide a fine band spectrum with two lines of the metal, magnesium sulphate gives a spectrum of magnesium oxide consisting of broad degraded bands composed of closely adjacent fine lines and one line belonging to the metal, λ 2852.

The sulphates of calcium, strontium, and barium give both bands of the oxides and lines of the elements. Phosphorus pentoxide yields a continuous spectrum with one peculiar line, seen also in the spectrum of arsenic.

The chlorides of the alkali metals give also lines of the elements with a more or less continuous spectrum, which, it is believed, is due to the metal in each case. Lithium chloride gives no continuous spectrum.

The Volatility of Metals.—One of the most interesting facts ascertained by this investigation is the volatility of all the metals examined, except platinum, and particularly the extraordinary volatility of manganese, and, to some extent, of the infusible metal iridium. Metal believed to be pure iridium is seen to have diminished after the flame has played upon it for about two hours.

Physical Society, May 26, Prof. A. W. Rücker, F.R.S., President, in the chair.—Mr. C. J. Woodward showed some experiments with a vibrating bar. On suspending the bar by two loops of cord, and placing it over a resonance box, the sound was greatly intensified. When placed crosswise, and partly over the box, a position could be found where no increase of sound resulted, whilst a little movement in either direction from this position caused a considerable increase.—The discussion on Dr. Lodge's paper, the foundation of dynamics, was then resumed. Communications on the subject from Mr. S. H. Burbury, Dr. G. Johnstone Stoney, and Prof. E. F. Herroun were read. Prof. Minchin said the first fundamental axiom of dynamics postulates the existence of *Force* as an entity distinct from *Matter*, *Space*, and *Time*, and this was the object of Newton's First Law. It also gave the criterion of the presence of force. To merely retain the law as defining *equal times* was to degrade it. As regards the supposed impossibility of defining uniform motion he said, similar difficulties occur in all sciences, even in geometry. Nevertheless a rational science of geometry existed. In dynamics we had notions of a right line and of uniform motion in it, although no criterion of either may exist. The fact that the science harmonises with ordinary experience constitutes its validity. In his opinion the extraordinary devices which had been suggested for defining directions fixed in space were unnecessary, and merely served to cover the subject with ridicule. He disagreed with Prof. Lodge in admitting the first law as a particular case of the second, for unless force was postulated (the function of the first law), the second became a mere definition, and not a law. Speaking of the third law he said the author had made a serious error in stating that it could be deduced from the first, for the centre of mass of a system might be at rest, without action and reaction necessarily being equal and opposite. The third law was not superfluous; neglecting it had led to great misconception and mystery about the Principle of Virtual Work, and D'Alembert's Principle, both of which are simple deductions from it. In opposition to Dr. Lodge, he defended the ordinary definition of Energy, and asserted that without the notions of *force* and *work*, the term *energy* loses all meaning. Speaking of transference and transformation of energy, he inquired if the proof given could be applied to the case of a body sliding down a rough rigid inclined plane, for here the stress (friction) does work on the body but not on the plane, and there was no transference. He regretted that the expression "potential energy" was used in different senses in the paper, sometimes meaning "static energy," and at others "the available portion of the kinetic energy of a body." Referring to the idea of all energy being ultimately kinetic, he asked if by accepting this the author meant to surrender the independent existence of force. If so, difficulties would arise; for example, in the kinetic theory of gases the expression for the pressure, $p = \frac{1}{3} \rho v^2$, was only arrived at by assuming the existence of force. The statement on the top of slip 9 about making a "moving body do work" was not necessarily true, as might be seen by considering the case of a sphere rolling down a rough inclined plane. Prof. O. Henrici thought axioms should be treated as true logical definitions, as for example in geometry, "two straight lines cannot enclose a space." Every new notion required its axiom. In passing from geometry to kinematics the idea of Time presented itself, and the appropriate axiom was contained in Newton's first law. On approaching dynamics Force and Mass were met with. He disagreed with Prof. Minchin in regarding force as most fundamental. Mass was more essential, for force might be abolished. On the other hand, he concurred with Prof. Minchin in thinking that the idea of a centre of mass was not axiomatic. Referring to Dr. Lodge's summary (NATURE, p. 62) he agreed with axiom (*a*) fully, and with (*b*) partially. Axiom 3 required further development. The crucial point, however, was axiom 4, "Stress cannot exist in or across empty space." This he regarded as very incomplete, and maintained that axioms defining the properties of the ether were necessary to further progress. If varieties of space be contemplated each advance required fresh axioms. Dr. C. V. Burton remarked that contact movement did not necessitate equal velocities; sliding motion was a case in point. Again, in deforming an incompressible fluid, although force and motion might exist, no work was done. Conservation could not be proved from denial of action at a distance. Speaking of the doctrine of transference and transformation of energy, he said it was a convenient working rule, but not true universally. Newton's laws were simple and consistent, but some doubt existed as to how much was definition and how much *law* or fact. Mr. Swinburne protested against the difference between theory and a working hypothesis being overlooked. All conceptions were based on experience, and ideas of ether and atoms derived from "jelly" and "cricket balls." We ought also to remember what "explanation" means, viz. describing the unfamiliar in terms of the more familiar. It was customary to describe the phenomena of fluids by reference to solids because we were more familiar with solids; an intellectual fish would probably do the reverse. The so-called "Theory of Magnetism" which breaks up a bar of iron into a number of small pieces, each possessing the properties of the original bar, he regarded as absurd. It was no "explanation" and not a "theory." Ether might be used as a working hypothesis, but must not be treated as an entity. Mr. Blakesley questioned whether transference of energy was always accompanied by transformation, and he did not see why energy should be looked upon as $(mv)\frac{v}{2}$, in preference to any other subdivision of the factors. As regards effects being proportional to their causes, he pointed out that the heating of an electric circuit, and thermoelectric action, followed laws not linear. Prof. S. P. Thompson, referring to the demonstration of the law of transference, &c., given on slip 8, said that attempts to translate it into Latin or Greek at once revealed the ambiguous character of the proof. Speaking of Ohm's law, he pointed out that R, a constant, was not an essential feature, as Dr. Lodge supposed. Ohm never said R was constant. In identifying energy, a difficulty presented itself, for one never came across it as a single thing but as a product, and in being transformed the paths of the two factors might possibly be different. Mr. Dixon said the whole of geometry and dynamics could be based on verbal definitions. The conservation of energy could be written as: Kinetic energy + potential energy = a constant, but on substituting the expressions for kinetic and potential energies, an identity resulted; therefore the original statement was not a law. Both the kinetic and potential energies of a system were functions of its configuration. Potential energy could not belong to a particle, but to a system. The president doubted whether Dr. Lodge's scheme was more simple, natural, and logical, than the ordinary one. The statement in NATURE (p. 62) that "strains were proportional to stresses" was simple enough, but it was questionable if "frequency of vibration is independent of amplitude" could be considered so. The author appeared to ignore *mass* in comparison with *force*, whereas the idea of *mass* seemed to be the more simple one. Dr. Lodge, in reply to Mr. Burbury, said two bodies never do attract one another; the thing which acted on either was the medium immediately in contact with it. Mr. Herroun had used metaphysical arguments against ether, but he (Prof. Lodge) thought it was a good thing to investigate ether. He agreed with what Prof. Minchin said about force and the first law of motion. *Force* was the more fundamental, but *mass* was best as a standard unit. As regards ether, he was prepared to say that it has no motion. It possessed electromagnetic kinetic energy, and probably all the stress energy that exists. Referring to the slipping body mentioned by Prof. Minchin and Dr. Burton he said that in speaking of the velocities of acting and reacting bodies being equal, he always meant that their velocities along the line of action were equal. The action between the sliding body and plane was a "catch and let go" one, like a fiddle bow and string. On the second laws of thermodynamics he hoped to say something in a subsequent paper. When he spoke of R being constant as the essence of Ohm's law he meant constancy as regards terms which appear in the equation $\frac{E}{c} = R$.

Linnean Society, June 1.—Prof. Stewart, President, in the chair.—Dr. J. Lowe gave an account of a newly-observed habit of the blackcap, *Sylvia atricapilla*, in puncturing the petals of certain flowers (*Hibiscus Rosa-sinensis* and *Abutilon frondosum*), specimens of which he exhibited, thus causing the exudation of a viscid secretion which proved attractive to insects upon which the bird preyed. The observations in question were made at Orotava, Teneriffe, during the month of March last.—By way of introduction to a paper by Mr. W. B. Hemsley on Polynesian plants collected by Mr. J. J. Lister, the latter gave an interesting account of the geology of the Tonga Islands, their volcanic nature, and the coral and limestone reefs with the soil formed chiefly of volcanic outpourings, on which dense patches of bush were growing. Referring then to the bird-fauna of the Tonga group, Mr. Lister compared it with that of Fiji and Samoa, and showed that it had no special affinity with the avifauna of New Zealand, and exhibited very little specialisation. Mr. Hemsley then gave an account of the plants collected there, as also in the Solomon Islands.—Mr. A. B. Rendle gave an abstract of a paper on fossil palms, in which his remarks were directed to a revision of the genus *Nipadites*, Bowerbank, and were illustrated by drawings of specimens from the London clay, Sheppey, from the Sussex coast, Selsey, Brussels, N.E. Italy, and elsewhere. The paper was criticised by Mr. Carruthers and by Mr. Clement Reid, who described the finding of specimens *in situ* at Selsey.—The secretary then read a paper by Dr. Baur on the temperature of trees, from observations taken in Colorado.—Mr. W. M. Webb gave an abstract of a paper on the mode of feeding in *Testacella*, illustrated by lantern slides prepared from original drawings of the living animal in various attitudes.

Royal Microscopical Society, May 17.—A. D. Michael President, in the chair.—Mr. G. C. Karop read a letter from Dr. R. L. Maddox on the subject of his rod illuminator.—A letter from Mr. W. H. Youdale, referring to some diseased beard-hairs, was also read by Mr. Karop.—Mr. C. Lees Curties exhibited and described a new form of camera lucida, made by Herr Leitz, of Wetzlar.—Sir David L. Salomons gave an exhibition with his projection microscope.—The President said they were extremely indebted to Sir David Salomons for the very admirable and interesting exhibition which he had given them, the value of which was not only on account of the defraction phenomena, which had been so well shown, but because of the advance which was indicated in the construction of the apparatus. He could not help observing, as the exhibition proceeded, that there was a remarkable flatness of field not generally seen under similar circumstances. There was one point on which he should like to ask for information; it sometimes happened that great concentration of light produced also a great concentration of heat, and that consequently objects in balsam, if exposed for too long a time, were apt to get spoilt through the softening of the medium. Was this difficulty got over in the present instance by using the electric arc light as an illuminant?—Sir David Salomons said he obviated it very much by using lenses cemented with balsam. The customary alum and water he found to be rather a trouble, and so he used simple distilled water, and found that it answered all the necessities of the case.

Zoological Society, June 6.—Sir William H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May, 1893, and called special attention to a young Water-Buck (*Cobus ellipsiprymnus*), born May 4, 1893, being, so far as was known, the first antelope of this species that has been bred in captivity.—Mr. Walter Rothschild exhibited and made remarks on an egg of the Duckbill (*Ornithorhynchus anatinus*), taken from the pouch of the mother; the leg-bones and egg of an extinct bird of the genus *Æpyornis* from south-west Madagascar; and series of lepidopterous insects from Jamaica and from the Bolivian Andes.—Mr. Sclater exhibited and made remarks on some skins and skulls of mammals obtained in the Shiré Highlands by Mr. H. H. Johnston, Mr. B. L. Sclater, Messrs. Buchanan, and Mr. Alexander Whyte.—A communication was read from Messrs. F. E. Beddard and F. G. Parsons containing notes on the anatomy and classification of the parrots, based on specimens lately living in the Society's Gardens.—Mr. Sclater called attention to two front horns of an African rhinoceros belonging to Mr. F. Holmwood, which were stated to have been brought by native caravans from the district of East Africa, south of Lake Victoria Nyanza. They were remarkable for their great length and extreme thinness.—A communication was read from Mr. R. Lydekker containing an account of a collection of bird-bones from the miocene deposits of St. Alban, in the Department of Isère, France. The more perfect specimens were referred mostly to new species (*Strix sancti albani*, *Palæortyx maxima*, *P. grivensis*, and *Totanus majori*), while others were regarded as undeterminable from their fragmentary condition.—Mr. G. A. Boulenger read a paper describing some new species of reptiles and batrachians based on specimens lately obtained in Borneo by Mr. A. Everett and Mr. C. Hose.

PARIS.

Academy of Sciences, June 5.—M. de Lacaze-Duthiers in the chair.—Note on the works of Comte P. de Gasparin, by M. Th. Schlœsing.—Researches on iron of Ovifak, by M. Henri Moissan. Three specimens of native iron, discovered by Prof. Nordenskiöld at Ovifak, Greenland, were tested for any crystallised forms of carbon they might contain. The first specimen had a metallic lustre, and was nearly black. This was found to contain a small quantity of the kind of graphite which swells up in boiling sulphuric acid. It also contained ordinary graphite distinctly crystallised, which gave rise to graphitic oxide on being treated with potassium chlorate. Fused potassium bisulphate dissolved all the residue. The second specimen also had a metallic lustre, but a light grey colour, and weighed 18 gr. After treating with hydrochloric acid the residue showed fragments of schreibersite, an opaque white mass of irregular form, and a large number of highly refracting grains. On treating this residue with hydrofluoric and then with boiling sulphuric acid the volume of the carbon increased, showing the presence of swelling graphite. No ordinary graphite was found. The third specimen, which consisted of metallic globules disseminated through a stony matrix, left after treatment with the three acids a residue containing some fragments of blue sapphire, which could be picked out with the forceps. Amorphous carbon was contained in all the specimens, swelling graphite in two of them, and ordinary graphite in one. Neither black nor transparent diamonds were found in any of them.—On the genesis of natural phosphates, especially those which have derived their phosphorus from organised beings, by M. Armand Gautier.—On the multiplicity of homologous parts in its relation to the gradation of vegetable species, by M. A. Chatin. The multiplicity of the homologous organs of a given apparatus is a certain sign of organic degeneration. The more numerous the homologous parts, the more they deviate from the verticillary type of floral organs and approach the spiral type. Their reciprocal symmetry is also less regular, and their position less stable. This view is confirmed by other incontestable signs of degeneration found to go together with multiplicity of homologous parts, and is illustrated by corresponding gradation in the animal kingdom, where the myriapod is classed below the hexapod insect.—On the repeated application of Bernouilli's theorem, by M. Jules Andrade.—On problems of dynamics reducible to quadratures, by M. Paul Staeckel.—Sketch of a new theory of electrostatics, by M. Vaschy.—On some phenomena exhibited by Natterer's tubes, by M. Gouy.—Absorption of seleniuretted hydrogen by liquid selenium at high temperatures, by M. H. Pélabon. If selenium be melted in a tube containing hydrogen and then cooled, it is found to contain a large number of bubbles with a brilliant internal surface, which are absent in selenium fused in air. On reducing the mass to powder the characteristic smell of seleniuretted hydrogen is observed, and if the mass is broken up under water the latter is coloured red by the finely divided selenium liberated from the seleniuretted hydrogen by the oxygen of the air.—Organometallic combinations belonging to the aromatic series, by M. G. Perrier.—On the coccidia of the birds, by M. Alphonse Labbé.—On the Plankton of the Polar Sea, by M. G. Pouchet.—On pseudo-fecundation in the Uredinei and accompanying phenomena, by M. Sappin-Trouffy.—On two cases of parasitic castration observed in *Knautia arvensis*, Coulter, by M. Molliard.—On the sedimentary strata of Servia, by M. J. M. Lugovic.—On the eclogites of Mont Blanc, by MM. L. Duparc and L. Mrazec.—On the employment of vine leaves for feeding cattle, by M. A. Muntz. In the south of France sheep are often let into the vineyards after the vintage and allowed to strip the vines of their leaves. The vines do not appear to suffer thereby in the least. Fresh vine-leaves contain 67·0 per cent. water, 18·5 extractive matter, 3·8 nitrogenous matter, and 2·3 per cent. fatty matter. When dried, the proportions are: extractive matter, 51 per cent.; water, 15; nitrogenous matter, 11; cellulose, 8·5; and fatty matter, 5·5 per cent. In the various vineyards of southern France the amount of leaves per hectare (2·47 acres) varies from 2500 to 9500 kgr., or about the average yield of hay for the same area. Moreover, the leaves, instead of getting blown away by the wind and lost, are converted into manure by the cattle, and, in addition, the vine is much less sensitive to drought than the ordinary fodder crops.—On the effects of inoculation of human cancer or cancerous products upon animals; positive result in one case, by M. Mayet.—On the amplitude and mean duration of the extreme oscillations of the barometer at Paris, by M. Léon Descroix.—On the density and alkalinity of the waters of the Atlantic and the Mediterranean, by M. J. Y. Buchanan. Along the entire south coast of Spain the water was of the same density as the Atlantic. Eastwards of Cape Gata, where the eastward current is no longer active, the denser water of the Mediterranean set in. The mean ratio of salinity and alkalinity was 0·50 for the Atlantic, and 0·4875 for the Mediterranean, the difference being probably due to the abundance of calcareous rocks on the latter.

AMSTERDAM.

Royal Academy of Sciences, May 27.—Prof. van de Sande Bakhuysen in the chair.—Mr. Hubrecht gave a description of phagocytic and vasifactive processes by which the trophoblast of *Tupaja javanica* attacks the maternal uterine epithelium and prepares congested surfaces against which the area vasculosa and afterwards the allantois are applied. The placenta of Tupaja is double, and situated right and left of the fœtus. The trophoblast of Tupaja was furthermore compared to that of Sorex and of Erinaceus, in all of which it displays a considerable degree of activity. It was more rigorously defined as being the epiblast of the mammalian blastocyst, after deduction of what is intended for the formation of the embryo and for the internal coating of the amnion. In conclusion, certain phylogenetic speculations concerning the trophoblast were brought forward.—Mr. Schoute exhibited three new thread-models of developables related to higher algebraical equations. The first is the discriminant of the general cubic $u^3 + 3xu^2 + 3yu + z = 0$. It divides space into two parts, corresponding to points with 3 or 1 real roots. The ordinary twisted cubic forms its cuspidal edge. The discussion of the number of real roots situated between two given limits is facilitated by means of a certain tetrahedron. The second surface corresponds to the quartic $u^4 + 6xu^2 + 4yu + z = 0$. It divides space into three parts, containing points with 4, 2, or 0 real roots. By planes perpendicular to the x-axis it is cut in rational quartics with two cusps and one node. It possesses a parabolic nodal curve. And the third model realises the surface corresponding to the sextic $u^6 - 15u^4 + 15xu^2 + 6yu + z = 0$. It divides space into four parts, with points admitting 6, 4, 2, or 0 real roots. Any plane perpendicular to the x-axis meets it in a rational sextic curve with four cusps and six nodes. The cusps of the cuspidal edge are very remarkable points on this surface. In general the developable corresponding to a likewise mutilated equation of the nth order with three coefficients x, y, z, will show rational sections of the nth order with the planes perpendicular to the x axis, admitting $n - 2$ cusps and $\frac{1}{2}(n - 2)(n - 3)$ nodes, &c.—Mr. van der Waals gave a formula for the law of molecular force. By putting

$$-f\frac{e^{-\frac{r}{\lambda}}}{r}$$

for the potential of two material points, all the known laws of molecular action may be deduced. In this formula λ is a line equal to the quotient of La Place's H and K. This law may be explained by supposing (1) that the action of the point itself varies inversely as the square of the distance, (2) that the universal medium gradually does absorb the lines of force.

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