THURSDAY, MARCH 21, 1895.

MODERN BACTERIOLOGY.

Lehrbuch der Bakteriologischen Untersuchung und Diagnostik. By Dr. Ludwig Heim. Crown 8vo. Pp. 528. (Stuttgart: Verlag von Ferdinand Enke, 1894.)

THE writer of this volume takes care to leave us in no doubt as to its purpose. We are told in the preface, "Für den Praktiker ist dieses Buch geschrieben." Again, "Ein Lehrer und ein Führer soll dies Buch sein." Even the unfortunate student, who, in spite of attending a practical course on bacteriology, has failed to carry away an adequate knowledge of his subject, is to turn to this book for consolation, where "he may yet arrive by its assistance at his goal, providing he follow step by step and point by point the instructions which it contains."

But after a careful perusal of this bulky octavo volume, we find ourselves unable to agree with the author's estimate of his book. It contains a mass of facts, a bewildering maze of detail through which we think no student would have the patience to thread his way, much less the student who has failed in spite of passing through a course of practical instruction. Possibly Dr. Heim knows too much, or is too generous in giving his knowledge away. A little more reticence would have not only made his book less unwieldy in dimensions, but the whole treatment of the subject would have gained in simplicity.

The excessive love of minute detail is characteristic of most German text-books, but we do not think the following example of it will easily be surpassed: "Smokers must put their cigars or cigar-ends so down that the burning part rests on the table, the mouth-piece remaining free. Eating must not under any circumstances be carried on in the laboratory. The moistening of the fingers in the mouth is to be rigidly avoided. Gum labels must only be wetted with water." We can only say that if the student approaches his subject with as little feeling for it as the necessity of these instructions implies, he will, we predict, never do much, however often he may read through Dr. Heim's volume!

The work is divided into three parts—bacteriological manipulations, including microscopic investigations; the preparation of culture media, and experiments on animals. The latter section is given in greater detail than in most text-books, and is very clearly described. Secondly, the morphological and other characteristics of bacteria, containing an admirable though brief account of the subject of immunity and the latest developments of serum therapeutics. Thirdly, the diagnosis of bacteria in disease, as well as their demonstration in our surroundings. The information imparted is, in nearly all cases, gathered from the most recent publications in Germany; but on consulting the list of journals referred to in the text, the only foreign publication considered worthy of notice is the *Annales de l'Institut Pasteur*, English periodicals being completely ignored, as well as the excellent *Annali dell' Istituto d'Igiene Sperimentale*, published in Rome, and the official reports, published in St. Petersburg, of the work carried out in the Imperial Institute of Experimental Medicine.

This accounts for the omission of all reference to Palermo's most interesting experiments on the attenuation of the pathogenic properties of the cholera bacillus through exposure to sunshine. In the section describing the methods which may be adopted for reducing and increasing the virulence of particular bacteria, mention is made of Arloing's isolated investigation on the attenuation of the disease-producing powers of the anthrax bacillus through three hours' insolation; but the fact is passed over, that Palermo succeeded in reducing cholera bacilli to the condition of vaccine through the action of sunshine, so that guinea-pigs, when inoculated first with *insolated* cholera bacilli, and then with ordinary virulent cholera bacilli, instead of dying, as usual, in about eighteen hours, remained alive.

The survey of the present state of our knowledge on the question of immunity is, perhaps, the most interesting and best-written portion of the book. Theoretical considerations of the subject are kept in abeyance, and prominence is only given to the practical outcome of the investigations which have been made. The results of Roux's application of serum in the treatment of diphtheria in the Paris hospitals appeared too recently to admit of incorporation here. In the section on the production of spores, the author throws doubt on Roux's method for obtaining anthrax bacilli permanently deprived of their power of producing spores, so-called *asporogene* anthrax. He states that he has not been able to succeed in procuring such a race of anthrax bacilli, although he has made numerous attempts with the utmost regard to Roux's recipe. The method devised by Phisalix is preferred, which consists in prolonged exposure of anthrax cultures to a temperature of from 30° to 42° C.; but this device only answers as long as the bacilli are kept in ordinary culture media, for even when introduced into broth containing a fraction of guinea-pig's blood, they are at once sufficiently revived to produce spores.

In describing the capacity for multiplication possessed by bacteria, an interesting experiment is cited, which we do not remember having seen elsewhere, showing that 149 cholera bacilli kept at 37° C. had within three hours increased to as many as 96,000, and that the minimum time occupied by these bacilli in the production of a new generation was twenty minutes. This involves, however, the assumption that in the process of multiplication from every individual cell two new ones are started, never more or less.

The concluding portion of the volume, which deals with bacteriological diagnosis, and occupies close upon 200 pages, is helpfully illustrated by photographic plates of many pathogenic micro-organisms. In this section, in speaking of the vexed question of the microbic origin of scarlet fever, Dr. Heim considers that the cause of this disease has not yet been discovered, and that the streptococci which have been found by various observers must be regarded as a secondary and not primary infection; in his own words, "man muss sich wohl hüten dabei die Grundkrankheit zu übersehen." According to Doehle, scarlet fever may be with more likelihood ascribed to protozoa; and this authority is of opinion that similar organisms may very possibly be found to be the exciting cause of both measles and small-pox. In malaria protozoa are now accepted as the origin of the disease, and a similar suggestion has been made to account for yellow fever in the absence of all trustworthy microbic evidence. The examination of air, water, &c., for micro-organisms, is, of course, only dealt with in a very cursory manner. In the small section devoted to water-bacteriology, we are glad to find Dr. Heim calling attention to the errors which may so easily occur in the correct numerical estimation of bacteria in water.

Dr. Heim has spent an immense amount of patient labour on the compilation of this volume, and he approaches his subject invariably from the point of view of a man who has worked out things and problems for himself; it is thus that his book acquires an original flavour, which, whilst making it more palatable to the teacher, renders it less likely to find favour, or prove useful to the student. We venture to think that it will, in the concluding words of the preface, "sich den Herrn Kollegen nützlich erweisen"; and it must in any case be regarded as a responsible and noteworthy contribution to the bacteriological text-books, now fairly numerous, already in existence. G. C. FRANKLAND.

CHEMICAL ANALYSIS.

Die wissenschaftlichen Grundlagen der analytischen Chemie. Von W. Ostwald. (Leipzig: Wilhelm Engelmann, 1894.)

THE Professor of Chemistry in the University of Leipzig has taken so assiduously to the making of books that, as regards the fruitfulness of his pen, he may well take rank with even the more prolific of our writers of fiction. Despite this fact, it is not too much to say that none of his productions will appeal to a larger section of the chemical public than the little volume under notice. For although it is professedly a work on general analytical chemistry, it will mainly make its mark as a concise exposition of qualitative analysis, based upon the most recent developments of chemical theory.

The author first deals with the modes of recognising substances—*Zustands-* and *Vorgangseigenschaften*—and the modes of separating substances prior to recognition. Amongst other things the theory of filtration and washing is discussed, together with the complication introduced by "adsorption"—that curious property in virtue of which the concentration of a solution near the surface of an immersed solid is greater than the average concentration. Separation, it is emphasised, must always be mechanical, and if it cannot be effected directly by the physical methods described, such as distillation or the action of solvents, chemical operations, such as form the subject-matter of qualitative analysis, have first to be performed.

At this point we meet with views which are novel in an analytical text-book. The theory of analysis, it is urged, is now upon a new platform. With van't Hoff and Arrhenius, we must regard the properties of dilute solutions of acids, bases, and salts as mainly those of their ions; and herein lies a simplification of the utmost importance, for it is possible to express in terms of the properties of, say, 50 anions and 50 cathions the properties of the 2500 odd salts to which they may give rise. A digest of the new theory of the constitution of solutions is here given, and of the mode in which the law of mass action may be extended to analytical reactions by regarding the ions as individual substances.

A precipitate in its mother-liquor we are to regard as a system in equilibrium. Precipitation is never complete. On precipitating $BaSO_4$, for example, a small amount remains in solution, and portion of this is dissociated into the ions Ba and SO_4. The precipitate is in equilibrium with the soluble $BaSO_4$, while it in turn is in equilibrium with the ions. Now the active mass of a solid is constant, hence for equilibrium the product of the concentrations of the ions in the solution must have a definite value—the solubility product. If the product be raised above this definite value, more precipitate must form; if it be lowered, more precipitate must dissolve. We have here a reason for the common practice of adding an excess of precipitant in order to ensure complete precipitation. In the case quoted the solubility product of the $BaSO_4$ will be partly kept up to the necessary value by means of the Ba ions of the excess of precipitant, and hence less $BaSO_4$ will require to remain in solution. This is a particular instance of the general rule that the solubility of a substance is diminished by the presence of another having an ion in common with it.

We can thus formulate a theory of precipitation. It is in general the result of interaction between ions; consequently, if on mixing two solutions ions are present which can form a substance having a sufficiently small solubility product, that substance is precipitated, and causes which affect the solubility product are the causes affecting the precipitation. Here are one or two instances of this method of treating analytical reactions.

The solubility of $Mg(HO)_2$ in water is regulated by the solubility product of Mg and HO ions. If hydrochloric acid, which is almost completely dissociated, be added to the water, the H ions of the acid at once unite with the HO ions of the dissolved $Mg(HO)_2$ to form water, because water is practically undissociated. In this way the solubility product of the $Mg(HO)_2$ is diminished, and more solid $Mg(HO)_2$ must dissolve in order to maintain the product at the value necessary for equilibrium. If sufficient HCl be present, all the $Mg(HO)_2$ will pass into solution.

The following case of precipitation is more complex:—If CO_2 be passed through a solution of $Pb(NO_3)_2$, little or no precipitate is obtained, whereas two-thirds of the lead is thus removed from a solution of $Pb(C_2H_3O_2)_2$. In solution carbonic acid is but slightly dissociated into its ions 2H and CO_3; yet if $Pb(NO_3)_2$ be present, the product of the concentrations of the Pb and CO_3 ions is greater than the solubility product of $PbCO_3$; hence a precipitate forms. At the same time, however, HNO_3 is produced, and H and NO_3 ions accumulate in the solutions, since HNO_3 is strongly dissociated. Now H ions diminish the electrolytic dissociation of the H_2CO_3 just as excess of NH_3 or HCl diminishes the ordinary dissociation of NH_4Cl. The solubility product of the CO and Pb ions is thus diminished, and but a small quantity of HNO_3 has to accumulate, that is, but little decomposition has to take place, before the solubility product is reduced to the critical value, and no more precipitate is produced.

If $Pb(C_2H_3O_2)_2$ be used, since acetic acid is but feebly dissociated, much more precipitate can be produced before the H ions introduced into the solution by the acetic acid are numerous enough to reduce the solubility product to the critical value, and thus stop further precipitation.

Reactions may also be due to the formation of complex ions. Alumina in presence of water is in equilibrium with the ions Al and 3OH. If KOH be added, K_3AlO_3 is produced, of which the ions are 3K and AlO_3. The latter is not available for equilibrium with alumina, hence the solubility-product is reduced, and more alumina must dissolve.

With a chapter on quantitative estimations, such is the subject-matter of the theoretical part of the book. The second, or practical part, is concerned with the important reactions of qualitative analysis, treated as much as possible from the above standpoints.

The book is not written for the beginner, but to supply adequate theoretical support to the routine work of general analytical chemistry. Enough has been said to show that it is in great part unique, and throughout it is refreshing and profitable reading; indeed, it affords the easiest means yet offered to the general reader of getting the gist of current views, not only of the theory of analytical processes, but of the constitution of solutions, and of chemical mechanics—the law of mass action and the velocity of chemical change.

The ideas put forward relating to the nature of analytical processes are, of course, open to differences of opinion. The time has no doubt passed when the conceptions of ions and electrolytic dissociation were regarded as but the vain imaginings of mathematicians who had dabbled in chemistry. Nevertheless the view is still widely spread, at any rate in this country, that although they serve as a means of correlating otherwise isolated properties, and of predicting phenomena in solution, they are altogether too artificial to be anything but the crudest picture of what actually exists. Be this as it may, the book before us serves a good purpose, inasmuch as it puts in a clear light the fact that the direction of analytical reactions is determined by the solubility of the possible products of the interaction, and that when the reaction has run its course we have a system in equilibrium again governed by solubility.

In the common method of presenting qualitative analysis to the student, theoretical considerations are either entirely ignored, or are supposed to be supplied by statements asserting that a precipitate AB is formed in a given solution because the affinity of A for B is greater than its affinity for the other radicles present. It is this system, coupled with the abuse of the ordinary chemical equation, whereby all reactions are regarded as perfect, that fills the ranks of budding chemists with disciples of Bergmann, the gospel according to Berthollet, Wenzel, and Guldberg and Waage, notwithstanding.

J. W. RODGER.

ANALYTICAL GEOMETRY.

An Introductory Account of certain Modern Ideas and Methods in Plane Analytical Geometry. By Charlotte Angas Scott, D.Sc., Professor of Mathematics in Bryn Mawr College, Pennsylvania. Pp. xii. + 288. (London: Macmillan and Co., 1894.)

DR. SCOTT'S treatise is a welcome addition to the many excellent text-books on analytical geometry which have been published during the last few years. But while most of the text-books in use at the present time adequately explain the initial difficulties of the subject, scarcely one can be regarded as a satisfactory book for those students who wish to go beyond the elements as treated with the use of Cartesian coordinates. For such students Salmon's "Conics" is still the standard work. But although every fresh edition of this is carefully revised to meet modern requirements, there are many beautiful geometrical methods and theories which are only briefly noticed, but which should be fully discussed in a standard work. The book under review does not, indeed, aim at replacing Salmon's, but it is admirably adapted to be used as a companion to it. It aims at giving a concise account of the principal modern developments due to Cayley, Clebsch, Reye, Klein, and a few other continental geometers. As an introduction to the study of the higher branches, it may be confidently recommended to students as a clear, full, and well-arranged exposition of the leading principles of the subject. At the same time the book is something more than a text-book for students. Those who wish to keep up their mathematics, and have no time to spare to read the various papers and memoirs that are published every year, will find much that will interest them—many beautiful geometrical ideas that are here published for the first time in an English text-book.

The author starts with the general idea of coordinates, and develops simultaneously the theory of point-coordinates and line-coordinates, with a full explanation of the special peculiarities of the two systems. The principle of duality is then explained, and the descriptive properties of curves discussed. After a short but adequate chapter on curve tracing, the theory of projection and homography is introduced, leading up to the theory of correspondence. The chapter devoted to this theory is very well written, and is in fact one of the principal features of the book. In it will be found a full discussion of quadric inversion, based on a memoir by Dr. Hirst. The remaining chapters are devoted to a discussion of the generalisation of metrical properties of curves obtained by replacing the circular points by a conic, and a brief explanation of the connection which subsists between geometry and the algebraical theory of invariants.

The treatise is confined to plane geometry, in which figures are considered as combinations of points and straight lines. In constructing a system of coordinate geometry for such figures, two theories naturally present themselves; the two in which the point and the straight line are, respectively, the *primary* elements, and the straight line and point the *secondary* elements. But although Dr. Scott states that any other geometrical entity might be taken as the primary element, she makes no allusion to any such theory. We wish that she had found it possible to introduce a brief notice of the analytical theory in which the circle is taken as the primary element in view of the fact that most of the properties of an important class of curves—bicircular quartics—are best discussed by expressing the equations of these curves in terms of *circular* coordinates.

It is also a matter of regret that the use of trilinear coordinates is retained, although results are usually given in terms of areal coordinates as well. The use of both systems is confusing to students, and the use of the areal system has a double advantage; firstly, the fundamental metrical formulæ are more easily proved, and secondly, the areal system is intimately connected with the tetrahedral system in solid geometry. For the latter reason, if for no other, it is very desirable that the use of trilinear coordinates should disappear from our text-books on plane geometry. In this book the proofs of two fundamental results (§§ 20, 21) are long and tedious.

The only other point we have to find fault with is that harmonic relationship and involution are introduced as particular cases of cross ratio and homography. The author herself admits (p. 160) that this view disguises the real difference between the two conceptions, and explains that while cross ratio and homography relate to different spaces, harmonic relationship and involution relate to pairs of elements in the same space. The theories are developed independently, but we should have preferred that the theory of harmonic groups and the theory of involution should have been developed before the introduction of the idea of cross ratio and homography.

The examples chosen by the author to illustrate various theorems have been very carefully selected, and should be found quite sufficient for the use of students. Among them will be found many theorems of independent importance, which could scarcely be said to come within the scope of the book. We may add that an excellent index is provided. R. L.

OUR BOOK SHELF.

Les Aurores Polaires. By Alfred Angot. Pp. 318. (Paris: Félix Alcan, 1895.)

FRANCE has made two important contributions to the knowledge of auroræ. Perhaps the first work devoted entirely to the study of auroral phenomena was the "Traité physique et historique de l'aurore boréale," by Mairan, published by the Paris Academy of Sciences in 1733. A century later a volume was published containing the results of aurora observations made on the *Recherche* during the scientific expedition to Lapland. The plates which illustrated the observations then made have been laid under tribute by M. Angot for the present volume. Since the publication, however, of the "Aurores Boréales" which resulted from the 1838–39 expedition, we have it on the authority of M. Angot that no work dealing wholly with the subject has appeared in France. This volume, therefore, stands as practically the only one in which our neighbours on the other side of the Channel can find a popular account of auroræ, written by one of their own countrymen.

M. Angot has treated the subject lightly, yet scientifically. He traces the history of aurora observations from the time of Aristotle; describes the apparently adventitious forms assumed by the phenomena; explains the facts as to the extension, position, frequency, and periodicity of auroræ; develops the relations between auroral and terrestrial magnetism and electricity, and connects them with meteorological phenomena; and, finally, he presents the cosmical, optical, magnetic, and electrical theories put forward to account for the phenomena.

A list is appended, giving in chronological order all the auroræ seen in latitudes above 55° North from 1700 to 1890, with the names of the places at which observations were made. Eighteen rather coarse illustrations are distributed through the book. Altogether, the volume is a valuable summary of the growth of knowledge of auroræ.

A Few Chapters in Astronomy. By Claudius Kennedy, M.A. (London: Taylor and Francis, 1894.)

IN these 150 pages are discussed four or five of the numerous problems in astronomy, and these are handled in such a manner as to make them full of interest, both for the general reader and for the student. This book, unlike many others, is not written for the sole purpose of pouring condensed knowledge into the student's head, but for those who wish to sit down for half an hour or so and read for recreation, and so gain a fair understanding of some of the discussions contained in them, without going into too great detail. The points chiefly referred to, are, visual illusion affecting certain astronomical phenomena; the effect of the earth's rotation on certain moving bodies, as projectiles, paths of projectiles, Foucault's Pendulum and the Horizontal Pendulum; the causes of the tides; the moon's variation; and the parallactic inequality. In the last two chapters the text is accompanied by several figures.

As a supplement to the ordinary text-books on astronomy, this small volume will be found especially useful, as it deals with subjects not generally referred to in them, or at least only briefly mentioned.

Mechanics for Colleges and Schools: Statics. By R. T. Glazebrook, M.A., F.R.S. Pp. 180. (Cambridge University Press, 1895.)

THIS addition to the physical series of the Cambridge Natural Science Manuals will hardly add to the reputation of the assistant director of the Cavendish Laboratory. The only noteworthy feature is the prominence given to the experimental verification of statical principles; but excepting this, little can be found to distinguish the book from others of a similar type. Many of the experiments described are intended to be performed by the students, and the theoretical consequences are, when possible, deduced from experiments. This is undoubtedly the right line to go upon, but we are afraid that few of our schools or colleges possess at present sufficient apparatus for the laboratory work described. The text is clear and concise, and sufficiently illustrated; and the examples are numerous.

The Telegraphist's Guide. By James Bell, A.I.E.E. Pp. 101. (London: *Electricity* Office, 1895.)

TELEGRAPHISTS in the Government service have now to submit themselves to a technical examination before they can obtain promotion. Herein we have a guide in which the subjects of the new examination are considered in the order laid down by the Postmaster-General. The aspiring telegraphist will find the book a means of acquiring the knowledge he needs; and students of telegraphy not directly connected with the service, may obtain from it useful information on the practical working of telegraphic systems.

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.*]

Corrections of Maximum and Ex-Meridian Altitudes.

IN navigation the error introduced by taking the maximum altitude of a heavenly body for its meridian altitude is not sufficiently great to need correction when it is due to variation of declination alone, as it is then much within the probable errors of observation. When, however, a ship is steaming at a high speed, the error is considerably increased by the variation of latitude, especially when this is of opposite sign to the variation of declination.

The formula giving the correction in seconds of arc to be applied to the zenith distance of a body for reduction to the meridian is

$$x = Ch^2 \; . \; . \; . \; . \; . \; . \; . \; . \; (1)$$

where, with the usual notation $C = \frac{\cos l \cos \delta}{2 \sin (l \mp \delta)} \cdot \frac{\sin^2 15'}{\sin 1''}$, and h is the hour angle in minutes of time. Thus, if z be the zenith distance, we have the equation

$$z - Ch^2 = l \mp \delta,$$

the upper or lower sign being taken according as l and δ are of the same or of opposite sign. Since we may consider z, h, l, and δ as functions of the mean time t and C constant, we have on differentiation, if z be a minimum,

$$-2Ch\frac{dh}{dt} = \frac{dl}{dt} \mp \frac{d\delta}{dt}.$$

Let H and H′ be the hour angles of the body and the ship's zenith measured from some fixed meridian, and let u, v denote the northerly and westerly components of the ship's velocity in knots; then $\frac{dh}{dt} = \frac{dH}{dt} - \frac{dH'}{dt}$ and $\frac{dl}{dt} = v$. Also if the body's projection on the Earth's equator moves round at the rate of U knots,

$$\frac{dH'}{dt} \Big/ \frac{dH}{dt} = u \sec l/U \; ;$$

and the above equation becomes

$$-2Ch\frac{dH}{dt}(1 - u \sec l/U) = v \mp \dot{\delta} \quad . \; . \; . \; (2)$$

Now this equation will assume different forms according as the body under consideration is the Sun, a star, or the Moon. For, since the motion of the ship is expressed in mean solar time, the motion of the body must likewise be expressed in that time.

The unit of time being a minute of mean time, and the unit of arc a second of arc, we have for the Sun

$$\frac{dH}{dt} = 1 \text{ and } U = 900,$$

so that (2) becomes

$$-2Ch(1 - u \sec l/900) = v \mp \dot{\delta}.$$

For latitude 60° and $u = 20$ the value of u sec $l/900$ is about ·04, so that we see for ordinary speeds and ordinary latitudes reached the term involving u may be neglected, and the equation reduces to

$$-2Ch = v \mp \dot{\delta} \; . \; . \; . \; . \; . \; . \; . \; . \; (3)$$

For a star

$$\frac{dH}{dt} = \frac{\text{length of mean solar day}}{\text{length of sidereal day}} = 1$$

with sufficient accuracy, and as before we obtain equation (3).

For the Moon

$$\frac{dH}{dt} = \frac{\text{length of mean solar day}}{\text{length of lunar day}} = \frac{1}{1{\cdot}035}$$

and

$$U = 869,$$

so that in this case (2) becomes

$$-2Ch = 1{\cdot}035\,(v \mp \dot{\delta}).$$

On giving C its proper value, and putting w for the velocity compounded of the velocity in latitude of the ship and the velocity in declination of the body (3) becomes

$$h = -w(\tan l \mp \tan \delta) \sin 1'' \operatorname{cosec}^2 15' \quad . \; . \; (5)$$

The reduction is therefore from (1)

$$x = -\frac{w^2}{2}(\tan l \mp \tan \delta) \sin 1'' \operatorname{cosec}^2 15' \quad . \; . \; (6)$$

Equations (5) and (6) therefore give the hour angle (from the ship's meridian) and reduction for the Sun or a star at the maximum altitude. For the Moon $1{\cdot}035w$ must be substituted for w. The form of these equations has suggested the construction of the accompanying table, which gives the value of

°		°		°	
1	·004	21	·098	41	·221
2	·009	22	·103	42	·229
3	·013	23	·108	43	·237
4	·017	24	·113	44	·245
5	·022	25	·118	45	·254
6	·026	26	·124	46	·263
7	·031	27	·129	47	·273
8	·035	28	·135	48	·283
9	·040	29	·141	49	·293
10	·045	30	·147	50	·303
11	·049	31	·153	51	·314
12	·054	32	·159	52	·326
13	·059	33	·165	53	·338
14	·063	34	·171	54	·350
15	·068	35	·178	55	·363
16	·073	36	·185	56	·377
17	·078	37	·192	57	·392
18	·083	38	·199	58	·407
19	·088	39	·206	59	·424
20	·093	40	·213	60	·441

$\tan x^\circ \sin 1'' \operatorname{cosec}^2 15'$ as far as $x = 60$. Thus in latitude l° when a body (Sun or star) of declination δ° is at its maximum altitude, the sum or difference (according as l and δ are of different or of the same name) of the arguments corresponding to l and δ multiplied by w gives the hour-angle in minutes of time: the sum or difference multiplied by $\frac{w^2}{2}$ gives the reduction in seconds of arc. For the hour angle of the Moon the sum or difference must be multiplied by $1{\cdot}035w$, and for the reduction by $\frac{1}{2}(1{\cdot}035w)^2$.

Example.—D.R. latitude 48° N. Moon's declination 18° 48′ S. decreasing 120″ per 10m., ship steaming S. 20° E. 16 knots.

Remembering that when the ship is in N. latitude, and steaming towards south

$$w = -v \mp \dot{\delta},$$

we have

$$w = -27,$$

and

$$h = 27 \times 1{\cdot}035({\cdot}283 + {\cdot}087) = 10{\cdot}3\text{m}$$
$$x = 144''$$

If a ship whose maximum speed is 20 knots does not reach a higher latitude than 60, the greatest values that h and x can have, are for the Sun, 9m. 15s. and 1′ 37″; for the Moon, 17m. 20s. and 5′ 41″.

I will now investigate the nature of a diagram[1] from which the reduction in ordinary ex-meridian observations may be obtained, as well as the hour angle and reduction for maximum altitudes. It is found convenient for this purpose to express x in minutes of arc, when (1) becomes

$$h^2 = 2x(\tan l \mp \tan \delta) \sin 1' \operatorname{cosec}^2 15' \quad . \; . \; . \; (7)$$

Now if a circle of radius a be referred to a point in its circumference as origin, its equation is

$$r^2 = 2ax,$$

r being the radius vector and x the abscissa measured along the diameter through the origin. Comparing this with (7) we see that if a system of circles be described passing through a common origin o, their centres being collinear and on the same side of o, the reduction x is the abscissa of the point whose radius vector is h on one of these circles: the particular circle on which the point lies being that whose radius is the sum or difference of the ordinates of the curve

$$y = \tan x \sin 1' \operatorname{cosec}^2 15'$$

corresponding to

$$x = l \text{ and } x = d.$$

[1] A diagram based on the properties of the parabola was given by Prof. Foscolo, of Venice, and published by the Hydrographic Office about 1870.

It will be noticed that when

$$h > 2(\tan l \pm \tan \delta) \sin 1' \operatorname{cosec}^2 15',$$

the above construction fails, and x may be then considered as twice the abscissa of the point on the circle whose radius is

$$2(\tan l \mp \tan \delta) \sin 1' \operatorname{cosec}^2 15',$$

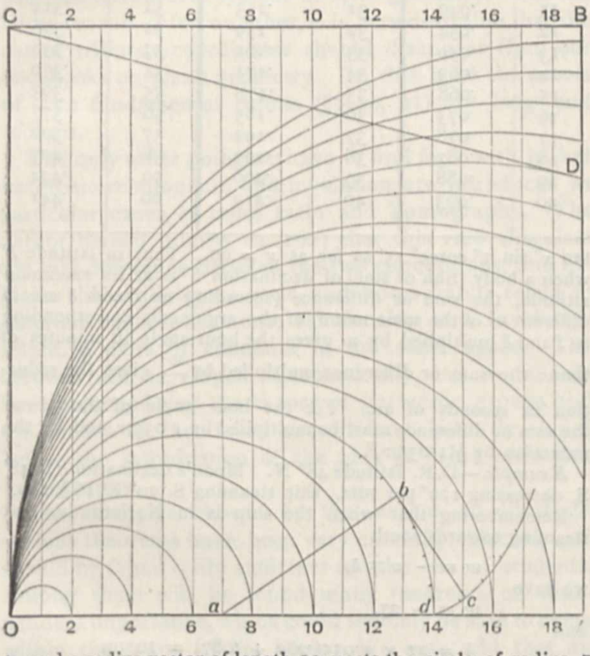
By making a diagram on ruled paper, the distance between the lines being taken as unit, the difficulty of measuring x and h is more or less overcome.

A portion of such a diagram is represented in the annexed figure, C D being a portion of the curve

$$y = \tan x \sin 1' \operatorname{cosec}^2 15'$$

described with C as origin, y being for convenience reckon ed negatively.

As an example of its use, suppose it were required to find the reduction for latitude 17° N., declination 9° S., and hour-angle 12m. By using a pair of dividers the sum of the ordinates of the curve C D corresponding to 9 and 17 is found to be



7, and a radius vector of length 12 meets the circle of radius 7 at a point whose abscissa is 10. The required reduction is therefore 10′.

Again, x being now expressed in minutes of arc (5) and (6) may be written

$$h = -\frac{w}{60}(\tan l \mp \tan \delta) \sin 1' \operatorname{cosec}^2 15'$$

$$x = \left(\frac{w}{60}\right)^2(\tan l \mp \tan \delta) \sin 1' \operatorname{cosec}^2 15'.$$

So that h and x are the lengths of the arcs of a circle and its involute respectively, corresponding to the angle at the centre whose circular measure is $w/60$ in the case of the Sun, and $1{\cdot}035w/60$ in the case of the Moon. Now for the former body w will not in general exceed 20, and for the latter 38, so that we may assume for graphical purposes that in the case of the Sun w is the number of degrees in an angle of circular measure $w/60$, and in the case of the Moon w is the number of degrees in an angle of circular measure $1{\cdot}035w/60$.

Thus in both cases h is approximately the arc of a circle of radius

$$(\tan l \mp \tan \delta) \sin 1' \operatorname{cosec}^2 15'$$

intercepted between the diameter and the radius which makes an angle w degrees with it.

Having obtained h, x may be found as in the general case, or by drawing a tangent to meet the involute, as in the figure.

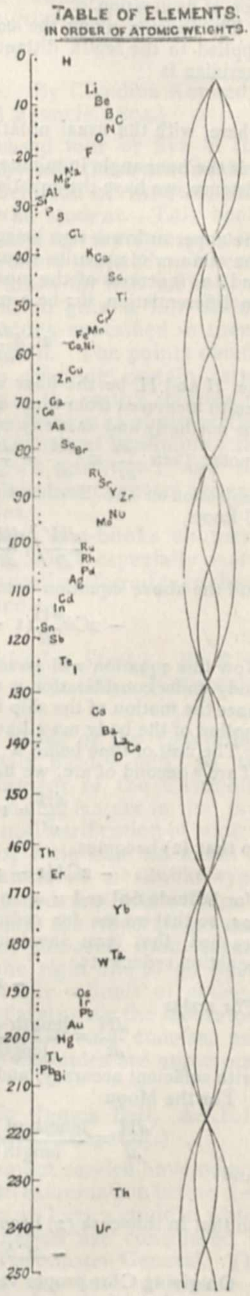
In the preceding example, suppose the ship to be steaming south 20 knots, the declination decreasing 160″ per 10m. Here $w = -36$. By laying off at an angle of 36°, the intercepted arc bd is found to be about 4·3, and by drawing the tangent at b the intercepted arc of the involute is about 1·3. The hour angle and reduction for the maximum altitude are therefore 4m.·3 and 1′·3 respectively.

The graphical method considered above will be found to give results which, although approximate, are sufficiently accurate for purposes of navigation; in fact, if the diagram be constructed on a large scale, the reduction may be easily obtained within fifteen seconds of the truth.

H.M.S. *Hawke*, Mediterranean. J. WHITE.

Argon and the Periodic System.

THE annexed engraving is a copy, on a small scale, of a large diagram which I have used with advantage for some years in dealing with the periodic classification of the elements. It may prove of some little interest to your readers who are actively discussing the probable position of "argon," on the assumption that this remarkable substance is an element.



To the left of the illustration is a scale of equal parts, and the dots indicate the atomic weights of the elements the symbols of which are placed farther to the right. The latter are arranged in zig-zag fashion so as to exhibit the periodic rise and fall in general properties, observed in each set of seven elements. A certain analogy may be traced between these periods and the loops into which a suspended cord of somewhat unequal weight can be thrown when set in vibration. Each small loop pictures for us a small period; and, just as the *alternate* loops are those which are in the same phase at any given moment, so the alternate periods of the elements are those between which the closest resemblances can be traced.

The members of Mendeléef's eighth group, or the "triplets," as they are sometimes called, viz. Fe, Ni, and Co, with atomic weights from 56 to 59: Ru, Rh and Pd, 102 to 106: Os, Ir and Pt, 191 to 195, seem to form another system of elements which—to pursue the analogy of the vibrating cord—is related to that of the other elements somewhat as a given note to its octave. On carrying the eye along the curves it will be seen that the atomic weights of triplets occur nearly opposite to the points of maximum displacement of three of the greater loops. We know very little as yet about the elements the atomic weights of which lie between 140 and 180, hence we cannot recognise the triplets the atomic weights of which should be near to 150; and a similar remark applies to the elements above 210. But the distribution of the triplets throughout the whole of the best-known elements is so nearly regular that it is difficult to avoid the inference that *three* elements should also be found in the symmetrical position between 19 and 23, *i.e.* between fluorine and sodium. And further, that these elements—of which "argon" may be one—should exhibit properties differing chiefly in degree from the alternate palladium and platinum triplets; while hydrogen would appear as the primary of both systems of elements.

Dr. Gladstone's letter, which appeared in your issue of February 21, admirably puts the reasons for preferring an atomic weight of about 20 for argon to the higher number which Lord Rayleigh and Prof. Ramsay are now disposed to assign to it; but Dr. Gladstone seems to think that there is room for only one element, whereas three are possible, as I pointed out at the Oxford meeting, for the reasons given in the foregoing.

It will be seen from the illustration that an element with an atomic weight between 36 and 39 would belong to a third system of elements. But the sole ground for concluding that the atomic weight of argon lies between these points, is the ratio of the specific heats as determined by Kundt and Warburg's method. Lord Rayleigh and Prof. Ramsay found this ratio to be nearly equal to that afforded by mercury gas, the molecule of which is monatomic and density only half its atomic weight; hence they conclude that the argon molecule is monatomic, and that its density of nearly 20 represents but half the atomic weight. Now, while any opinion on this point, coming from the distinguished discoverers of argon, is of the highest value, it seems possible to attach undue weight to the very slender evidence afforded by the specific heats, for mercury at present is the only one of the known cases of monatomic elementary molecules in which the ratio of the specific heats has been determined. But, even admitting that the energy of the mercury and the argon molecules is chiefly translational, it is still conceivable that the argon molecule includes two atomic vortices so closely interlinked as to have a common centre, and therefore to enable the molecule to simulate a monatomic character. Such a structure would be consistent with great stability and, consequently, with exceptional chemical indifference. J. EMERSON REYNOLDS.

Trinity College, Dublin, March 19.

Variation in *Caltha palustris*.

READING the notice of Mr. Burkill's paper on "Variations in Stamens and Carpels," in NATURE of February 7 (p. 359), I remembered the following notes on *Caltha palustris*, which my wife and I made at Corfe, Dorset, June 11, 1891.

C. palustris: heads in pairs on a dichotomously branching stalk; number of follicles in each head, counted in several specimens, as follows:—

7 follicles on one, 4 on the other, of a pair. 8—5, 5—7, 5—6, 6—6, 6—7, 7—5, 9—9, 10—8, 11—8, 9—6.

Thus there is great variation. One stalk is longer than the other, of a pair, and it is presumed that in every case the shorter one flowers first. It will be noticed that in the above eleven instances, only two had the same number of follicles on both stalks. Of the remaining nine, three had most follicles on the longer of the stalks, and six had most on the shorter. Those on the shorter stalk were larger than those on the longer, presumably because older.

A second memorandum gives the results of fifteen more counts, all taken at random, thus (L. = longer, S. = shorter stalk):—

L. with most follicles. L. S.		L. and S. equal. L. S.		S. with most follicles. L. S.
5—4	...	8—8	...	4—6
				4—8
9—8	...	5—5	...	6—7
9—7	...	10—10	...	8—10
		7—7	...	9—10
		10—10	...	7—8
				4—5

It accordingly appears that the later-flowering, longer-stalked head produced more follicles in just half the number of cases counted (13 out of 26), and the shorter-stalked head had a majority in only 5 cases, the remainder being equal.

In a *Bidens* found at Barbadoes (West Indies), on July 6 of the same year, there were similarly two heads, a long-stalked and a short-stalked, the latter flowering first. It would be interesting to get statistics of the numbers of akenes in the heads in this. The species was not certainly determined, but it is of the section of *B. bipinnata*. T. D. A. COCKERELL.

New Mexico (U.S.A.), February 24.

DR. M. FOSTER ON THE TEACHING OF PHYSIOLOGY IN SCHOOLS.[1]

THE teaching of science in schools has, it seems to me, two uses. The first is what I may call the "awakening" use. Many minds who feel no interest in the ordinary subjects of school learning, to whom the ordinary lessons appear as so much dull mechanical work, are at once stirred to intellectual activity when the teaching of this or of that science is presented to them. The second use is the more distinctly "educational," training use.

The minds of the young being, happily, differently constituted, one mind is especially "awakened" by one branch of knowledge, another by another. One boy or girl dates the beginning of his or her intellectual activity from the day on which he or she had a first lesson in chemistry. Another starts in the same way with botany. And the number of those to whom physiology thus serves as "awakening" knowledge, is, it seems to me, sufficiently great to render it desirable, by the introduction of the teaching of physiology into schools, to afford adequate opportunities for its exercising this benefical effect.

It follows that, taught from this point of view, physiology should be taught as a new independent subject, not demanding any previous knowledge; it should be presented as a wholly new field into which the natural mind may wander at will without any restrictions as to being qualified for entrance. It also follows that the teaching must be of a most elementary kind, that as much of chemistry or physics as is necessary for the comprehension of the physiological matters should be taught with the physiology, and, as it were, as a part of it, the pupil being led into chemistry and physics by his interest in physiology, and not being compelled to learn the one for which he or she perhaps does not, at present at least, care before beginning the other.

The instruction given, however elementary it may be, should consist in part of demonstrations and practical exercises. I need not enumerate these in detail, but they must necessarily be limited in scope; the dissection of a rabbit or some other animal to show structure, some little microscopic work, such as the microscopic study of the blood and of a few tissues, the examination of the structure and working of the heart, the mechanics and elementary chemistry of breathing, and the like. But all these demonstrations, like the rest of the teaching, I may repeat, should teach so much of chemistry, of mechanics, &c., as is needed, as a part of the physiological lesson.

As an "awakening" study, I am in favour of physiology being very widely taught; but, as almost necessarily follows from the view on which I have been dwelling, it ought not to be made a compulsory study. Made compulsory, it would as an awakening study lose much of its virtues. I do not hide from myself the fact that the present gross ignorance which prevails among most men and women as to the most elementary facts concerning their own bodies is most undesirable, especially perhaps as regards women; but I am most decidedly of opinion that it is better to meet this evil by encouraging the study of physiology than by making it compulsory.

Physiology, as a distinctly educational study, as a training for the mind, is a very different matter; and it is, in my opinion, in this aspect unsuitable for schools. The training for the mind which physiology affords is one, I venture to think, of no small value, but is one

[1] A short time ago, on my consulting him on behalf of a committee appointed by the Headmasters' Association, to draft regulations for major scholarships' examinations, Prof. Michael Foster was good enough to give me this statement of his opinion on the teaching of physiology in schools—a subject of great importance, but of great difficulty, regarding which much misconception prevails: it appears to me to be so valuable, that I have sought for and obtained his permission to publish it.—HENRY E. ARMSTRONG.

which, especially compared with that afforded by some other sciences, is relatively slight when the knowledge is elementary, increasing rapidly as the study becomes advanced. Further, while I have just urged that elementary physiology as an awakening study may be and indeed should be taught by itself, independent of other kinds of knowledge, I can now urge equally strongly that a study of physiology, beyond the mere elements, is impossible without a previous adequate knowledge of chemistry and physics. Again, while the practical teaching of the rudiments of physiology can be carried out anywhere and by any one, the further study of physiology demands no inconsiderable laboratory accommodation, complicated apparatus, and experiments on animals. Lastly, if the study of physiology is to be real, the whole body must be dealt with, no parts being excluded for special reasons; and this means that the real study cannot be taken up until after puberty. For these reasons it seems to be undesirable to press the introduction of physiology into schools as an educational subject; all the more so, since not only both chemistry and physics are admirably adapted for this purpose, but also a not inconsiderable knowledge of both these sciences is needed for the proper study of physiology; and I imagine that by the time a boy or girl is thus prepared to study physiology, it is time that he or she should leave school.

While I am thus opposed to physiology being placed in a false position in the school curriculum, I feel myself all the more free to urge the very general introduction of an elementary study of the subject on account of its awakening value. I cannot define the amount of physiology which should thus be introduced more closely than by saying that the ground covered should be about that covered by my Primer. I would add that so far as is possible the pupils should *see* for themselves everything which is talked about in the lesson.

As to "physiology being a proper subject to be included among subjects for scholarship examinations for young pupils," I am so impressed with the painful evils of the present scholarship system, that I am most loth to say anything that would in any way lead to an addition to that system. If the scholarship examination is to be a test of education, of intellectual training, it is obvious from what I have said above, that physiology cannot be put on the same level with chemistry and physics. At the same time, if such subjects as physiology or botany are excluded from scholarship examinations, no little injustice, it appears to me, is likely to be done in the following way. A lad, let us say, shows an early bent towards physiology, and acquires at school a very considerable knowledge of its rudiments. His future career depends on his gaining a certain scholarship. If in the examination for that scholarship his place depends solely on the way in which he has acquitted himself in chemistry and physics, in which his interest is of a secondary character —he regarding them merely as helps to physiology—the world may be robbed of an eminent physiologist. Hence I would say that if the evil of a scholarship examination must come, I would give an opportunity of an elementary knowledge of physiology being, in some way, rewarded.

NOTES.

PROF. RAMSAY has been good enough to forward to us the following translation of a passage in a letter he has recently received from Prof. Olszewski: "I have at last succeeded in determining the critical temperature and the boiling-point of hydrogen. I have found for the former $-233°$ and for the latter $-243°$. I have used the dynamical method, which I described in the *Philosophical Magazine*. A thermal couple proved of no use, and I was obliged to avail myself of a platinum-wire thermometer, measuring the temperatures by the alteration in resistance of the wire. I have obtained satisfactory results, and intend to publish an account of them in English."

MR. FREDERICK WEBB has presented the sum of £1000 to the Medical School of St. George's Hospital, to found an annual prize in bacteriology.

PROF. VICTOR HORSLEY, F.R.S., has been elected into the Athenæum Club, under the provisions of the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

WE are glad to learn that there is no foundation for the report of the death of Prof. H. Wild, of St. Petersburg, noted in these columns on February 28. The mistake arose owing to the announcement of the decease of a German investigator of the same name.

AT the meeting of the Royal Irish Academy, on March 16, the following were elected honorary members. In the section of Science: Dr. Karl Weierstrass and Prof. du Bois Reymond, and Prof. E. Suess. In the section of Polite Literature and Antiquities: Prof. A. Erman, Dr. E. Zeller, Lieut.-General H. L. F. Pitt-Rivers, and Mr. S. R. Gardiner.

AT the Paris Academy of Sciences last week, a bronze medal, engraved by Chaplain, was presented to M. Bertrand, in honour of his jubilee. The medal has on one side a likeness of M. Bertrand, and the reverse side bears the following sentiment: "To Joseph Bertrand, member of the French Academy, Perpetual Secretary of the Academy of Sciences, in honour of fifty years' devotion to science and education, from his pupils, admirers, and friends. March, 1844-1894."

THE Anniversary Dinner of the Fellows of the Chemical Society will be held at the Hôtel Métropole on Wednesday, March 27, when Dr. Henry E. Armstrong, President of the Society, will occupy the chair. The Right Hon. A. J. Balfour, M.P., James Bryce, M.P., the Presidents of some of the learned Societies, and several other distinguished guests have accepted invitations to the dinner.

A NUMBER of organisations for scientific research in the leading cities of the American sea-board, including Philadelphia, Princeton, New York, Brooklyn, and Boston, have combined to organise an expedition to the west coast of Greenland. The expedition will be fitted out at Newfoundland, and will sail next June. Elaborate preparations are under way to insure important results to science. Each of the Societies participating will send a representative, including several who went last year, such as Profs. Libley and Chamberlin. The Brooklyn Institute will send a representative, to be chosen hereafter.

THE death is announced of Mr. A. W. Beetham, at Dawlish, in his ninety-fifth year; he was elected a Fellow of the Royal Society in 1835. We also notice the death of Mr. J. C. Smith, president of the Institution of Civil Engineers of Ireland; of Dr. Hermann Grote, one of the most eminent experts in numismatics; of Mr. G. N. Lawrence, a leading American ornithologist; of General de Nasouty, founder and director of the Pic du Midi Observatory, which for twenty-one years has rendered great service to agriculturists in the French Pyrenees; and of Prof. Julien Brunhes, at Dijon.

THE Belgian Academy of Sciences offers a prize of 600 francs for the best essay on each of the following subjects:—(1) On the number of chromosomes before impregnation in an animal or a plant; (2) On the Quaternary Flora, especially that of peat-bogs; (3) Is there a nucleus in the Schizophyta? if so, what is its structure and its mode of division? The essay must contain a critical review of the publications existing on the subject. Each essay must be the result of original investigation.

THE Bologna Academy of Sciences offers a gold medal having the value of one thousand Italian lire (£40) as a prize to the author of a memoir which describes the best system or new apparatus for preventing or extinguishing fires, by chemical, physical or mechanical means. The competition is open to persons of all nationalities, and the memoirs must reach the Secretary of the Academy before the end of May, 1896. The descriptions should be written in Italian, Latin, or French, but memoirs will be permitted to compete if written in any other language, provided a translation in Italian accompanies them.

THE *Times* correspondent at Cairo reports that the Council of Ministers has approved Mr. Garstin's proposal for clearing Philæ of débris, in order to make a thorough examination of the bases of the temples, and explore the subterranean passages which intersect the island. This work, which is of high importance to the scientific world, will be done by the Public Works Department, an official from the Antiquities Department attending to insure that all objects of interest are preserved. The Ministry of War will be asked to lend Captain Lyons, R.E., to superintend the work.

THE United States Government is (we learn from the *British Medical Journal*) about to undertake an investigation of the climates of the country in connection with the indigenous diseases. The investigation will be conducted by the Weather Bureau of the Department of Agriculture, the Chief of which, Mr. Mark W. Harrington, has on many previous occasions given proof of an active interest in sanitary climatology. The precise manner in which the results of the investigation will be made public has not yet been decided upon, but it is hoped soon to publish a periodical devoted to climatology, and its relations to health and disease.

BY the consent of her Majesty the Queen, a piece of ground —the Palace Meadow—about four and a half acres in extent, has been ceded to the Royal Gardens at Kew, for the use of the public. The concession is a great convenience, for the removal of the fences will allow visitors to make a direct, instead of a circuitous, access to the finest part of the Arboretum. The Gardens are 251 acres in extent. It is not generally understood (says the *Kew Bulletin*) that they were originally the private property of the Crown, and not acquired out of public funds. The building used for the Herbarium and Library was sold to the nation by George IV. Access to the remainder has been step by step conceded to the public by the liberality of her Majesty the Queen.

The annual general meeting of the Italian Botanical Society will be held this year in Palermo, from April 16 to 23. The opportunity will be taken of celebrating the hundredth anniversary of the foundation of the Botanic Garden at Palermo.

ON Thursday next, March 28, Dr. E. B. Tylor, F.R.S., will deliver the first of a course of two lectures at the Royal Institution, on "Animism as shown in the Religions of the Lower Races." The Friday evening discourse, on March 29, will be delivered by Dr. H. E. Armstrong, F.R.S. His subject will be "The Structure of the Sugars and their Artificial Production."

THE Zoological Society of France held its second annual reunion on February 28, under the presidency of Prof. Léon Vaillant. The meeting was a marked success, a number of zoologists from all parts of France favouring the Society with original communications. It has been decided to make these annual conferences, to which all naturalists are cordially welcomed, a permanent feature, and to arrange in future for microscopical and other demonstrations, as well as numerous social gatherings.

WHEN the Council of the Zoological Society of France voted to support the movement for the establishment of an international bibliographical bureau, it charged one of its members, Prof. E. L. Bouvier, to present a report at the annual reunion of the Society. Basing its decisions upon this report, the Society has nominated a central Committee of Management, composed of the following titular members:—Dr. Raph. Blanchard, Prince Roland Bonaparte, Prof. Ives Delage, Prof. Henri Filhol, Prof. Albert Gaudry, Baron Jules de Guerne, Prof. A. Milne-Edwards, and Prof. A. Raillet. Twenty zoologists, residing in various parts of France, have been nominated as associate members. To complete the organisation, eleven special correspondents have been appointed, whose duty will consist in reporting to the Bureau such works as are inaccessible to it. A preliminary inquiry among the various scientific societies and the leading publishers has shown, however, that nearly all the zoological publications of France will be sent gratuitously to the Central Bureau. Not a single failure to accept this invitation to co-operate has thus far been reported.

THE annual meeting of the German Zoological Society will be held this year at Strassburg, on Tuesday, Wednesday, and Thursday, June 4 to 6. A preliminary general programme of the meeting has already been issued, and in the list of papers promised for the occasion we notice one by Prof. Goette, "On the Ancestry of the Vertebrata," and another by Dr. Bürger, "On Nemertines." The mornings will be devoted to general business and the reading of scientific communications and reports, and the afternoons will be reserved for demonstrations and the inspection of the laboratories. The meeting should possess considerable interest, and many will probably be glad to avail themselves of the cordial invitation which the Society extends to zoologists of other nationalities to attend the meeting as guests, and to take part in the proceedings of the Society.

THE Paris Geographical Society has awarded its prizes for 1895, as follows:—Gold medals, to Lieut. L. Mizon, for his explorations in West Africa; E. Gautier, for his explorations in Madagascar; F. Foureau, for his explorations in the Sahara; E. Ponel, for his explorations in the region of the French Congo; Th. Moureaux, for his magnetic map of France; Father Colin, for his observations and triangulations in Madagascar; A. Courtry, for the production of a map of the Congo; V. de la Blache, for his general atlas; and Dr. Thoroddsen, for his explorations in Iceland. Silver medals have been conferred upon E. D. Poncins, for his journey from Turkestan to Kashmir by the Pamirs; J. Gaultier, for his works on the production of plans by photography; B. d'Attanoux, for his exploration in the Sahara; and J. Forest, for his studies on the breeding and habits of the ostrich in the Sahara. The Jomard prize has been awarded to L. A. Rainaud, for his memoir entitled "Le Continent austral: hypothèse et découverte."

SINCE the decision in the case of the Leeds Sunday Lecture Society, when it was held that the delivery of a lecture on a Sunday came within the meaning of the "Act for Preventing certain Abuses and Profanations on the Lord's Day, called Sunday," if the public were not admitted free, the Sunday Society has been exerting itself to procure an amendment of the vexatious Law as it now stands. Lord Hobhouse, who presided at a conference of Sunday Societies held last month, has introduced a Bill into the House of Lords for amending the Act in accordance with a resolution passed on that occasion. The Bill aims at securing that in future—"No action for the recovery of any penalty shall be commenced against any person in respect of the opening of any Museum, Art Gallery, Science or Art Exhibition, Garden or Library, as such, or the delivery of any lecture on science, literature, art, or kindred subject, or any recitation, or the giving of any performance of music, either vocal or instrumental, on Sunday, provided that the same take place under the management and control of a Society, Committee, or other body of persons, for the public advantage and not for pecuniary profit."

IT is proposed to hold an International Exhibition at Atlanta, Georgia, U.S.A., from September 18 next, to December 31. The classification includes the usual departments of International Exhibitions, the following being the divisions:—Minerals and Forestry; Agriculture, Food and its accessories, Machinery and Appliances; Horticulture, Viticulture, Pomology, Floriculture, &c.; Machinery; Manufactures; Electricity and electrical appliances; Fine Arts, Painting, Sculpture, and Decoration; Liberal Arts, Education, Literature, Music, and the Drama; Live Stock, Domestic and Wild Animals, Fish, Fisheries, and Fish Culture; Transportation. The United States Government have given permission for exhibits to be brought in free of Customs' duties, unless the goods are entered for consumption in the States. Exhibits are invited from foreign countries on the usual conditions. Further information may be obtained from the Director-General, Mr. C. A. Collier, Piedmont Park, Atlanta, Georgia, U.S.A. Copies of the classification and general regulations have been sent to the Secretary of the Society of Arts, and can be seen at the Society's offices by any persons interested.

AT a recent meeting of the Oriental Club of Philadelphia (Dr. D. G. Brinton writes in *Science*), Dr. J. P. Peters, whose researches among the ruins of the valley of the Euphrates are well known, mentioned his observations on the deposition of alluvium by the river as a chronometer for measuring the antiquity of some ruin-mounds. The deposits from the known date of Alexander's conquests display marked uniformity; and taking the depths of these as a standard, the foundations of Ur (the "Ur of the Chaldees" of Genesis, the modern Muchair) and of Eridu (the modern Abu-Shahrein) must have been laid about seven thousand years B.C.

A SUBSTITUTE for wood is badly wanted in the construction of warships. In the recent actions between the Chinese and Japanese fleets, several ships were disabled by serious fires on board, and this has caused much attention to be given to the invention of artificial wood, both at home and abroad. A Board of experts, says the *Journal* of the Franklin Institute for March, was lately convened by direction of the Secretary of the U.S. Navy to consider the subject of dispensing with wood in the construction of the naval ships now building, and also for the purpose of finding some suitable substitute for wood where it is impracticable to use metal. The Board has decided that a substitute for wood should be light, or not heavier than wood, non-conducting, non-combustible, and, when struck by shot, should not fly into splinters. Wood has the very objectionable property of splintering from the effect of shot; and the fact is well known that, in wooden ships, frequently as many persons are wounded by splinters as by shot.

A SOLUTION of the problem of finding a substitute for wood, seems, in the opinion of the Board, to lie in the following direction:—Select something in the nature of cheap wood or vegetable fibre and fine sawdust; treat them chemically with some insoluble fire-proof substance, not too heavy; then press and roll into boards, more or less dense, according to the use for which the material is desired. Such a material will be non-inflammable all through, will not splinter, will not be heavy, and will be a non-conductor. Possibly this artificial board can be strengthened by enclosing within it a tough, fine wire netting. If sawdust, or other fine cellulose material, after being rendered non-inflammable, can, by mixing with other materials not too heavy—or, if heavy, in small quantities—be applied to metal in a plastic state, so as to harden into a compact mass impervious to water, then it will be of great value. In other words, if a light, non-conducting, non-inflammable, insoluble cement can be discovered, it will be of great use in ship construction.

NUMEROUS objects made of wood and covered with copper have been found during the exploration of mounds in Ohio. Prof. F. W. Putnam has described specimens of this kind, and copper objects sheathed with silver. The examples found are quite sufficient to show that the American aborigines in the Mississippi valley and in South America had the art of cold-hammering copper, of heating it to overlie and fit upon a warped or curved surface, and of turning the edges under. This process must not be confounded with the mere hammering-out of implements, nor with the process of making a sheet of copper as thin and uniform as a ship's sheathing, and then producing figures by rubbing or pressure. A note by Prof. O. T. Mason, in the *Proceedings* of the U.S. National Museum (vol. xvii. No. 1015), shows that the Haida Indians, who occupy the Queen Charlotte Islands, and are famous for their carved work, also cover wood and bone with copper. He describes two figures of humming-birds carved in wood, and having their wings and tails overlaid with a covering of sheet copper. The surfaces are neatly engraved with the conventional wing and eye signs of the Haidas. These specimens, and those from the mounds of Ohio, throw some light upon the processes employed by the aboriginal metallurgists of America.

IT will be remembered that in June last, Prof. C. V. Riley resigned his position as Chief of the Division of Entomology of the United States Department of Agriculture, and was succeeded by Mr. L. P. Howard. Owing to these changes, the publication of *Insect Life*—the premier of entomological bulletins—appears to have ceased for a time. The periodical has, however, been revived, and three numbers of a new volume (vol. vii.), edited by Mr. Howard, have come to us, together with the last number of vol. vi., published under the joint editorship of Prof. Riley and Mr. Howard. Each of the numbers contains a store of information, in the form of articles or notes, on the life-habits of insects, especially in relation to agriculture. In one (vol. vi. No. 5) we notice an address on "Bees," by Prof. Riley, and in another (vol. vii. No. 1) we have an illustrated description of the senses of insects, by the same writer. The second number of the new volume is devoted to the proceedings of the sixth annual meeting of the Association of Economic Entomologists, held in August 1894. The presidential address delivered by Mr. Howard on that occasion, dealing with the rise and present condition of official economic entomology, shows what official encouragement is given to the investigation of insect problems in all parts of the world.

MOST of the great advances in entomology have come from America, but, as Mr. Howard points out in the address referred to above, this progress would not have been possible without legislative encouragement. At the present time the amount of money expended for work in economic entomology is far greater in the United States than in any other country. There the regular annual expenditure in the support of entomological offices amounts to about one hundred thousand dollars. Probably the total sum expended annually in experiments and publications exceeds the entire amount expended in the same direction by the remainder of the world. No wonder, then, that the whole world looks to America for instruction in economic entomology. And the results obtained justify the money expenditure. Not a year passes, Mr. Howard remarks, in which the sum saved to agriculture and horticulture, as the direct result of the investigations of entomologists, does not amount to many times that which the United States Government grants. The results have thus added greatly to the productive wealth of the world, and this fact alone should be sufficient to lead our own Government to a more generous recognition of work in economic entomology.

SEVERAL German periodicals have published an account of a remarkable balloon ascent made in the "Phœnix" by Dr. A. Berson, on December 4 last. The balloon was inflated with 70,600 feet of hydrogen, and ascended from Stassfurt (Prussia) in the morning, taking a north-westerly direction, the weather at the time being somewhat misty. The temperature at first increased up to a considerable height; at 4900 feet the thermometer stood at 41°, and at 16,400 feet it read 0°, with a very dry air. At noon, an hour and half after starting, a height of 22,150 feet was reached, and the thermometer fell to −20°. At this time Dr. Berson began the artificial inhalation of oxygen, with excellent results. At about 29.500 feet the balloon passed through a veil-like stratum of cirrus clouds; these did not consist of ice crystals, but of perfectly formed flakes of snow. About two and a half hours after starting, a height of about 31,500 feet had been reached, the thermometer dropped to −54°, and indicated only −11° in the sun's rays; at this height Dr. Berson, being alone, thought it prudent to commence the descent. At 4600 feet the highest temperature was recorded, viz. 43°, and between this point and the earth it dropped to about 34°. The ascent occupied 3 hours, and the descent 2h. 20m., the balloon having travelled 186 miles, notwithstanding that the wind was almost calm on the surface of the earth. Dr. Berson obtained observations at a greater altitude than they had before been made; in Mr. Glaisher's celebrated ascent of September 5, 1862, the last actual observation was at 29,000 feet, although it is supposed that the balloon rose at least 7000 feet higher. The above particulars are taken from an account given in the *American Engineer* for this month.

ABOUT three years ago, the Botanic Garden at Cape Town was transformed into a town garden supported by municipal rates. A similar change has lately taken place at King William's Town, in the eastern province of the colony. The *Kew Bulletin* for March rightly condemns these changes, and the perfunctory manner in which botanic gardens in South Africa have generally been treated. It points out that, at the present moment, Cape Colony is the only important British possession which does not possess a fully-equipped botanical institution. It is true it possesses a fine colonial herbarium, under the competent charge of Prof. MacOwan, and an agricultural department which he efficiently advises on botanical subjects. But beyond this it has no central authority dealing with the practical aspects of the science of botany, and no gardens under technical control where careful experimental cultivation could be carried on, or where special seeds and plants could be obtained for starting new industries. This condition of affairs, the *Bulletin* holds, is scarcely credible to a large and wealthy community like that at the Cape. Something more than an ornamental garden, dotted here and there, is required in South Africa. A central establishment in the neighbourhood of Cape Town, devoted to the scientific study and experimental cultivation of plants, fully equipped to discharge its studies as a national institution on the lines of Kew, would alone be worthy of the future of South Africa. The flora of this part of the world is one of extreme interest. It deserves to be carefully and exhaustively studied, and numerous plants, now in danger of becoming extinct, should be preserved in some central spot for the observation of students. Of the economic influences of such a central institution it is needless to enlarge. There are hundreds of problems connected with the cultivation of industrial plants in South Africa awaiting solution, and these could only be dealt with at an institution specially devoted to scientific research, where careful trials could be conducted extending over many years.

IN a recent publication by Dr. L. A. Bauer, entitled "Beitraege zur Kenntniss des Wesens der Saecular Variation des Erdmagnetismus" (Inaug. Diss., University of Berlin), some interesting and important contributions to our knowledge of that enigmatical phenomenon of terrestrial magnetism—the secular variation—have been made. The author has constructed the actual curve described in the course of centuries by the north end of a "free magnetic needle" at various stations (24) distributed over the globe. The result has been the establishment of a law governing the *direction* of the curve, which the author claims is the first law that has been established thus far with regard to the secular variation as applying to the whole earth. This law may be expressed as follows:—The north end of a freely suspended magnetic needle, as viewed from the point of suspension of the needle, moves, in consequence of the secular variation of terrestrial magnetism on the entire earth, in the direction of the hands of a watch. With regard to the period, Dr. Bauer believes that it has not yet been proved that the earth actually possesses a common secular variation period. The only way he thinks it possible to deduce a common period is by the supposition that the curve described by the magnetic needle is not a single closed one, but consists of loops. Indications of such loops, he says, make themselves apparent at various stations. A comparison is also drawn between the secular variation and the momentary distribution of terrestrial magnetism. A secular wave is followed around the earth with the aid of the projected curves. It would appear as though a continuation of the secular curve is obtained by going around the earth eastwardly. The fact thus revealed, the author says, would have, as a direct consequence, that if a survey be made along a parallel of latitude in an easterly direction, a similar motion of the magnetic needle would be encountered as in the case of the secular variation. Dr. Bauer has carried out this idea for three epochs, viz. 1780, 1829, and 1885, and along several parallels of latitude. The curves described by the needle are projected and given on a special plate. It has been found that in every case the north end of the needle, as observed from the centre of the needle, moves clockwise. Furthermore, by a comparison of both sets of curves—the secular and the momentary—it would appear as though they are subject to similar laws.

THE method adopted in the Physikalisch-Technische Reichsanstalt for turning true spheres is described by Herr von Liechtenstein in the *Zeitschrift für Instrumentenkunde*. Three grinding cylinders, the diameter of which is less than that of the sphere, are mounted in a lathe, two of them being carried by one head and one by the other. They are disposed at angles of 120° to each other in a horizontal plane, and grasp the sphere between them. Their rotation produces a perfectly irregular motion of the sphere, and between the three cylinders it is ground to an extraordinary truth of figure. Iron and steel spheres of 25 mm. diameter thus produced showed errors of diameter not exceeding 0·0015 mm.

IN the yearly report of the Russian Geographical Society, we notice that M. Roborovsky, chief of the Tibet expedition, has made a careful survey of the Lukchun depression, the level of which, as is known, lies below the level of the ocean. It appears that the depression has a length of nearly 100 miles, and an average width of 50 miles, and that its level is from 100 to 150 metres below the level of the sea. The desert which is situated in the south of it was crossed in several directions, and M. Roborovsky succeeded in obtaining no less than six specimens of the wild camel. After having reached Sa-chou, the expedition made extensive surveys in the Nan-shan highlands, and then it went out for the exploration of the country in the east of Lake Kukunor.

With reference to Mr. Culverwell's recent criticism of the astronomical theory of the Ice age, the Rev. O. Fisher (*Geol. Mag.* for March) quotes the opinion of the late Prof. Adams, expressed to him in a letter dated February 28, 1866. He says: "I do not myself believe in the change of eccentricity of the earth's orbit being a cause of climatal changes on the earth. The effect, if any, would depend only on the *square* of the eccentricity; and this always remains so very small, that I believe the effect on the earth's mean temperature would be almost insensible. Depend upon it, geologists who look in this direction for the cause of glacial epochs are entirely on the wrong track. It seems to me much more likely that the actual act of emission of heat from the sun is variable, than that the change of eccentricity of the orbit should have any sensible effect."

Prof. F. Brioschi read before the Accademia dei Lincei, on March 3, a very full account of the life and works of the late Prof. Cayley, who was a Foreign Associate of the Academy.

A work almost entirely concerned with Insurance statistics is "Bourne's Handy Assurance Directory," now carried on by Mr. W. Schooling. Every one interested in statistical information relating to human life will find the volume useful.

In the "Handbook of Jamaica" (Stanford) for 1895, compiled by Mr. S. P. Musson and Mr. T. L. Roxburgh, short biographical descriptions are given of the men of science who have been associated with the island, in addition to the historical, statistical, and general information concerning it.

The number of the *Bulletin* of the Botanical Department, Jamaica, for January 1895, edited by the Director, Mr. W. Fawcett, is largely occupied with the insect enemies of the cocoa (*Theobroma*) and pine plantations, and some of the Coccidæ or scale-insects. It also contains a very interesting report on the services rendered in the island by the Botanical Department of Jamaica.

With the March number, *Science Progress* commences its third volume. Dr. E. Klein, F.R.S., contributes to the number an article on antitoxin, and Mr. J. E. Marr, F.R.S., summarises recent literature concerned with foreign work among the Precambrian and Palæozoic rocks. The subjects of the remaining articles are:—"Insular Floras," by Mr. W. B. Hemsley, F.R.S.; "Peptone," by Dr. W. D. Halliburton, F.R.S.; "Budding in Tunicata," by Mr. W. Garstang; and "The Reserve Materials of Plants," by Prof. J. R. Green.

The first part of Mr. C. B. Moore's valuable report of his excavations in the prehistoric sand mounds of the St. John's River, Florida, was noticed in these columns last November (vol. li. p. 27). The second part, which has now reached us, contains the results of seven months' continuous work upon all the remains that could be found, and the complete report practically exhausts the study of the mounds on the banks of the St. John's River; for the river has been explored from the source to its outlet. The mounds described in the part of the report before us are, perhaps, not quite so interesting as those of which an account was given in the former part, but this does not diminish their value to archæologists. Future workers among the mounds will find that all the objects found are recorded, instead of merely the rare ones, and those of unusual workmanship. The flint implements, curious types of earthenware, and human remains described, and finely illustrated, furnish material for much scientific study. The Philadelphia Academy of Sciences, in the *Journal* of which (vol. x.) Mr. Moore's report appears, deserves much credit for the admirable illustrations.

Meteorologists and physicists have reason to be grateful to Mr. S. P. Langley for the valuable series of numerical tables which he has projected, to take the place of a series of meteorological tables compiled by Dr. Arnold Guyot, and published by the Smithsonian Institution in 1852. Dr. Guyot's tables were widely used and appreciated, but the new series will be of even greater service. The work will be completed in three parts: Meteorological Tables, Geographical Tables, and Physical Tables. The first of these volumes appeared in 1893; the second (Smithsonian Miscellaneous Collections, No. 854) lies before us. This has been prepared by Prof. R. S. Woodward, whose experience in geodetic work particularly qualifies him for the task. The introductory part of the volume is divided into seven sections, under the heads: useful formulæ, mensuration, units, geodesy, astronomy, theory of errors, and explanation and use of tables. This section takes up a hundred pages, after which come tables running into one hundred and eighty pages. Every effort appears to have been made to avoid errors, and Prof. Woodward has made a judicious selection of matter from a vast amount of available material. It requires no great prophetic instinct to say that his compendium will be prized by geographer and meteorologist, as a standard work of reference.

The Meteorological Society of Berlin has published its Report for the year 1895; the Society holds monthly meetings between October and May, and a summary of the papers read is regularly printed in our columns. Prof. Hellmann, the President, appends to the Report a discussion of the wind velocity at Berlin from ten years anemometrical observations. The principal maximum, in the yearly period, falls in March, and the minimum in September; in the daily period, the maximum throughout nearly the whole year occurs between 1h. and 2h. p.m., with a tendency to a second maximum during the night in the cold season. The greatest hourly velocity recorded was fifty miles an hour, which is about half the rate that has been registered in the greatest storms on our own coasts.

We have received from Dr. Henry Bovey a paper of high technical value, containing the results of numerous experiments which have been carried out in the testing laboratories of the McGill University, on the strength of Canadian Douglas fir, red pine, white pine, and spruce. The tables given tend to prove that timber, unlike iron and steel, may be strained to a point near the breaking-point without being seriously injured. In almost all cases the increments of deflection and extension, almost up to the point of fracture, are very nearly proportional to the increments of load, thus showing that it is difficult to define a limit of elasticity for timber. This, Dr. Bovey thinks, probably accounts for the continued existence of many timber structures of wood in which the timbers have been, and are still, continually subjected to excessive stresses, the factor of safety being often less than one and a half. Whether it is advisable so to strain timber is another question, and experiments are still required to show how wood is affected by frequently repeated strains.

A further memoir concerning the interesting sodium derivative of nitro-ethane, and the sodium compounds of nitro-paraffins generally, is contributed by Prof. Victor Meyer to the *Berichte* of the German Chemical Society. The nature of these unstable compounds has not hitherto been satisfactorily determined, for in a communication to the *Annalen der Chemie*, J. U. Nef, some time ago, stated that they do not partake of the nature of true derivatives of nitro-paraffins, but contain an altogether differently constituted organic residue. The experimental evidence adduced in support of this view consisted chiefly of the observation which he made that the parent nitro-paraffin was not, or only to a slight extent, regenerated upon treating the sodium compound with dilute sulphuric acid, the compound being decomposed with evolution of nitrous oxide and formation of an aldehyde or ketone. Prof. Meyer has made further experiments in this direction, and their results definitely fix the nature of these sodium compounds, proving that they are indeed true sodium derivatives of the nitro-paraffins, being formed by the replacement of one of the hydrogen atoms of the alkyl radicle by sodium. It is a fact that when sodium nitro-ethane, $C_2H_4NaNO_2$, is dissolved in excess of dilute sulphuric acid at the ordinary temperature, a somewhat vigorous evolution of nitrous oxide occurs. But if the most elementary precautions are taken to prevent the decomposition of so unstable a substance by the thermal change involved in so energetic a reaction, the decomposition proceeds quite differently. If the sodium compound is first dissolved in a little water well cooled by ice, and then an equivalent added of dilute sulphuric acid similarly cooled to near 0°, only a very few bubbles of gas escape, and barely a trace of the odour of aldehyde is perceptible, while a layer of oil, consisting of nitro-ethane, separates out. Even after the operations of purification, which involve some loss owing to the volatility of nitro-ethane, over 60 per cent. of the theoretical quantity of the pure nitro-paraffin was isolated. Moreover, the small quantity of decomposition indicated by the few bubbles of nitrous oxide can be entirely avoided by employing acetic instead of sulphuric acid; the reaction is then less vigorous, and consequently produces at temperatures not far above 0° no dissociation of the nitro-paraffin. The observation of Nef, that the sodium derivatives of the nitro-paraffins are decomposed at the ordinary temperature by the stronger acids, even when diluted, into nitrous oxide and an aldehyde or ketone, is an interesting one; but Prof. Meyer's work now shows that this is due merely to the fact that the nitro-paraffin first regenerated is decomposed in all probability by the heat of the reaction between the sodium and acid, and that when the precaution is taken to prevent this rise of temperature by reacting with ice-cold solutions, the regenerated nitro-paraffin remains intact. Hence it must be concluded that the sodium compounds are true derivatives of the nitro-paraffins which can thus be regenerated from them.

The additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*, ♀) from South Africa, presented by Captain Scarlett Vale; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Miss K. Fleming; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. Richmond Allen; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mrs. Lewis; fifteen —— Rats (*Mus*, sp. inc.) from Sunday Island, Kermadee Group, presented by the Countess of Glasgow; a Hooded Finch (*Spermestes cucullata*) from West Africa, a Chestnut-eared Finch (*Amadina castanotis*) from Australia, presented by Mr. C. H. Hastings; a Woodcock (*Scolopax rusticula*), British, presented by Mr. Charles Smoothy; a Long-necked Chelodine (*Chelodina longicollis*) from Australia, deposited; four Marbled Newts (*Molge marmorata*), European, purchased.

OUR ASTRONOMICAL COLUMN.

PARTIAL ECLIPSE OF THE SUN, MARCH 26.—On March 26 a small partial eclipse of the sun will, if the weather be favourable, be seen from all parts of the British Isles, with the probable exception of places which are to the east of a line joining Lowestoft and Hastings. At Greenwich the magnitude of the eclipse, sun's diameter = 1, will be 0·013, and the first contact will occur at 9.56 a.m., with a duration of only 27 minutes. At Oxford the magnitude will be 0·03, and the duration 40 minutes. At Dublin the magnitude will be 0·09, with a duration of 67 minutes, and at Edinburgh 0·08, with a duration of 62 minutes. The eclipsed part will be a maximum (0·36) as seen from the north-east of North America.

In the *Nautical Almanac* for the current year the eclipse is said to be *invisible* at Greenwich, but the error was corrected in the *Almanac* for 1897. The mistake, however, has not been corrected in many of the almanacs in common use.

DISTRIBUTION OF MINOR PLANETS.—An interesting diagram has been constructed by General Parmentier, to show the distribution of the minor planets at present known between the orbits of Mars and Jupiter (*Bulletin Soc. Ast. de France*, March). Of the 390 planets for which sufficient data are available, 93 have a mean distance between 2·16 and 2·48; 152 between 2·52 and 2·82; 128 between 2·85 and 3·25; and 10 between 3·38 and 3·48. The interval between Brucia (at 2·16) and Mars, is occupied by a single asteroid, comparatively recently discovered, with a mean distance of 2·09. On the outer side of the dense swarm, there are only six minor planets in a zone very nearly as wide as that occupied by the group of 383, and extending to a mean distance 4·68. The region of greatest density of the asteroids so far discovered is at a mean distance from the sun very nearly equal to that indicated by Bode's law (2·80); Ceres, Pallas, and Juno fall a little short of this distance.

At the present rapid rate of discovery of minor planets by the photographic method, data will no doubt soon be available to determine if the outer zone between Camilla and Jupiter is really an almost deserted region.

THE ROYAL OBSERVATORY, EDINBURGH.—We are glad to hear that the new National Observatory for Scotland is making rapid progress towards completion. The buildings are quite finished so far as the outside is concerned, and it is hoped that the two equatorials and the transit instrument will be erected in the early summer. The library will be ready to receive the magnificent collection of twenty thousand volumes as soon as the heating arrangements are completed.

THE PHYSICAL WORK OF HERMANN VON HELMHOLTZ.[1]

II

KÖNIG has shown that in many cases, when two notes are sounded simultaneously, beats are heard, as though the most prominent phenomenon was the production of beats not between the two fundamental notes, but between the upper of these, and the nearest partial of the lower note. Inasmuch as these beats are heard when the lower note (as far as can be tested) is free from upper partials, this rule is not the explanation of the phenomenon, but it is a convenient way of expressing the results. In the experiment just described, the frequencies of the two notes were in the ratio 12 to 15. The first partial of the lower note (12) is therefore the nearest to the higher tone; that is to say, König's beat tone and the first difference tone are identical.

It is easy to arrange an experiment in which these conditions are not fulfilled. Thus let the notes be in the ratio 9 : 15. The second partial of the lower note is 18, which is nearer to 15 than to 9; hence the König beat-tone would have a relative frequency of $18 - 15 = 3$. If the siren rotates 10·6 times per second, the frequencies of the two fundamental notes are $9 \times 10{\cdot}6 = 96$ and $15 \times 10{\cdot}6 = 160$ respectively. As before, the difference tone is 64.

In this case we can use another method of determining the speed of the siren. In 1880 Lord Rayleigh constructed an instrument in which the mass of air enclosed in a tube is excited by resonance, and the fact of the excitation is indicated by a light mirror, which is set where the motion is greatest, inclined at 45° to the direction of the air-currents. In accordance with the general law that a lamina tends to place itself perpendicular to the direction of a stream, the mirror moves when the air vibrates. In the original apparatus the amount of the movement was controlled by magnets. Since that date Prof. Boys has modified the instrument by substituting a quartz thread suspension for a silk fibre, and using the

[1] A discourse delivered at the Royal Institution, by Prof. A. W. Rücker, F.R.S., on Friday, March 8. (Continued from page 475.)

torsion of the thread instead of the directing force of the magnets. In a lecture delivered before the British Association, in Leeds, he exhibited the apparatus, which is sometimes called a mirror resonator. Prof. Boys has been good enough to make two of these instruments for me, and for reasons, which I will not at the moment enter into, we decided that one of them should respond to 161 vibrations per second. It so happens that this coincides almost exactly with the frequency of one of the notes in the experiment under discussion (160). It is thus possible to use the mirror resonator as an auxiliary instrument to test the speed of the siren. When the proper note is reached the spot of light will move, and if the difference tone is objective the interference bands ought to disappear simultaneously. We tried this experiment several times. An observer, so placed that he could not see the interference bands, lifted his hand when the spot of light moved. It was quite extraordinary to note the absolute agreement between his movements and the behaviour of the bands.

By throwing the spot of light and the bands near together on the screen, the coincidences can be watched by a number of persons. We have tried whether the difference tone is objective in four cases, and in all have detected it by the disappearance of the interference bands. The details of the experiments are collected in the following table. In the first two experiments the first difference tone is, and in the last two it is not, coincident with König's lower beat note.

Difference Tones.

Number of holes in siren.	Interval.	Frequencies.		Difference—and König's beat-tones.	
15 and 12	Major third	320	256	64	64
16 ,, 12	Fourth	256	192	64	64
15 ,, 9	Major sixth	160	96	64	32
18 ,, 8	An octave and a major tone	115·2	51·2	64	12·8

Of course the question at once arises, whether, when it can be distinguished separately, König's beat tone is also objective. I do not wish to express a final opinion on this point, but I may say that when the rows of eight and eighteen holes were opened the speed of the siren was increased till the notes corresponding to 256 and 576 vibrations were produced. König's note would in that case have a frequency of $576 - 2 \times 256 = 64$. We tried twice to obtain this. On the second occasion, especially, all the conditions were favourable, and the experiment was carried on for a long time. On neither occasion did we obtain the smallest sign of an effect on the fork and interference bands.

We must next turn to the summation tone which Helmholtz discovered. It has been almost universally denied that this note is objective. Without going into details, it is only necessary to remark that the late Mr. Ellis, the translator of the "Tonempfindungen," who took a dispassionate view of the controversy, thought that the position assumed by Helmholtz had been disproved. To the statement of Helmholtz that "it was formerly believed that the combinational tones were purely subjective and were produced in the ear itself," Ellis appended the note: "the result of Mr. Bosanquet's and Prof. Preyer's quite recent experiments is to show that they are so."

In an experiment on the summation tone, as the total number of vibrations must not exceed 64, the notes will be too low to be well heard. I shall therefore use a third method of determining the rate of speed of the siren. A mirror attached to the lower plate of the instrument rotates with it. Concentric with, and lying on this, is a circle of paper with eighteen cogs. Light reflected from the mirror passes through holes in two pieces of tinfoil attached to the prongs of a tuning-fork. When the fork is at rest, these holes are superposed; but when the fork vibrates, they move apart, are closed by the tinfoil, and only cross each other twice in each complete vibration. The tuning-fork makes 27·2 vibrations per second, and thus allows the light to pass 54·4 times per second. But when the siren makes 3·048 revolutions per second, the rows of nine and twelve holes give a summation tone of 64 vibrations, and each cog moves over $18 \times 3{\cdot}048 = 54{\cdot}9$, or say 55 times the distance between two consecutive cogs. If the wheel were viewed 55 times a second, the cogs would appear stationary, as in that interval each would be replaced by the next. As they are really seen about 54·4 times a second, they appear to move slowly forwards at the rate of about one inter space in two seconds. When this speed is attained the bands disappear, thus proving the objective existence of the summation tone.

We have repeated this observation in various ways, and always with success. The results are summed up in the table.

Summation Tones.

Numbers of holes in siren.	Interval.	Frequencies.		Sum.
10 and 8	Major third	$35{\cdot}\dot{5}$	$28{\cdot}\dot{4}$	64
12 ,, 9	Fourth	36·57	27·43	64
16 ,, 9	Minor seventh	40·96	23·04	64

It is, perhaps, a drawback that all the notes in these experiments are very low. In order to remedy this, and also to put the matter to the test by means of another instrument, we have employed a mirror resonator, which responds to 576 vibrations per second.

The rows of 15 and 12 holes being opened, notes of 320 and 256 vibrations were produced. When they were sounded separately, the noise seemed just to make the resonator move. When they were sounded together, the spot of light was driven off the scale, when the upper note coincided with that of a 320-vibration fork, but immediately returned when this pitch was lost.

The summation tone of 576 vibrations was also obtained by two other combinations of holes. The 320-fork was used, and the disturbance occurred in the one case when the pitch of the upper note given by the siren was nearly the same as before, and in the other case when it was about a tone higher.

The results are summed up in the table.

Summation Tones.

Numbers of holes in siren.	Interval.	Frequencies.		Sum.
15 and 12	Major third	320	256	576
16 ,, 12	Fourth	329·15	246·85	576
16 ,, 9	Major sixth	360	216	576

I venture to think that these experiments prove the accuracy of von Helmholtz. They show that the siren, at all events, does produce objective tones, the frequencies of which coincide with those of the first difference and summation tones, and that this statement is valid as regards the difference tone, whether it is or is not coincident with König's beat-tone.

I have now in one single case tried to convey to you some idea of the complexity of the problems with which von Helmholtz dealt. He was the first man who detected a relation between the surging mass of partials and combination tones and our sensations of concord and discord. The main facts of his theory are, I believe, generally accepted. On some points modern opinion has tended to stray from his views; one of these we have studied afresh this evening.

It was the fact that I had to deliver this discourse which led me to investigate the question anew, and therefore I felt bound to tell you the results we have at present attained. Had it not been for this, I should not have published them as yet. We have several improvements of the apparatus in view. We do not pretend to have covered the field. I do not, therefore, wish to generalise. My object has been to refute hasty generalisations. I am content if I have convinced you, as I have convinced myself, that Helmholtz was correct in stating that the siren produces objective tones, whose frequencies are equal to the sum and difference of their primaries, and that the methods we have employed have brought to light no facts opposed to his view that these notes cannot be explained as secondary effects of partials, but as phenomena of the first order—in other words, as real combination tones.

But brief space now remains to discuss the vast remainder of his work, and as I have already published an appreciation of that (*Fortnightly Review*, November 1894), I must content myself with trying to give you, in a few sentences, some idea of the range of his intellect.

His investigations on optics were not less important than those on sound. He invented the ophthalmoscope, by which the oculist can study the inmost recesses of the eye. The theory of colour vision, the theory of binocular vision, the curious subjective effects which are produced when we deliberately deceive our own senses by the stereoscope; these subjects he made especially his own.

In the field of mathematics he was the first to define the peculiar rotatory motion of a liquid known as vortex-motion. Great men had laid the foundations of hydrodynamics before him, but all had overlooked the importance and laws of the vortex. Since the memoir of Helmholtz was published the subject has been widely studied. Lord Kelvin has originated the famous vortex-ring theory of matter; Prof. Fitzgerald has suggested that the ether may be a complex of vortices, or, as it has been called, a vortex-sponge.

On electricity he wrote much—on the theory of the galvanic cell, on electrolysis, on electromagnetism.

In England, at all events, we give the preference, as regards the last subject, to the theory and writings of our own Maxwell.

A lecture, or rather many lectures, might be delivered on each of these topics, but I prefer to devote the few minutes that remain to other subjects.

As I have already said, von Helmholtz, in an age of specialists, was a universal genius. His intellect could light on nothing which it did not illuminate. Hence his opinions on side issues are of more than ordinary importance, his "obiter dicta" are worth attention, his popular lectures acquire a special interest. Let us for a few moments turn to these.

The watchword of Helmholtz in dealing with educational problems is "freedom." Freedom for the student, freedom for the teacher.

In England we are fond of insisting that there are certain things which everybody who aspires to academic rank must know; of hedging in our students by prescribed courses of study. We make them feel that general culture is an iron-bound safe, which they must wrench open before they can attain the gem of real knowledge, rather than a setting, without which the most profound acquirements seem unattractive and dull. Yet von Helmholtz, one of the most highly educated men, one of the most comprehensive geniuses of the latter end of the century, will have no set courses, except as a preparation for a definite profession, is proved that Germany has "retained the old conception of students, as that of young men responsible to themselves, striving after science of their own free will, to whom it is left to arrange their own plan of studies as they think best." Not content with having made the attainment of this ideal almost impossible for English students, doctrinaire educationalists are now beginning to throw their net around the teacher. It is claimed that as the student must go through a prescribed course of study in order to learn, so the teacher must be drilled and examined before he is allowed to teach. Whatever can be said for this plan as regards the less advanced class of teachers, who are to devote themselves to the instruction of children—and in this case I believe there is something to be said for it—it is quite opposed to von Helmholtz's view of what is best when the teaching is of university rank, and the students are men and women. Make it easy for whoever has given some proof of knowledge, and wants to teach, to try his hand; make it easy for the student to go to the teacher from whom he gains the most. Look for the best educational results, not necessarily from the best lecturer, but from the man who is in closest contact with his subject. Do not force your teacher on his audience, but do all you can to establish a bond of sympathy between them. Trust, in a word, to the free play of living forces, and not to the hampering restrictions of "necessary subjects" and "compulsory lectures." This is a paraphrase of the views which Helmholtz held, and he illustrated them by the history of this Institution itself.

"I have often," he said, "wondered that the Royal Institution of London, a private society, which provides for its members and others short courses of lectures on the progress of natural science, should have been able to retain permanently the services of men of such scientific importance as Humphry Davy and Faraday. It was no question of great emoluments; these men were manifestly attracted by a select public, consisting of men and women of independent mental culture." And then he goes on to show that in a German university the teacher is attracted to his work, because he has to deal with a body of students, who are capable of forming opinions, and of judging what is best for themselves.

And this leads us to another point. Von Helmholtz insisted that it is useless and dangerous to crowd the universities with students, who are not capable of taking advantage of the opportunities they offer. "The majority of students," he says, "must come to us with a sufficiently logically trained judgment, with a sufficient habit of mental exertion, with a taste sufficiently developed on the best models to be able to discriminate truth from the bubbling appearance of truth. . . . It would be very dangerous for the universities if large numbers of students frequented them, who were less developed in [these] respects. The general self-respect of the students must not be allowed to sink. If that were the case, the dangers of academic freedom would choke its blessings. It must, therefore, not be looked upon as pedantry, or arrogance, if the universities are scrupulous in the admission of students of a different style of education. It would be still more dangerous if, for any extraneous reasons, teachers were introduced into the faculty, who have not the complete qualifications of an independent academical teacher." ("Popular Lectures," vol. ii. 1881, p. 264-5.)

It would be out of place on this occasion to attempt to apply these views to existing circumstances in London; but with the knowledge that the final constitution of a Teaching University for the metropolis may be decided within the next few months, I cannot but feel that London will be happy if it escapes from the fetters which some of its so-called friends are forging for learning; and if, on the other hand, the wise determination of the Gresham Commissioners to include in the university only institutions of university rank, can be maintained against the attacks which will be made upon it.

Lastly, I wish to defend the memory of von Helmholtz from a possible misconception. Those who cultivate art may perhaps look upon him as the poet or the master of style look upon the grammarian, as a mere gerund-grinder, occupied with the study of the dead materials which they alone can use. Of course Helmholtz was not a great artist in the sense that he was a great scientific man, but it would be most unfair to picture him as interested only in the study of laws, and as insensitive to beauty, as occupied with sound and light, but careless as to music and painting. I could quote passage after passage from his works to prove his keen sense of the loveliness as well as of the order of nature, to show the homage that he paid, and the freedom he accorded to art. His object was not to lead art captive to science; but rather to unite them in an alliance of mutual confidence and support.

"The horizons of physics, philosophy, and art have," he said, "been too widely separated, and, as a consequence, the language, the methods, and the aims of any one of these studies presents a certain amount of difficulty for the student of any other of them." To smooth away these difficulties, to bridge over the separating gulf, to supply the common language, were the objects of the life-work of von Helmholtz. It was a noble ideal, nobly pursued, and crowned with as much success as could reward the efforts of one man. It is an ideal akin to that which dominates this Institution, where science, literature, and art are all heard in turns.

If it is possible to sum up in a sentence the teaching of von Helmholtz, and the work of his life, it is that, in spite of the apparent diversities between science and science, between science, philosophy, and art, there is a fundamental unity, and that the future is for those who detect, amid the seeming discords of the schools, the true harmony which underlies and dominates them all.

ELECTRIFICATION OF AIR AND OTHER GASES.[1]

§ 1. AT the meeting of the British Association in Oxford in August 1894, a communication was given to Section A, entitled "Preliminary Experiments to find if Subtraction of Water from Air Electrifies it." These experiments were performed during July of 1894, and were a continuation of experiments which were commenced in the Physical Laboratory of the University of Glasgow in December of 1868 with the same object, but which were then, for various reasons, discontinued before any decisive result had been obtained.

[1] A Paper by Lord Kelvin, P.R.S., Magnus Maclean, and Alexander Galt, read at the Royal Society on February 21.

§ 2. A glass U-tube with vertical branches (Fig. 1), each 18 inches long and about 1-inch bore, with the upper 8 inches of one of the branches carefully coated outside and inside with clean shellac varnish, was held fixed by an uninsulated support attached to the upper end of this branch. The other branch was filled with little fragments of pumice soaked in strong sulphuric acid or in water, and a fine platinum wire, with one end touching the pumice, connected it to the insulated electrode of a quadrant electrometer. A metal can, M, large enough to surround both branches of the U-tube without touching either, was placed so as to guard the tube from electric influences of surrounding bodies, the most disturbing of which is liable to be the woollen cloth sleeves of the experimenters or observers moving in the neighbourhood. This metal can was kept in metallic connection with the outside metal case of the

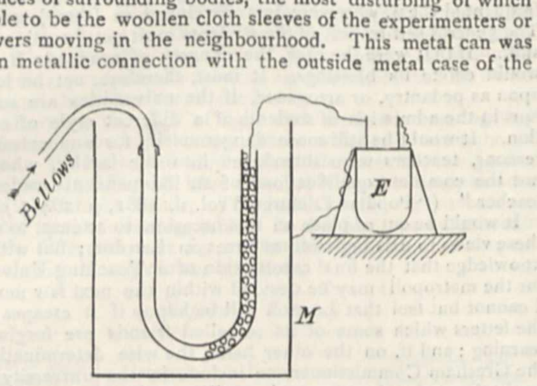


FIG. 1.

quadrant electrometer. The length of the exposed platinum wire between the U-tube and the electrometer was so short that it did not need a metal screen to guard it against irregular influences. An india-rubber tube from an ordinary blow-pipe bellows was connected to the uninsulated end of the U-tube. Air was blown through it steadily for nearly an hour. With the pumice soaked in strong sulphuric acid in the other branch, the electrometer reading rose in the course of three-quarters of an hour to about 9 volts positive. *When the pumice was moistened with water, instead of sulphuric acid, no such effect was observed.* The result of the first experiment proves decisively that the passage of the air through the U-tube gave positive electricity to the sulphuric acid, and therefore sent away the dried air with negative electricity. A corresponding experiment with fragments of pure chloride of calcium instead of pumice in sulphuric acid, gave a similar result. In repetition

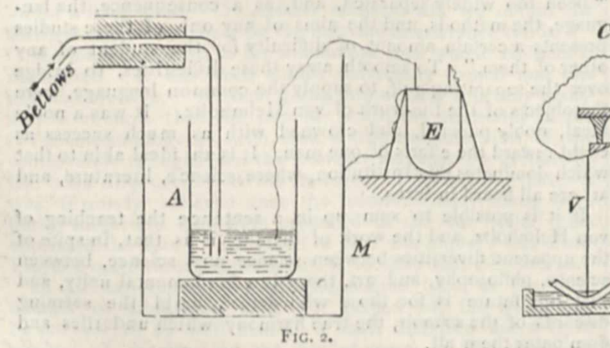


FIG. 2.

of the experiments, however, it was noticed that the strong positive electrification of the U-tube seemed to commence somewhat suddenly when a gurgling sound—due to the bubbling of air through free liquid, whether sulphuric acid or chloride of calcium solution in the bend of the U-tube—began to be heard. It has since been ascertained that it was because no liquid accumulated in the bottom of the U-tube that no electric effect was found when the pumice was moistened with pure water.

§ 3. Arrangements were made to prevent any bubbling of the air through liquid, by using a straight tube instead of a U-tube. In a large number of experiments with pumice, moistened with pure sulphuric acid in the straight tube, and air blown through for about half an hour, no definite electrification was obtained. In this straight tube, as formerly with the U-tube, pumice moistened with pure water gave no electrification. Chloride of calcium in lumps, not specially dried, gave no effect in the straight tube; but if previously heated to 180° or 200° and put into the straight tube when still hot, it gave an enormous positive electrification immediately on the commencement of blowing. Strong positive electrification was obtained a second time, by discharging the electrometer to zero, re-insulating, and recommencing the blowing. But after discharging a second time, re-insulating, and re-commencing the blowing, no further electrification was found.

§ 4. In continuation of these experiments on September 25, the arrangement represented in Fig. 2 was set up. The outer metallic guard-vessel, M, was kept connected by a wire to the case, and to one pair of quadrants of a quadrant electrometer, E. The water in the inner glass jar, A, was connected by a platinum wire to the other pair of quadrants of the electrometer.

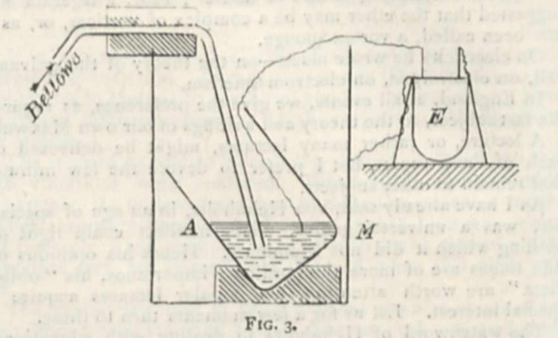


FIG. 3.

To have this inner jar well insulated, it was supported on a block of paraffin; and the other end of the glass tube dipping into the water was fitted into one end of a tube of paraffin, to the other end of which was fitted a tube for ingress of air, from bellows, as shown in the figure. The insulation of this arrangement was found to be good. When air was blown through the water it was found that the jar containing the water became positively electrified.

§ 5. To prevent splashing of water out of the jar, a paper cover was put on its mouth, or the jar was tilted, as shown in Fig. 3, so that the bubbles broke against the inside of the jar. In three experiments thus made, the same electrification was still found, amounting to about 6 volts positive in a quarter of an hour.

§ 6. As the jar was in every experiment positively electrified

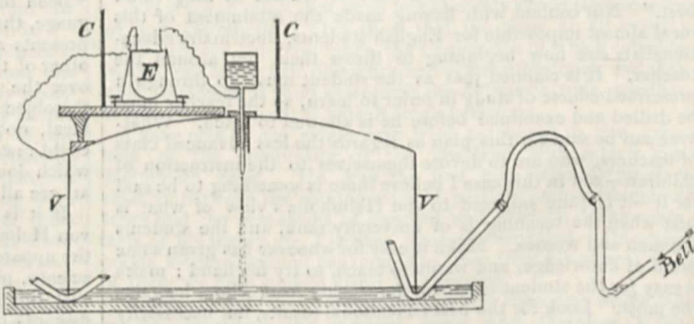


FIG. 4.

the air, if unelectrified[1] when entering it, must have been negatively electrified when leaving it.

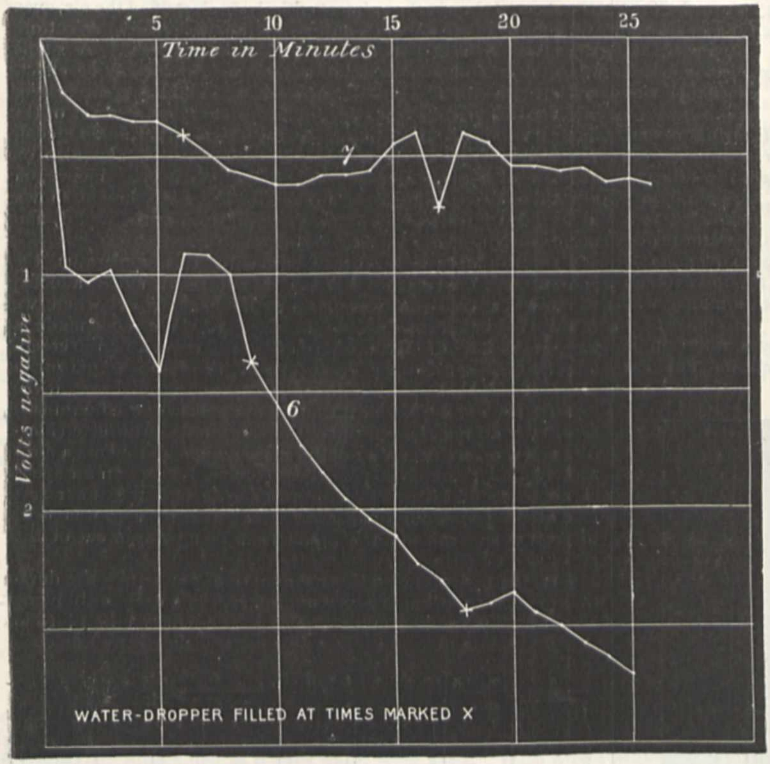
§ 7. To test if the air was negatively electrified after bubbling, on October 11 the apparatus[2] shown in Fig. 4 was set up. The apparatus consists of a large sheet iron vat, V V, 123 cm. in diameter and 70 cm. in height, inverted on a large wooden tray lined with lead, and supported by three blocks of wood. By filling the tray with water the air is confined in the vat.

C C is a metal screen kept metallically connected with the

[1] Air was similarly blown from bellows into the vat (see § 7) without any bubbling, and no electrification was observed.

[2] The vat, the water-dropper, and the electrometer are the same as in the apparatus described in the *Proceedings* of the Royal Society, vol. 56, year 1894, "Electrification of Air," by Lord Kelvin and Magnus Maclean.

case of the electrometer, and with the vat. It surrounds both the electrometer and the water-dropper, to prevent any external



CURVES 6 AND 7.

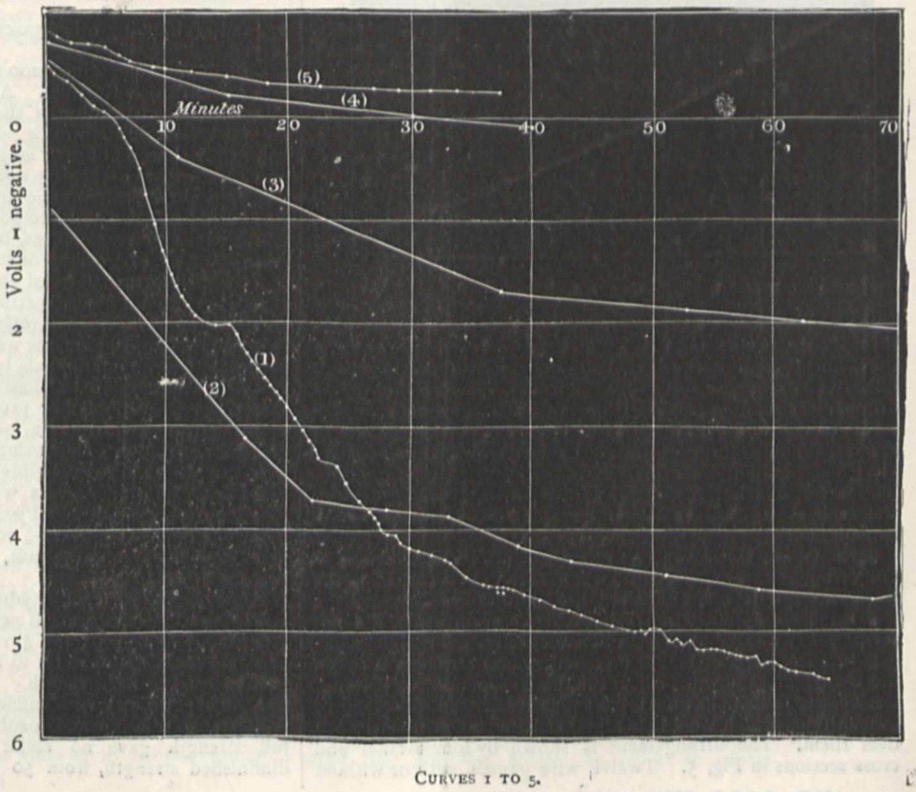
varying electrifications from vitiating the proper results of our experiments.

This screening of the electrometer is absolutely necessary when it is used with high sensibility (70 scale divisions per volt in our experiments) in a laboratory or other place where various other electric experiments may simultaneously be going on. Four years ago the electrometer, the vat, and the water-dropper, were set up on the class-room table *without a metal screen.* When the deflection indicated about 4 volts negative (see § 8), the negative lead of Lord Kelvin's house electric-light circuit, which passes through the class-room, was joined to earth. This changed the deflection of the electrometer suddenly by 1 volt in the positive direction. When the positive lead was "earthed," the deflection was changed suddenly by 6 volts in the negative direction. Putting on sixteen 8 c.p. electric lamps, eight on each side of the class-room, changed the deflection by two-thirds of a volt in the negative direction.

§ 8. In experimenting with the same apparatus[1] in 1890, it was found that the water jet gave negative electricity to the ordinary air of the laboratory enclosed in the vat. The present experiments fully confirm this result, showing a gradual negative electrification of the enclosed mass of air rising to about 5 volts in an hour, once every day for the first few days. For twenty-eight days after the vat was set up, in October 1894, fifteen observations of an hour each were taken to find the effect of the water-dropper, with no other disturbing influence on the unchanged volume of air inside the vat. These experiments verify the conclusion (*Phil. Mag.*, August 1890) that the more the air inside the vat became free of dust, the less became the rate at which the air was negatively electrified by the water-dropper.

§ 9. On October 15 last the vat was lifted from the tray to remove some obstruction in the nozzle of the water-dropper, which was not then flowing freely. Curve (6) was obtained that afternoon. The air in the vat was the ordinary air of the laboratory, and the curve shows the effect of the water-dropper alone in electrifying the air negatively. For the next two days the water-dropper was kept running continuously for about eight hours each day, to wash the dust out of the air, and on October 18 curve (7) was obtained. It shows a much less rate of negative electrification than curve (6). In the experiments of summer 1890 an aspirator was used to draw the air from the vat, and a tube full of cotton-wool was used to filter the air drawn into the vat.

Curves (1) to (5) are reproduced from the *Philosophical Magazine*, and they show that the more the air becomes free from dust the less is the rate at which the



CURVES 1 TO 5.

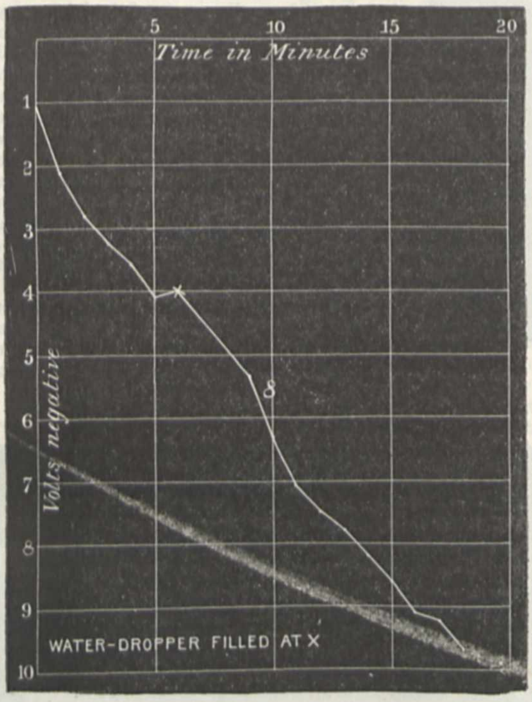
[1] *Phil. Mag.* August, 1890, "Electrification of Air by a Water Jet," by Maclean and Goto.

water-dropper electrifies. Thus curve (1) was obtained from the ordinary air of the laboratory in the vat, and curve (2) after the aspirator was working for some time. In this curve the water-dropper itself was running for some time before the first observation was taken. The other curves were obtained after further continuous working of the aspirator.

After curve (4) was obtained the aspirator was worked continuously for twenty-five hours, and then curve (5) was obtained.

§ 10. At the end of twenty-three days of October and November 1894 (§§ 8, 9, above), when the air inside the vat must have been fairly free from dust, and when the water-dropper of itself was giving little negative electrification, we bubbled air into it by a forked tube, one end of which was connected to a bellows, and three other open ends were below the water inside the vat. In five experiments thus made—two on November 7, two on November 8, and one on December 17, an average negative electrification of 5 volts in twelve minutes was obtained.

§ 11. We now arranged a U-tube with pure water in it (Fig. 4) outside the vat. Air from the bellows bubbled



Curve 8.

through the water in this U, and was carried thence by a block-tin pipe into the vat without any further bubbling. Observations by the quadrant electrometer, while the water-dropper was running and the bellows worked, gave us measurements of the varying state of the electrification of the air in the vat. The average of fifteen experiments gave a negative electrification of the air in the vat of $8\frac{1}{2}$ volts in 25 minutes. The rate at which the air was blown in in these experiments was such as to displace the entire volume of air in the vat in half an hour.

§ 12. Curve (8) shows the rate of electrification of air, in one of the fifteen experiments, when thus bubbled through the water in the U-tube and then admitted into the vat.

§ 13. Two U-tubes, in series, with water in each, did not seem to give a perceptibly cumulative effect.

§ 14. The effect of one or more wire gauze strainers between the U-tube and the vat, or between the U-tube and the bellows, was next tested. The gauzes were placed between short lengths of lead tube, which were held together by a rubber tube slipped over them. The arrangement is shown by longitudinal and cross sections in Fig. 5. Twelve wire gauzes, with or without cotton-wool between them, placed between the bellows and the U-tube, did not prevent the subsequent electrification by bubbling of the air thus filtered. But when placed between the U-tube and the vat they almost entirely dis-electrified the air, even without the cotton-wool, and still more decidedly when cotton-wool was loosely packed between the wire gauzes. A single wire-gauze strainer produced but little of dis-electrifying effect.

§ 15. The interpretation of these experiments is complicated, and the time required for each is lengthened, on account of the large mass of air in the vat to start with, whether uncharged or retaining electricity from previous experiments, and also on account of the effect of the water-dropper itself. Hence, in our later experiments, we fell back on the arrangement shown in Fig. 2, by which we test the electrification of the liquid, and not directly that of the gas blown through it.

§ 16. In our first experiment with this apparatus the amount of the electrification did not seem much affected when a paper cover was put on the beaker, or when we tilted the beaker as shown in Fig. 3. We now made a large number of tests with different covers and screens (chiefly of sheet copper or sheet zinc, or brass wire gauze) at different heights above the liquids, and we concluded that, if the screens are not within a centimetre and a half of the liquid surface, they do not directly affect the magnitude of the electrification obtained. In nearly all of the subsequent experiments a horizontal circular screen of thin sheet copper, leaving an air space of about 3 mm. all round between its edge and the inner surface of the jar, about 3 cm. above the liquid surface, was used to prevent spherules of the liquid from being tossed out of the jar by the bubbling.

§ 17. In the following short summary of our results the duration of each experiment was ten minutes. The effect of blowing air through water and other liquids is summarised in §§ 18 to 27, and of blowing other gases than air through water in §§ 28 to 31.

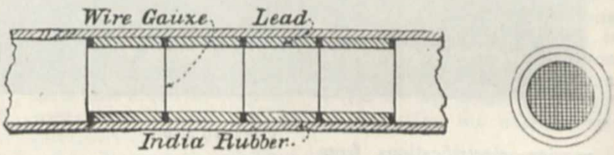


Fig. 5.

§ 18. The jar contained 200 c.c. of the Glasgow town-supply water (from Loch Katrine). A mean of seventeen experiments showed an electrification of the jar to four volts positive when air was blown through it for ten minutes.

§ 19. A solution of zinc sulphate of different strengths was now used instead of the pure water. Three experiments, with 150 c.c. of water containing one drop of a saturated solution of the zinc sulphate, gave half the positive electrification that would, under similar circumstances, have been obtained from water only. With five drops no definite electrification was obtained. With greater proportions of the zinc sulphate solution up to saturation (twenty-four experiments altogether) the electrification was on the average slightly negative.

§ 20. Twelve experiments were then made to test the effect of adding a solution of ammonia to the water. One drop reduced the electrification to one-half; two drops brought it down to one-quarter. With larger proportions of ammonia than this, up to a saturated solution, we found a very slight positive electrification, never amounting to more than a small fraction of a volt, and therefore negligible in the circumstances.

§ 21. Seven experiments with sulphuric acid of different strengths all showed small *positive* electrification, the amount gradually decreasing from $\frac{1}{4}$ volt, in ten minutes, with 0·5 per cent. acid in water to $\frac{1}{16}$ volt, in the same time, with acid of full strength.

Seven experiments with hydrochloric acid solution of different strengths all showed a small *negative* electrification, the amount gradually increasing from $\frac{1}{2}$ volt, in ten minutes, with $\frac{1}{3}$ per cent. acid solution in water to $1\frac{1}{4}$ volts, in the same time, with acid solution of full strength.

Nine experiments with calcium chloride solution were made. A saturated solution and a solution diluted to 75 per cent. of full strength gave no result; but solutions of gradually diminished strength, from 50 per cent. down to $\frac{1}{10}$ per cent., showed a negative electrification from fully ½ volt, in ten minutes, down to $\frac{1}{10}$ volt.

Additions of very small quantities of washing soda to water greatly reduce the positive electrification obtained.

Loch Katrine water, supersaturated with carbonic acid, and placed in the insulated jar, showed, when air was bubbled through it for ten minutes, a negative electrification of ¼ volt.

§ 22. Ten drops of paraffin oil added to water reduced the electrification to about half of that obtained from water only. Thirty drops reduced it to about a tenth, which, as it amounted to only 0·4 volt during the time of the experiment is negligible.

§ 23. Ten drops of benzene reduced the electrification to half, and thirty drops to about a third of that taken by pure water.

§ 24. A saturated solution of granulated phenol (carbolic acid) was made, and small portions of it added to the water in the jar. Several experiments showed no diminution in the electrification as long as the quantity of the phenol solution present in the water was under 10 per cent. With 25 per cent. the electrification was reduced to a third. With strengths greater than this up to saturation the electrification was reduced to one-sixth.

§ 25. A saturated solution of common salt was prepared. Blowing air through 200 c.c. of water containing the quantities of the salt solution mentioned, gave us in ten minutes the following electrifications:—

Per cent. of saturated solution of salt in water.	Volts positive.
(a) 0·004	2·4
(b) 0·02	1·2
(c) 0·1	0·6
(d) 0·5	0·4
(e) 2·0	0·15
(f) 4·0	0·0

§ 26. Several experiments showed that with 200 c.c. of water containing not more than ten drops of absolute alcohol, practically the same amount of positive electrification (4 volts in ten minutes) is obtained as if pure water were used. With fifty drops less than 2 volts were got, and with 100 drops less than 1 volt. 25 and 50 per cent. alcohol in the water gave very small and hence negligible positive electrification.

§ 27. One drop of saturated solution of copper sulphate in 200 c.c. of water showed one volt positive in ten minutes. With ½ per cent. of it in the water, the electrification was reduced to a fraction of a volt positive. With greater proportions of copper sulphate present, up to saturation, slightly negative electrifications were obtained, but never amounting to more than about one-tenth of a volt, and hence negligible.

§ 28. On blowing carbonic acid gas from a cylinder obtained from the Scotch and Irish Oxygen Company, through pure water in the glass jar, the water became electrified to 8¾ volts positive in ten minutes. Blowing the breath through water gave an electrification of 3 volts positive in the same time: this diminished result is doubtless due chiefly to the diminished rate of bubbling.

§ 29. The blowing of oxygen from a cylinder, obtained from the Oxygen Company, through water, gave as a mean of four experiments a positive electrification to the water of half a volt in ten minutes. When continued for fifty-five minutes, it gave the very decided result of 5 volts positive.

§ 30. Hydrogen prepared from zinc and dilute sulphuric acid was passed into a large metal gas-holder; and was passed on from this to bubble through the water in the insulated jar. In two experiments this was done immediately after the preparation of the hydrogen; in another it was done after the hydrogen had remained eighteen hours in the gas-holder. In each of the three experiments the water was electrified to 2 volts positive in ten minutes.

When the hydrogen was allowed to pass direct through a tube from the Wolffe's bottle where it was generated, to bubble in the insulated jar, the magnitude of the effect obtained was very much larger. In one case a mixture of muriatic acid and sulphuric acid and water was used, and the reading went off the scale positive in thirty seconds (more than 10 volts). In other two experiments with dilute sulphuric acid and zinc in the Wolffe's bottle, the electrifications obtained were 6 volts positive in seven minutes, and 7·3 volts positive in thirteen minutes, in the last of which the hydrogen was allowed to bubble through caustic potash contained in a small bottle between the Wolffe's bottle and the insulated jar.

The hydrogen was next generated in the insulated jar itself, the tube for ingress of air used in the ordinary experiments being taken away. 200 c.c. of pure water, along with some granulated zinc, was put into the jar. Then some pure sulphuric acid was added, and electrometer readings were taken. In two experiments with no screen in the jar (§ 16) the reading went off the scale *negative* (1) in two minutes and (2) in four minutes (more than 9 volts in each case). In another experiment in other respects the same, but with a copper screen 7 cm. above the surface of the liquid, the electrification showed 2 volts *negative* in two minutes, then came back to zero in five minutes, and in the next six minutes went 4 volts *positive*. The jar and pair of quadrants connected with it were then metallically connected with the outer case of the electrometer for a few seconds, and reinsulated; in five minutes the reading went up to 2 volts *positive*. A little more sulphuric acid was added to the jar, which was disinsulated for a short time and reinsulated; the reading went up to 7 volts *positive* in four minutes. The jar was again disinsulated for a few seconds and reinsulated; the reading went up in four and a half minutes to 6½ volts *positive*.

§ 31. Coal-gas, bubbled through water in the insulated jar, gave 1·4 volts positive in ten minutes.

§ 32. In the ordinary experiment of bubbling air through a small quantity of water in the bottom of the jar it was noticed that the electrification did not commence to be perceptible generally till about the end of the first minute; and that it went on augmenting perceptibly for a minute or more after the bubbling was stopped. The following experiment was therefore tried several times. One of us stood leaning over the jar, with the head about 10 inches above it, and the mouth so partly closed that breathing was effected sideways; another blew the bellows, and another took the readings of the electrometer. After bubbling had been going on for some minutes, and the readings were rising gradually (4 volts per ten minutes, as in § 18), blowing was stopped. As soon as the bubbling ceased, the first-mentioned observer, without moving his head or his body (see § 7, regarding the necessity to have the electrometer screened from outside influences), blew into the jar to displace the negatively electrified air in it. In every case the electrometer reading showed instantly a small rise in the positive direction.

In the carrying out of these experiments we have received much valuable help from Mr. Walter Stewart and Mr. Patrick Hamilton.

§ 33. The very interesting experiments described by Lenard, in his paper on the Electricity of Waterfalls (*Wiedemann's Annalen*, 1892, vol. 46, pp. 584-636), and by Prof. J. J. Thomson, on the Electricity of Drops (*Phil. Mag.* April 1894, vol. 37, pp. 341-358), show phenomena depending, no doubt, on the properties of matter, to which we must look for explanation of the electrical effects of bubbling described in our present communication, and of the electrification of air by drops of water falling through it, to which we have referred as having been found in previous experiments which were commenced in 1890 for the investigation of the passage of electrified air through tubes.[1]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Isaac Newton Studentship in Astronomy has been awarded to Mr. S. S. Hough, Scholar of St. John's College, Third Wrangler in 1892, and Smith's Prizeman in 1894.

Mr. C. T. Heycock, Lecturer in Chemistry at King's College, First Class in the Natural Sciences Tripos 1889 has been elected to a Fellowship.

The discussion by the Senate of the proposals for the encouragement of Advanced Study and Research, by the admission under special conditions of Graduates of other Universities, was on the whole favourable to the scheme. There seems little doubt that the preliminary resolutions on the subject will be passed early next term.

Mr. Arthur R. Hinks, of Trinity College, has been appointed Second Assistant at the Observatory for five years, from July 1, 1895.

1 "Electrification of Air by a Water Jet." By Magnus Maclean and Makita Goto, *Phil Mag.* August 1890, vol. 30, pp. 148-152.

SIR JOHN LUBBOCK has been elected President of the London Society for the Extension of University Teaching, in succession to Mr. Goschen, M.P., resigned.

MR. GILBERT R. REDGRAVE has been appointed Chief Senior Inspector of Schools and Classes under the Science and Art Department, and Mr. T. B. Shaw, Inspector of the North-Western District, has been promoted to a Senior Inspectorship.

SCIENTIFIC SERIALS.

WE have received two recently issued parts of the *Journal of the Asiatic Society of Bengal* (vol. lxiii. part ii. Nos. 1 and 3) containing, *inter alia*, an important paper by Mr. Lionel de Nicéville (the author of the admirable book on the butterflies of India, Ceylon, and Burma, now approaching completion), on new and little-known butterflies from the Indo-Malayan region, illustrated by five excellent coloured plates, representing species belonging to most of the principal families represented in the district. Among the species figured is a handsome new species of *Stichophthalma* (*S. sparta*) from Manipur, allied to the well-known Chinese *S. howqua*, of Westwood, belonging to a genus allied to the great blue Morphos of South America, and not inferior to some of them in size; a gynandomorphous specimen of the common, but very remarkable, Indian Fritillary, *Argynnis niphe*, L., the female of which mimics the abundant, highly-protected, and much-imitated *Danaus chrysippus*, L.; several species of *Laxita*, Butler, a beautiful genus allied to our Duke of Burgundy Fritillary, but much larger, and with rounded brown wings, generally suffused with crimson on the fore wings, and marked with metallic blue spots beneath; three species of *Papilio*, two of which mimic species of the widely-removed sub-family *Euplœinæ*; and many other interesting species. Several genera, as well as a large number of species, are described as new, and much fresh information is given relative to species already known. Several very useful lists and tables are also included in the paper, relative to the species of *Daphla*, allied to *D. teuta*, Doubleday and Hewitson, and those of the genera *Gerydus*, Boisduval, *Logania*, Distant, &c. When we look at the number of important books and papers that are now constantly issuing from the press on the butterflies of various parts of the British East Indies, it seems strange to remember that thirty years ago almost nothing had been published specially on the subject, except Horsfield and Moore's Catalogue of the Lepidoptera in the East India Company's Museum, and Westwood's "Cabinet of Oriental Entomology."

Memoirs (*Trudy*) *of the St. Petersburg Society of Naturalists*, vol. xxiv. part 1, Zoology and Physiology.—Notes on birds found in the Mediobor Mountains of Podolia, by I. D. Mikhalovsky. Seventy-two species are mentioned.—On the structures and reactions of the cells of the digestive tube of the pupæ of *Musca Cæsaris vomitoriæ*, by N. Kholin, with one plate.—The Natural History Museum of Great Britain, and other zoological institutions of West Europe, by A. Yaschenko.—Report on the cruise of the *Nayezdnik* in the Arctic Ocean in 1893, by N. Knipovitch. Leaving Reval, the cruiser visited the Murman coast, the Dvina and Onega bays of the White Sea, and the west coast of Novaya Zemlya, entering the Matochkin Strait and the Yugorskiy Shar. No less than eighty successful dredgings, down to depths of 190 fathoms, as well as measurements of temperature, were made. The author's remarks on the differences of colour and density of the blue Gulf Stream water, which is easily traced along the Murman coast, and the more so along the coast of Novaya Zemlya, are especially interesting. The colour and the density better delineate the south-east limits of the Gulf Stream current than the differences of temperature which are affected in both the Gulf Stream and the cold current by various local causes. In the bays of the White Sea, M. Knipovitch found in the bottom mud, which has temperatures of one or two degrees below zero, the *Yoldia arctica*, characteristic, as is known, of the Glacial period deposits and the Arctic Seas; while the same has never been found in the Arctic Ocean off the Murman coast, nor in the eastern parts of the Barents's Sea.—Report on the zoological institutions of West Europe, by Prof. K. Sainte Hilaire.—In the *Proceedings* we notice a very interesting report, by A. A. Birulia, on the part played by the phagocytes in the sexual processes with the *Galeodes*, and A. K. Trotsin's report on his zoological journey to the Transcaspian region and Russian Turkestan.

THE *Meteorologische Zeitschrift* for January contains a careful discussion of the rainfall of the Sandwich Islands, by Dr. J. Hann, based chiefly on observations supplied by the Director of the Weather Service at Honolulu. The amount of the rainfall is subject to great fluctuations. At Hilea, Kau (on the south side of Hawaii), 44·5 inches fell in 1886, and of this amount 51 per cent. fell in November. In 1889 the annual fall was only 13·9 inches, or about half as much as in November 1886. At Honolulu the average annual fall is 40 inches. The heaviest falls occur on the windward side of the largest of the islands, that is, on the north-east of Hawaii, and the smallest falls occur on the southern part of Oahu, and the south-west of Maui. The wettest period in almost all the islands is from November to March. The principal exception to this is on the leeward side of the mountains of Hawaii, where more rain falls in summer than in winter.

SOCIETIES AND ACADEMIES.

LONDON

Physical Society, March 8.—Mr. Walter Baily, Vice-President, in the chair.—Mr. Naber exhibited, and shortly described, a new form of gas voltameter. The chief advantages claimed for this instrument are that either the oxygen or the hydrogen can be collected separately, and that the level of the liquid inside and outside the burette can be made the same; thus no correction has to be applied to the volume of the gas on this account. Variations in the temperature and barometric pressure are allowed for by reading an air thermometer which is fixed alongside the burette. The inventor considers that this instrument will compare favourably in accuracy with the copper and silver voltameters now in general use. Prof. S. P. Thompson considered that now so much care had been bestowed on the design of a gas voltameter, this instrument might come into more general use than heretofore.—Dr. Johnstone Stoney, F.R.S., exhibited (1) the local heliostat, (2) an improvement in siderostats. By a local heliostat the author means one which can only be used in places the latitudes of which differ slightly from that of the place for which the instrument was specially constructed. The limits within which the instrument works with sufficient accuracy for ordinary spectroscopic work, are such that one instrument can be used in any place in the British Isles. The heliostat exhibited was a modification of one previously described by the author, which is now in very general use, and it is capable of sending a reflected ray in any direction in, or nearly in, a horizontal plane. In the new instrument the pendulum clock previously used to supply the motive power, is replaced by a balance-wheel clock; this change decreases the cost of the instrument, while it adds to its portability. A tangent screw, worked by a long rod, supplies a slow motion for adjusting the position of the reflected beam, and is of use when examining the spectra of the solar prominences, &c. The instrument is adjusted in the meridian by means of a gnomon and horizontal divided circle which form a sun-dial. This divided circle is so arranged that it is always horizontal when the polar axis is in adjustment, and can therefore be used whatever the latitude of the station at which the observations are being made. In connection with the use of a heliostat in conjunction with a spectroscope, the author recommends, when using a grating, the introduction of a large glass prism between the heliostat and the slit of the spectrometer. An impure spectrum is thus formed on the slit, and by moving the slit to the part of this spectrum corresponding to light of the wavelength under observation, the difficulties due to the overlapping of the spectra may in a great measure be overcome. After mentioning that the great difficulty in designing a siderostat which should work with "astronomical accuracy," is to get a form of sliding motion quite free from back-lash, and which will move perfectly regularly, Dr. Stoney exhibited a model of a form of mechanism for obtaining such a motion which he had devised. The principle on which the instrument depends is that, if you have a point fixed to a circle which rolls on the inside of another circle of double the diameter, this point will describe a straight line. The smaller disc does not, in the model exhibited, roll directly on the larger disc, but an idle wheel is introduced which rolls on the *outside* of both the discs. Slip is avoided by placing steel bands between the idle wheel and the discs, one end of each of the two bands being fixed to the circumference of the idle wheel, while the other ends are fixed, one to the circumference of each of the discs. Back-lash is prevented by means of a spiral spring attached to a point on the smaller disc; this point being so chosen that it moves nearly perpendicular to the direction in which the spring acts. Hence the spring is always stretched to nearly the same amount, and no extra strain is brought to bear on the driving-clock in different positions of the instrument. Prof. S. P. Thompson considered that the best method to employ when using sunlight was to incline the telescope, &c., parallel to the polar axis, under which circumstance the mirror of the heliostat need only rotate about a vertical axis.—A paper, on a simple form of harmonic analyser, was read by Mr. G. U. Yule. At a former meeting of the Society, Prof. Henrici showed a form of analyser in which the paper on which the curve is traced was given a to-and-fro movement, a planimeter being used as an integrator. The author being struck with the advantages of the use of a planimeter, both as regards cheapness and simplicity, has devised another form of analyser in which a planimeter is used. The principle on which this instrument works is as follows:—Suppose we have a straight line (X X) which can move parallel to the base line of the given curve, so that every point in this line describes a perpendicular to the base; further, suppose that a disc, the circumference of which is some aliquot part of the base of the curve, say $2l/n$ where $2l$ is the base length, is capable of rolling on the line (X X) without slip. If the centre of the disc is brought over the initial point of the curve, and any point (D) at a distance r from the centre on a horizontal diameter is marked, then if the centre of the disc is made to describe the curve which is to be analysed, the area of the curve described by the point D is given by the equation

$$R_1 = a + \cos n\pi \frac{rn\pi}{l} \int_{-l} y \sin n\theta \, dx,$$

where a is the area of the curve to be analysed. Similarly, if the point D is taken originally on a vertical diameter, the area of the curve traced out is

$$R_2 = a + \cos n\pi \frac{rn\pi}{l} \int_{-l}^{+l} y \cos n\theta \, dx.$$

In any practical case it is convenient to take r some multiple of $1/\pi$ units of length, say 10, then the above equations become

$$R_1 = a + \cos n\pi . 10n . B_n$$

and

$$R_2 = a + \cos n\pi . 10n . A_n$$

where B_n and A_n are the coefficients of $\sin n\theta$ and $\cos n\theta$ in the Fourier series expressing the equation to the curve. The areas of the curves traced out by the point D (R_1 and R_2) are obtained by allowing the tracing-point on an Amsler planimeter to rest in a small conical hole at D. The line X X is the edge of a rolling parallel ruler which has a rack cut along it. A series of toothed wheels give the coefficients of the different terms in the series. In the instrument exhibited there were wheels to give the first four terms, but the author said it was possible to work with wheels which gave the sixth term. The above analyser was the outcome of a simple step-by-step integrator which the author had devised. In this case the base line of the curve having been divided into a number of equal parts, then, by means of a scale of sines attached to the instrument, the tracing-point of a planimeter is set at a point whose abscissa is $\sin n\theta$, while it is moved parallel to the axis of y through a distance δy corresponding to one of the elements into which the base was divided. Prof. Henrici said he had at one time considered the question of constructing an analyser which should employ a planimeter as the integrator, and he was particularly pleased with the instruments exhibited. Since the area required was the difference between the area of the original curve, which is traced out by the centre of the disc (K), and the curve traced out by the point D, and since this area is really the area swept out by the straight line K D, if we attach an integrating wheel to the disc, with its axle parallel to K D, the required area can be directly obtained from the reading on this wheel. In addition, if a second integrating wheel were fixed to the disc, with its axle perpendicular to K D, the coefficients of $\cos n\theta$ and $\sin n\theta$ could both be obtained by going round the curve once. The instrument devised by Mr. Yule was practically the inverse of one he (Prof. Henrici) had invented. Dr. Burton pointed out some incorrect signs in the proof given; these, however, do not affect the final expressions obtained. Mr. Inwards suggested that errors due to back-lash might be avoided by using either a double wheel or a double rack, so that by means of a spring each side of the teeth which were engaged might be in contact at the same time.—Prof. Minchin gave a short account of a paper by Mr. H. N. Allen, entitled "The Energy Movements in the Medium Separating Electrified or Gravitating Particles." The object of the paper is to trace out the equipotential surfaces and lines of flow for two electrified points or gravitating particles, and then to consider the paths along which the "energy cells" move when the charged points or gravitating particles either move towards or away from one another. By energy cell the author understands the small volume of the dielectric bounded by the walls of a tube of force, and by two neighbouring equipotential surfaces, which can be looked upon as containing a certain definite amount of energy. The author gives two figures showing the paths of the energy cells: (1) when the charged particles come together and meet; (2) when they separate and move off to infinity in opposite directions. Using Maxwell's expression for the pressure along the lines of force, and the equal tension at right angles required by his theory to account for the attraction exerted by the sun on the earth, the author has calculated the energy density in the medium at the surface of the sun. The value obtained is 16-horse power-hours per c.c. Hence he concludes that, at a distance from all gravitating bodies, a c.c. of ether contains at least this amount of energy. Prof. Minchin showed how, by the use of polar coordinates the expressions given by the author could be simplified. He also gave a graphical method of obtaining the equipotential surfaces for any configuration having given those for any other configuration. He pointed out that by a similar line of reasoning to that used by the author, the energy per c.c. of the medium at the surface of Arcturus must be 8100 times as great as at the surface of the sun, so that the minor limit given above by the author must be multiplied by 8100 at least.

Entomological Society, March 6.—Prof. Raphael Meldola, F.R.S., President, in the chair.—Mr. B. G. Nevinson exhibited a long series of *Heliothis peltigera*. He stated that the specimens were bred from larvæ found on the Dorsetshire coast during July 1894, feeding on the flowers of *Ononis arvensis*, which were extremely luxuriant. A few also were taken on *Hyoscyamus niger*. He added, that all the larvæ went down by the end of July. The first emergence took place on August 20, and they continued coming out at the rate of about five a day, through the rest of that month and September; only five emerged in October, and the last one appeared on November 11. Mr. G. T. Bethune-Baker, Mr. Eustace Bankes, Mr. B. A. Bower, the Rev. Seymour St. John, and Mr. H. Goss made remarks on the habits and distribution of the species in England.—Mr. Bower exhibited a variable series of *Scoparia basistrigalis*, Knaggs, showing light, intermediate and dark forms, taken at Bexley, Kent, from June 12 to July 7, 1891-94. He said the species appeared to be poorly represented in collections, and when present was almost invariably misnamed. Mr. Bankes commented on the rarity of the species, and said the specimens exhibited formed the most interesting collection of it and its varieties which he had ever seen.—Lord Walsingham, F.R.S., exhibited larvæ of *Pronuba yuccasella*, which he received more than four years ago from Colorado, and which were still living. One specimen of the moth had emerged two years ago.—Mr. Goss exhibited, for Mr. G. C. Bignell, a pupa of a Tortrix, with the larval legs, and also a specimen of a Sawfly, *Emphytus cinctus*, L., with eight legs. Mr. G. H. Verrall and Mr. McLachlan made some remarks on the latter species, and as to the insertion of the fourth pair of legs.—Prof. Meldola exhibited a wooden bowl from West Africa, from which, after arrival in this country, a number of beetles (*Dermestes vulpinus*) had emerged. Specimens of the latter were also exhibited. It was not clear to the exhibitor whether the larvæ had fed upon the wood, or had simply excavated the cavities which were apparent in the interior of the bowl for the purpose of pupating. Mr. McLachlan, Mr. J. J. Walker, Herr Jacoby, and Lord Walsingham made some remarks on the habits of Dermestes.—Mr. Champion read a paper entitled "On the Heteromerous Coleoptera collected in Australia and Tasmania by Mr. J. J. Walker, R.N., during the voyage of H.M.S. *Penguin*, with descriptions of new genera and species.

Part ii." Mr. Walker and Mr. Gahan made some observations on the distribution of certain of the species described.—Mr. Roland Trimen, F.R.S., contributed a paper entitled "On some new species of butterflies from tropical and extra-tropical South Africa."—Mr. G. A. James Rothney contributed a paper entitled "Notes on Indian Ants," and sent for exhibition a number of specimens in illustration of the paper, together with nests of certain species.

Geological Society, February 20.—Dr. Henry Woodward, F.R.S., President, in the chair.—The President announced to the Fellows the grievous loss which the Society had suffered in the decease of its Foreign Secretary, Mr. J. W. Hulke, F.R.S., President of the Royal College of Surgeons. He dwelt on the great value of Mr. Hulke's work in vertebrate palæontology, on his long services as a member of Council and an officer of the Society, and on his amiable personal qualities, which had endeared him to a wide circle of friends. He read the following resolution which the Council had that afternoon unanimously voted, and communicated to Mrs. Hulke with the expression of their heartfelt sympathy: "That this Council most deeply deplore the sad loss that the Society and all those interested in palæontology have sustained by the untimely decease of our Foreign Secretary, Mr. J. W. Hulke, F.R.S., whose investigations in various branches of science have led to such valuable results."—Contributions to the palæontology and physical geology of the West Indies, by Dr. J. W. Gregory. The earlier part of the paper was largely concerned with the corals of the raised reefs of Barbados, and, on account of the confusion in the synonymy of the West Indian corals, the synonymy of the species was given in some detail. A list of the mollusca of the low-level reefs followed. In discussing the age of the Barbados rocks, the author stated that the following was the sequence (in descending order):—

Raised coral reefs	Low level: Pleistocene. High level: Pliocene.	
Oceanic series ...	*Archæopneustes-abruptus*-limestone. Thalassic marls.	Miocene (and possibly partly Pliocene) and partly Oligocene.
Scotland beds ...	Oligocene (probably Lower).	

—The Whitehaven sandstone series, by J. D. Kendall. The Whitehaven sandstone, with its associated shales, is a purple-grey deposit sometimes having a thickness of 500 or 600 feet. The author gave details of a large number of sections of the series, which also contains thin coal-seams and occasionally *Spirorbis*-limestone.—Notes on the genus *Murchisonia* and its allies, with a revision of the British carboniferous species, and descriptions of some new forms, by Miss J. Donald.

Zoological Society, March 5.—Sir W. H. Flower, K.C.B., 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 February, and called special attention to a fine female giraffe recently arrived from South Africa. This was believed to be the first example of the large, dark-blotched race ever seen alive in Europe, the giraffes previously exhibited having belonged to the smaller and paler form found in Northern Tropical Africa. The Society has also purchased a pair of Sable Antelopes (*Hippotragus niger*) and a pair of Brindled Gnus (*Connochætes taurina*), all in excellent condition.—Dr. St. George Mivart, F.R.S., read a paper on some distinctive structural characters in the hyoid bone in certain parrots.—Mr. A. D. Michael read a paper on a new Freshwater Mite found in Cornwall, and belonging to the genus *Thyas*, of which only two species were previously known. It is proposed to call it *Thyas petrophilus*.—Mr. G. A. Boulenger, F.R.S., read a paper "on the nursing-habits of two South-American Frogs," and exhibited a specimen of *Hyla goeldii* with eggs on the back. He also made remarks on a male specimen of *Phyllobates trinitatis* from Venezuela, carrying its tadpoles on its back, in the same way as had previously been observed in frogs of the genus *Dendrobates* from Surinam and Brazil.

Royal Meteorological Society, February 20.—Mr. R. Inwards, President, in the chair.—Mr. W. Marriott gave an account of the thunderstorm and squall which burst over London so suddenly on the morning of January 23. It appears that this storm passed across England in a south-south-easterly direction at the rate of about forty-seven miles an hour, being over Northumberland at 4 a.m., and reaching the English Channel by 11 a.m. Thunder was first heard in the vicinity of Leeds, and accompanied the storm in its progress across the country. One of the most remarkable features of the storm was the sudden increase in the force of the wind, for in London it rose almost at one bound from nearly a calm to a velocity of thirty-six miles an hour. This sudden increase of wind caused considerable damage, and at Bramley, near Guildford, twenty-eight trees were blown down along a track 1860 yards in length.—Mr. E. Mawley presented his report on the phenological observations for 1894. Between the third week in March and the third week in May plants generally came into blossom in advance of their usual time, and towards the end of April the dates of first flowering differed but little from those recorded at the same period in the very forward spring of 1893. The cuckoo made its appearance even earlier than in the previous year. The year 1894 was a very productive one, and both the hay and corn crops proved unusually heavy, but much of the latter was harvested under very trying conditions as regards weather. The frosts of May 21 and 22 entirely destroyed the previous prospect of a glorious fruit season. Indeed, the only really good crop was that of pears, which were singularly abundant throughout nearly the whole of England.—Mr. A. B. MacDowall read a paper on some gradual weather changes in certain months at Greenwich and Geneva.

DUBLIN.

Royal Dublin Society, November 21, 1894.—Prof. W. J. Sollas, F.R.S., in the chair.—The following papers were read: On the occurrence of seiches in Lake Derravaragh, co. Westmeath, by Staff-Commander J. R. H. MacFarlane, R.N. This paper (communicated by Prof. D. J. Cunningham, F.R.S.) is interesting as being the first record of observations, from the United Kingdom, of these phenomenal changes of the level of the water in lakes. These singular rhythmic movements, somewhat resembling tidal ebb and flow, were found occurring in the Swiss lakes towards the close of the last, and beginning of the present, century, and many skilful observers devoted considerable time in the endeavour to elucidate the cause or causes; but, as yet, no distinct explanation has been given, although it would appear to have been generally noticed that they are accompanied by a low barometer. It also appears that the characteristics of the land, surrounding the observation spot, influence the time occupied by a complete rise and fall of the water, which has been termed the *duration of the seiche*; and, further, that it is probable such durations are constant for each observation spot, but the *amplitude*, or amount of rise above, and fall below the level, will depend on the amount of influence exercised in causing the seiche; this influence being at present unknown. The observations made at Lake Derravaragh were necessarily confined to one spot, no other observers being available for synchronous observations at different stations. The maximum amplitude recorded was 5·8 inches, and the duration of seiche, fairly constant, about 39 minutes.—A paper was communicated by Sir Charles Cameron, on the effect of poisons and antiseptics on germination, by Mr. F. H. Perry Coste.—The Rev. R. Bodkin described an "automatic image-finder," the object of which is (1) to show where the image of any object placed before any lens must be formed; (2) to prove that the image is found there; (3) to help to explain the construction of the various optical instruments in use such as the microscope, telescope, camera, and projection lamp.

December 19.—Sir Howard Grubb, F.R.S., Vice-President, in the chair.—The following papers were read: Mr. John R. Wigham described and demonstrated a method of increasing the power of continuous lighthouse lights.—Prof. W. J. Sollas, F.R.S., gave a description of a new fossil, resembling annelid tubes, from the Cambrian of Puck's Rocks, Howth, near Dublin. Upon this fossil the author has bestowed the name *Pucksia MacHenryi*.

PARIS.

Academy of Sciences, March 11.—M. Marey in the chair.—On argon, by M. Berthelot. The author announces the combination of the new element with benzene vapour under the influence of the electric discharge, and promises details to follow.—Remarks on the curves defined by a differential equation of the first order, by M. Émile Picard.—On the total eclipse of the moon of March 11, by M. J. Janssen. The importance of observations of lunar eclipses by photographic photometry in connection with the constitution of the higher regions of our atmosphere is emphasised.—On the losses of nitrogen carried off by infiltrated water, by M. Schlœsing. The loss of nitrogen by soils in the basin of the Seine through the elimination of nitric acid in drainage waters is discussed. In conclusion the author believes such losses not to be very important; they are roughly proportional to the richness of the soil in organic matter, and do not much impoverish already poor soils.—Analysis of oyster-shells, by MM. A. Chatin and A. Muntz.—Demonstration of a theorem of whole numbers, by M. de Jonquières. If $a_1, a_2, a_3, \ldots, a_n$ are n different whole numbers, the product $\Pi(a)$ of all these numbers, multiplied by the product $\Pi(a_i - a_j)$ of their differences by twos, is a multiple λ of the product of n first numbers $1, 2, 3, \ldots, n$, multiplied by the product of their differences by twos, that is to say, is equal to $\lambda(1^n . 2^{n-1} . 3^{n-2} \ldots \overline{n-2}^3 . \overline{n-1}^2 . n)$.—Observations of Wolf's planet BP (23 February, 1895) made with the great equatorial of Bordeaux Observatory, by MM. G. Rayet and L. Picart, noted by M. G. Rayet.—Volumes of salts in their aqueous solutions, by M. Lecoq de Boisbaudran.—On M. Darboux' method for the integration of equations to the derived partials of the second order, by M. E. Goursat.—On certain algebraical groups, by M. E. Cartan.—On "fonctions entières," by M. H. Desaint. The "fonctions entières" of the type 0, 1 or 2, of which the exponential multiplier of the infinite product of primary factors of M. Weierstrass is of the form $Ae^{\alpha x^2+\beta x+\gamma}$, where A is a constant, α and β real and α positive, possess the property that, if their zeros are real, the zeros of their derivatives are also zeal.—On the direct measurement of the mean spherical luminous intensity of sources of light, by M. A. Blondel. A description of the instrument termed a *lumen-mètre* and its use.—On the analysis of silicon, by M. Vigouroux.—Action of formaldehyde on ammoniacal salts, by MM. A. Brochet and R. Cambier. The first action of ammonium chloride on formaldehyde may be admitted to be the production of $(CH_2 : NH.HCl)_3$. This reacts on heating as follows: $2(CH_2 : NH\ HCl)_3 + 3CH_2O + 3H_2O = 6(CH_3.NH_2.HCl) + 3CO_2$, giving a theoretical yield.—On acid chlorides and aldehyde chlorides, by M. Paul Rivals. The thermal data are given for monochloracetic chloride and trichloracetic chloride, and are shown to vary in the same way as with the corresponding acids.—Optical resolution of α-oxybutyric acid, by MM. Ph. A. Guye and Ch. Jordan. The synthetical α oxybutyric acid is a racemic form. The authors have successfully separated the lævorotatory form from the dextrotatory form by means of their brucine salts.—On daturic acid, by M. E. Gérard. The acid is shown to have a real existence, and forms definite metallic salts. It does not consist of a mixture of stearic and palmitic acids.—Glycogen in the blood in normal and in diabetic animals, by M. M. Kaufmann. Glycogenic matter is a constituent of normal blood. The blood of animals rendered diabetic by extirpation of the pancreas contains much more glycogen than that of healthy animals.—On the signification of the disengagement of carbonic acid by the isolated muscles of the body, compared to that of the absorption of oxygen, by M. J. Tissot. The total quantity of carbonic acid disengaged by a muscle placed in the air has no relation with the phenomena of physiological activity, of which the isolated muscle is yet the seat. The absorption of oxygen is alone related to the manifestation of physiological activity, the absorption being at the maximum when the muscular activity is greatest, and at the minimum when it is diminished or on the point of disappearing.—On the structure and affinities of *Microsporon*, by M. Paul Vuillemin. The author includes *Microsporon vulgare* among the Phycomycetes, and not among the Saccharomycetes. It is not a necessary parasite, is found on healthy skin, but is adapted for parasitism, and is most abundantly found in the epidermis of new-forming spots of simple pityriasis.—On the embryonic development of the Dromiacean genus *Dicranodromia*, by M. Eug. Caustier.—On a new combination of forms on quartz crystals, by M. Fred. Wallerant.—On an approximate estimate of the frequency of earthquakes on the surface of the globe, by M. F. de Montessus de Ballore.

BERLIN.

Physiological Society, February 1.—Prof. du Bois Reymond, President, in the chair.—After a discussion on Dr. Cohnstein's communication on "intravenous infusion of sodium chloride," Prof. G. Fritsch discussed the simple principles on which he had for many years obtained stereoscopic photographs on an enlarged scale. He exhibited a series of these photographs, among which those of the inner ear excited particular interest.

February 15.—Prof. du Bois Reymond, President, in the chair.—Prof. Zuntz gave an account of experiments, made in conjunction with Staff-Surgeon Dr. Schumburg, on the effect of load on the metabolism and body-functions of soldiers on the march. Two students, feeding uniformly on a somewhat complicated but accurately analysed diet, made on alternate days marches up to 45 kilometres with a load increasing to 31 kilograms. Taking first the nitrogenous metabolism, it was found that the excretion of nitrogen through the urine and sweat was but slightly increased by even the most severe exertion. The slight loss of proteid thus noticed was made good in the subsequent period of rest. At the end of each experiment the consumption of oxygen was found to be greater than at the beginning. When the marches were made on three consecutive days with an increasing load, it was found that the consumption of oxygen was increased even at the beginning of the third day's march, and was still further increased at its end. The body-temperature rose to 38°·5 C., and in some cases to 40° C. The heat production was three times as great as during rest, and the regulation of temperature to compensate for this was almost entirely brought about by the evaporation of sweat. The concentration of the blood was found to be but very slightly increased by exhausting marches; the red blood-corpuscles were scarcely more numerous than normally, whereas the white were markedly increased in number. The movements of the heart at the end of the experiments showed a lengthening of the systole and distension of the right ventricle, whose dull area on percussion, as also that of the liver, was extended during severe exertion. The respiratory activity was at first, and with light loads, improved, but later on difficulties of breathing made their appearance. The psychic condition, as measured by the reaction-time to simple stimuli, was not depressed by heavy marches; but when fatigued the patients reacted more slowly to complicated stimuli. Muscles not used in marching, were as readily excitable at the end of the most severe march as during complete rest. A high external temperature was found to exert the same influence with a light load, as the heaviest load did at more moderate temperatures, and some details of the experiments were found to depend on individual peculiarities.

Meteorological Society, February 5.—Prof. Hellmann, President, in the chair.—Prof. von Bezold spoke on the unstable equilibrium of the atmosphere which precedes a thunderstorm. The fact that in the interior most thunderstorms occur in the afternoon and during the summer, whereas near the coast they are most frequent at night and in the winter, shows that there must be different causes for the instability. As a matter of fact the speaker showed that not only over-heating of the lower layers of air, but also excessive cooling of the upper layers, must lead to unstable equilibrium and a correspondingly powerful upward current of air. A similarly unstable state is brought about by the sudden solidification of strongly cooled water-drops, or the condensation of air highly supersaturated with moisture. The conditions for the realising of the above states are different in the interior and at the coast or over the sea, and the mode of formation of a thunderstorm is also correspondingly different. He considered it very desirable that further observations of thunderstorms at sea should be collected.—Mr. Archenhold exhibited water-colour drawings, made by Captain Henning in 1884, of the unusual twilights then occurring, he being at the time ignorant of the abnormality as observed by others. One of the most remarkable features in the drawings were the sharp and straight lines of demarcation in the colours of the sky. The speaker further exhibited a photograph of a halo he had observed by moonlight.

Physical Society, February 8.—Prof. Schwalbe, President, in the chair.—Dr. Neuhaus exhibited a series of colour photographs taken by Lippmann's method with prolonged exposure. Spectra show, if the exposure is sufficiently long, a greenish band in the infra-red as well as in the ultra violet, in addition to the ordinary colours. The coloured band was very markedly displaced by both over- and under-exposure. The photographs of objects with mixed colours, such as fruits, flowers, butterflies, &c., were also good; but their production was extremely difficult, and only one plate in twenty-five was, on an average, successful. It was found more easy to photograph naturally mixed than artificially mixed colours. When describing his methods, it was pointed out that some substance such as eosin or cyanin must be added to the films to make them more sensitive to red rays, and less sensitive to blue. When dealing with the theory of colour photography, which was expounded by Dr. Zenker as early as 1868, the speaker referred to a number of difficulties which had not yet been solved. Thus, in the first place, nobody has as yet demonstrated the existence of the superimposed silver films in the gelatine, although they should be visible under the microscopic powers now available. In the next place, the presence in the gelatine film of granules whose diameter is equal to several half-wave-lengths is not reconcilable with the usual theory of colour photography; so that, on the whole, a comprehensive theory of the phenomena has still to be established.—Mr. Archenhold gave some additional details as to the mechanical parts of the great telescope he had described in the previous meeting of the Society.

February 22.—Prof. von Bezold, President, in the chair.—Prof. Lummer spoke on the necessary corrections of dioptric systems, and developed theoretically the possibility of the law of points holding good for certain relations between focal length and aperture. Prof. Raoul Pictet spoke on the "cri ical point," and explained his own views, according to which substances must still be in the fluid state at the critical point. This follow from the fact that the amount of heat which must be put into the substance, as reckoned from absolute zero, is less than the latent heat of the liquid, and the fact that solid bodies do not separate out from solution at the critical temperature. They must be still in solution in the fluid, since they separate out in the crystalline form by a further rise of temperature, and go into solution again as the temperature falls to the critical point. This last fact was demonstrated by the speaker on a solution of iodide of potassium.

AMSTERDAM.

Royal Academy of Sciences, January 26.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Franchimont communicated a paper on a new class of urea-derivatives, viz. the urea-alcohols or ureols, one of which, ureo æthanol, has been prepared by the author and Mr. Van Breukeleveen. This body, obtained from amino aethanol through Wöhler's synthesis of urea, forms colourless crystals, which fuse at 95°, and dissolve readily in water, methyl-alcohol and ethyl-alcohol, but very sparingly or not at all in most organic solvents. It appears to possess properties both of urea and of an alcohol. With nitric acid it forms a compound, which is decomposed by so-called real nitric acid at the ordinary temperature, with the formation of carbonic acid and nitrous oxide. With benzoyl chloride it yields a benzoate, which fuses at 129°, and is decomposed by nitric acid in the manner described above. With acetic anhydride and sodium acetate, a diacetyl derivative is obtained, which fuses at 102°.—Mr. Hoogewerff directed attention to an apparatus, devised last summer by Mr. J. Boot. The object of the apparatus is to easily and quickly graduate retorts, pipettes, and burettes, especially such as are intended for technochemical researches. The firm of Kobb at Stützerbach in Thüringen has been commissioned to make the apparatus. Mr. Van der Waals showed that the condition for the equilibrium between coexistent phases, viz. the equality of the thermodynamic potential, may be deduced from the kinetic theory by assuming that the two phases interchange an equal number of particles, and may be regarded as a particular instance of the more general law by which the kinetic theory expresses the density in different parts of a space, wherein the moving molecules are subjected to the action of forces.—Prof. Kamerlingh Onnes communicated the results of investigations in the Leiden laboratory by: (1) Dr. L. H. Siertsema on the magnetic rotational dispersion of oxygen and nitrogen at a pressure of 100 atm., giving the following relation between the rotation w and the wave-length λ: oxygen $w = C. \frac{868 \cdot 03}{\lambda}\left(1 + \frac{0 \cdot 07202}{\lambda^2}\right)$, nitrogen $w = C. \frac{560 \cdot 41}{\lambda}\left(1 + \frac{0 \cdot 32424}{\lambda^2}\right)$ and proving again the superiority of Maskart's formula (see p. 470). (2) Dr. P. Zeeman on the Kerr effect in polar reflection on iron and cobalt at normal incidence, tending to the conclusion that none of the proposed theories completely explains Sissingh's phase-difference. (3) Dr. P. Zeeman on the optic constants of magnetite, determined with regard to the relation between Sissingh's phase in the Kerr phenomenon and the maximum of magnetisation. (4) Mr. A. Lebret on the variation of the Hall effect in bismuth with temperature, it being found to be nearly linear between −38° and 239°.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—The Pygmies: A. de Quatrefages, translated by F. Starr (Macmillan).—The German Universities, their Character and Historical Development: Prof. F. Paulsen, translated by Prof. E. D. Perry (Macmillan).—A Treatise on Bessel Functions and their Applications to Physics: Profs. Gray and Mathews (Macmillan).—Meteorology, Weather, and Methods of Forecasting, &c.: T. Russell (Macmillan).—Diary of a Journey through Mongolia and Tibet in 1891 and 1892: W. W. Rockhill (Washington).—Bourne's Handy Assurance Directory, 1895 (Schooling).—An Elementary Text-Book of Hydrostatics; W. Briggs and G. H. Bryan (Clive).—The Telegraphist's Guide to the New Examinations in Technical Telegraphy: J. Bell (*Electricity* Office).—The Source and Mode of Solar Energy throughout the Universe: Dr. W. Heysinger (Lippincott).—Handbook of Jamaica, 1895 (Stanford).—Im Reiche des Lichtes: H. Gruson (Braunschweig, Westermann).—Honest Money: A. T. Fonda (Macmillan).—Collected Papers on some Controverted Questions of Geology: Dr. J. Prestwich (Macmillan).

PAMPHLETS.—N.S.W. Government Railways and Tramways—Annual Report of the Railway Commissioners for the Year ending June 30, 1894; ditto Supplement to the Railway Commissioners' Annual Report.—Die Reisen des *Jason* und der *Hertha* in das Antarktische Meer 1893–94: Dr. J. Petersen (Hamburg, Friederichsen).

SERIALS.—Science Progress, March (Scientific Press, Ltd.).—Medical Magazine, March (Strand).—Proceedings of the Physical Society of London, Vol. xiii. Part 4 (Taylor and Francis).—Engineering Magazine, March (Tucker).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 4th series, Vol. 9, No. 2 (Manchester).—Essex Institute, Historical Collections, Vol. 30 (Salem, Mass.).—Journal of the Franklin Institute, March (Philadelphia).—Internationales Archiv für Ethnographie, Band vii. Heft 4 (Leiden, Brill).—Himmel und Erde, March (Berlin).—Rendiconto delle Sessioni della R. Accademia delle Scienze dell' Istituto di Bologna, 1892-93, 1893-94 (Bologna).

CONTENTS.

PAGE
Modern Bacteriology. By Mrs. Percy Frankland . 481
Chemical Analysis. By J. W. Rodger 482
Analytical Geometry. By R. L. 483
Our Book Shelf:—
Angot: "Les Aurores Polaires" 484
Kennedy: "A Few Chapters in Astronomy" . . . 484
Glazebrook: "Mechanics for Colleges and Schools: Statics" 484
Bell: "The Telegraphist's Guide" 484
Letters to the Editor:—
Corrections of Maximum and Ex-Meridian Altitudes. (*With Diagram.*)—**J. White** 485
Argon and the Periodic System. (*With Diagram.*)—**Prof. J. Emerson Reynolds, F.R.S.** 486
Variation in *Caltha palustris.*—**Prof. T. D. A. Cockerell** 487
Dr. M. Foster on the Teaching of Physiology in Schools 487
Notes 488
Our Astronomical Column:—
Partial Eclipse of the Sun, March 26 493
Distribution of Minor Planets 493
The Royal Observatory, Edinburgh 493
The Physical Work of Hermann von Helmholtz. II. By Prof. A. W. Rücker, F.R.S. 493
Electrification of Air and other Gases. (*Illustrated.*) **By Lord Kelvin, P.R.S., Magnus Maclean, and Alexander Galt** 495
University and Educational Intelligence 499
Scientific Serials 500
Societies and Academies 500
Books, Pamphlets, and Serials Received 504