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THEORETICAL MECHANICS.

Theoretical Mechanics: an introductory treatise on the Principles of Dynamics, with applications and numerous examples. By A. E. H. Love, M.A., F.R.S., Fellow and lecturer of St. John's College, Cambridge. Pp. xiv + 379. (Cambridge: at the University Press, 1897.)

THIS book is vibrating with dynamical modernity, and proves in effect that Theoretical Dynamics has not yet been reduced to the level of one of the Exact Sciences; and so it shows little tendency to bridging over the gap still existing between the two modes of treatment of the one science of Mechanics. The two different methods are described by Newton in the preface of the "Principia"—

"Auctoris præfatio ad lectorem. Cum Veteres Mechanicam (uti Auctor est Pappus) in rerum Naturalium investigatione maximi fecurunt; et Recentiores, missis formis substantialibus et qualitatibus occultis, Phænomena Naturæ ad leges Mathematicas revocare aggressi sint: Visum est in hoc Tractatu Mathesin excolere, quatenus ea ad Philosophiam spectat.

"Mechanicam vero duplicem Veteres constituerunt: Rationalem quæ per Demonstrationes accurate procedit, et Practicam. Ad Practicam spectant Artes omnes Manuales, a quibus utique Mechanica nomen mutuata est. Cum autem Artifices parum accurate operari solent, sit ut Mechanica omnis a Geometria ita distinguatur, ut quicquid accuratum sit ad Geometriam referatur, quicquid minus accuratum ad Mechanicam. Attamen errores non sunt Artis sed Artificum. . . .

"Pars hæc Mechanicæ à Veteribus in Potentiis quinque ad artes manuales spectantibus exculta fuit, qui Gravitatem (cum potentia manualis non sit) vix aliter quam in ponderibus per potentias illas movendis considerarunt. . . ."

Rankine had this preface in his mind in preparing his inaugural address (1856), a "Preliminary Dissertation on the Harmony of Theory and Practice in Mechanics," prefixed to his treatise on Applied Mechanics.

"In physics and mechanics the notions of the Greeks were very generally pervaded by a great fallacy, which obtained its complete and most mischievous development amongst the mediæval schoolmen, and the remains of whose influence can be traced even at the present day—the fallacy of a *double system of natural laws;* one theoretical, geometrical, rational, discoverable by contemplation, applicable to celestial, ætherial, indestructible bodies, and being an object of the noble and liberal arts; the other practical, mechanical, empirical, discoverable by experience, applicable to terrestrial, gross, destructible bodies, and being an object of what were once called the vulgar and sordid arts."

We want in our theoretical treatises more of the spirit expressed on the title-page of Hayes's Fluxions, 1704, "A work very useful to those who would know how to apply Mathematics to Nature."

To do this we must come to close quarters, and "missis formis substantialibus et qualitatibus occultis" fire off the elegant artillery of analysis; in fact, reduce the formulas to their numerical applications; it is in this way only that the various differences so notable in the mode of treatment in different schools can ultimately become reconciled.

Suppose we set up our author as the champion of the first of these two schools of thought described above by Rankine, and pit him against Prof. Perry, as the champion mathematician of the engineers.

The first point of dispute will be the measurement of force; the engineer will insist on retaining in Dynamics the statical gravitational measure of force, considering that he works in a field of gravity, practically uniform over the surface of the Earth, on which the human race is imprisoned; and also because the gravitational measure of a force is the only one capable of direct experimental determination to the highest degree of accuracy; this is not the case with the absolute measure of force, the one solely adopted in the demonstrations of the present treatise.

There are certain advantages in recording the results of cosmical, electrical, magnetical, and astronomical results in absolute measure; for if the author should succeed in having his treatise adopted on another planet, his C.G.S. units would be immediately applicable, on the assumption of perfect astronomical observation and measurement; but for experimental verification each planet would have recourse to its own gravitation system.

A problem proposed recently in an American technical journal, "to find the work required to lift the Earth one foot," might perhaps serve a useful purpose in focussing discussion between the merits of absolute and gravitation measure.

A curious note on the last page of this treatise dismisses the units in which all our engineering calculations are carried out, in a few lines, such as—

"Thus the equation which we write $P = mf$, where P is the force producing acceleration f in a body of mass m, could be written in these units $P = (m/g)f$, where g is the same constant."

"It does not tend to simplicity that the writers who use these (*i.e.* the gravitation) units also use the word 'weight' for the quantity we call 'mass,' and the letter W where we use m, and thus they write the above equation $P = (W/g)f$."

"Much confusion has thereby been produced."

But Prof. Perry will retort by saying that the confusion is produced by those writers who never have to employ the theory they teach; and that the words "frequently not" should be changed to "never" in the statement in § 299—

"The C.G.S. system of units, although generally used in scientific work, is frequently not employed in practical applications of science."

Such a thing as an arithmetical mistake is unknown among those who work with gravitation units; the same cannot be said of the adherents of absolute measure who are very apt to slip a g in their calculations (there is a g missing in the result of ex. 60, p. 75.)

How does our author reconcile his definitions in Chapter v. with the precise legal terminology of the Act of Parliament on Weights and Measures?—

"The *weight* in vacuo of the platinum *weight* (mentioned in the First Schedule to this Act), and by this Act declared to be the imperial standard for determining the imperial standard pound, shall be the legal standard measure of *weight*, and of measures having reference to

weight, and shall be called the imperial standard pound, and shall be the only unit or standard of *weight* from which all other *weights* and all measures having reference to *weight* shall be ascertained."

How does Mr. Love propose to edit this clause? The word *weight* makes its appearance seven times where Mr. Love says the right word to employ is *mass*; he cuts the Act of Parliament to pieces on p. 98; and we have mass occur in almost every line. And if the word *weight* is to go, what is to be done with *pound*, *poids* (de kilogramme), and *avoirdupois*, all derived from the Latin *pondus*? According to § 91, *pondus* is given in dynes, and the word *pondus* above must be replaced by *massa*.

If this process of Restoration (to use the banal architectural word—

"to erect
New buildings of correctest conformation
And throw down old, which he called *restoration*."
DON JUAN.)

is to be carried out systematically, what is to be done with the words "in ponderibus movendis" of Newton's preface? and how are Ovid's lines to be restored describing the statue of Ladas, the work of the sculptor Myro?—

"Quæ nunc nomen habent operosi signa Myronis
Pondus iners quondam duraque massa fuit."

Or again the lines—

". . . et gravitate carentem Æthera. . . .
Cum quæ pressa diu massa latuere sub illa . . ."

Love's *Dynamics* versus Ovid's *Ars amatoria!* not to mention the ecclesiastical usage of Christmas, Childermass, Candlemass, Ladymass, Lammas, Loafmass, Martinmass, Soulmass, Michaelmass, . . . now exciting controversy in another place.

"The common use of the word "weight" covers two notions which are essentially distinct, the notion of pressure which a heavy body exerts on a support, and the notion of quantity of matter. In scientific writing and speaking, different words must be used to express distinct notions" (p. 99).

A very useful aphorism, worth adding to Newton's "Regulæ Philosophandi"; and so scientific writers must invent two new words to express these two distinct notions, and not attempt to force a word of common currency out of its most extended meaning.

At the same time another rule might have been made —"The names of a thing must not be multiplied more than is necessary."

"Since the centre of inertia of body small enough to be handled coincides with its centre of gravity as defined in Statics, we shall denote it by the letter G" (p. 102).

And now we have three names, *centre of mass* (d'Alembert), *centroid* (Clifford), and *centre of inertia*, where the single name centre of gravity is sufficient for ordinary purposes. It is a pity to waste the expression "centre of inertia" in this way, as it may prove useful for designating a point distinct from the centre of gravity, in the case of non-rigid systems, such as a carriage on wheels, or a fish, bird, or projectile moving in its medium.

This brings us to the "Conception of a Rigid System" in § 114—

"If the particles of a rigid system continuously fill a surface, the system is a rigid body, and the surface is the surface of the body."

At this rate the ball-bearings of a bicycle constitute a rigid system, contrary to the function for which they are designed.

The bicycle has done wonders in familiarising our youth with dynamical sensations; and the machine itself can be used in a variety of ways to illustrate the theory of the pendulum and the gyroscope. When testing the wheels for friction and balance, the elliptic functions, defined in rather a condensed way in § 191, can easily be watched in their fluctuations; while the new drawing-room game of trying to walk round holding a revolving wheel serves to emphasise gyroscopic domination. With this stimulus the languishing study of elliptic functions may again become popular, and lead on to the dynamical applications of the hyper-elliptic functions, sketched out by Prof. Klein in his Princeton lectures, as required for the complete solution of the bicycle problem, especially as the Prize offered by the French Academy for this subject is still open.

The influence of wind will excite an interest in § 212, on the motion in a resisting medium. In this article the author could have simplified the treatment, by introducing the notion of "terminal velocity," as in ex. 155, p. 227.

The statement on p. 195, that the resistance of the air is better represented by the cubic law, is not valid, except for a very limited region in the neighbourhood of the velocity of sound; but, considering that the retardation

$$\frac{d^2s}{dt^2}$$

can be replaced by

$$\frac{d^2t}{ds^2}v^3,$$

Mr. Bashforth found it convenient, in the reduction of his screen records, to take out the factor v^3, and to measure carefully the other factor, $\frac{d^2t}{ds^2}$.

The Science of Dynamics does not consist in labelling certain physical quantities with letters, such as m, W, f, g, . . .; these letters really mean numbers, expressed each in its own unit. Mathematical Tripos questions unfortunately pay scant attention to the units involved, and our mathematical students learn to loathe all numerical applications, and so lose sight of the true meaning of these algebraical symbols for numbers. One reason for this dislike of numerical computation is the absurd system of using 7 figure logarithms, where, as in the case of the gravitation constant γ, upon which all Celestial Dynamics depend, the numbers do not warrant such refinement. A gigantic cheese-auger cannot be driven into the earth, to determine the density of the strata up to the centre, so we have to be content with the indication of the Cavendish experiment, which, even in the experienced hands of Mr. Boys, do not warrant the use of logarithms of more than 4 places.

The two papers on the theory of the oscillations of a ship, and of the stresses produced thereby, read recently before the Institution of Naval Architects by Captain Kriloff, Professor at the Naval Academy of St. Petersburg, are worth the attention of theoretical students in showing the numerical computations, given to 3 significant figures only, required in a complicated problem of Rigid Dynamics, and showing also the system of gravitation units invariably employed in such calculations.

The letters m and W are the modern dynamical equivalents of the θ and π, the $\theta\epsilon\omega\rho\eta\tau\iota\kappa\acute{\eta}$ and $\pi\rho\alpha\kappa\tau\iota\kappa\acute{\eta}$, embroidered on the hem of the robe of the vision which appeared to Boethius in his dungeon, to inspire his *Consolation of Philosophy*.

Let the letter W still continue to denote the number of pounds of matter in the body, and let m denote the number of grammes; let us adopt the method of Prof. T. W. Wright's "Mechanics," reviewed by Prof. Perry, a new edition of which has just appeared, and employ the absolute system with Metric units only, so that the "poundal" is merely mentioned once to point out its uselessness. Now Prof. Perry can denote $W \div 32{\cdot}1912$ by the letter M, so that the unit of M is a 32·1912 pound shot; and if he calls M the mass of the body, in opposition to Mr. Love, he is only following the custom which can be traced back through the treatises of Todhunter, Parkinson, Earnshaw, Whewell, Poisson, Lagrange, &c., up to Euler.

Thus M. de Freycinet writes, in his *Essais sur la Philosophie des Sciences*:—

"Il ne suffit pas d'avoir la notion claire de la masse. Il faut aller plus loin. Pour les besoins de la Dynamique il est nécessaire de savoir *chiffrer* les masses.—Une quantité d'eau peu inférieure a 10 décimètres cubes, soit 9 litres, 8088, . . . le nombre habituellement désigné par la lettre g, voilà l'unité de masse."

With these writers we find that the gravitation unit of force alone is employed, and, contrary to Mr. Love's classification in § 294, the unit of mass is a *derived* unit, being that quantity of matter which will receive unit acceleration from the gravitational unit of force. The same method is employed in all engineering treatises, but we are inclined to agree with Mr. Love in thinking it might be abandoned with advantage, as being a mere lazy device to avoid writing $\frac{W}{g}$; and coming back to Euler, we find him explaining at length, in some six pages of his "Dynamics," 1760, that the acceleration $a = \lambda \frac{P}{M}$, due to a force P acting on a mass M, and that we must take $\lambda = 2g$, where g is taken by Euler to measure the distance a body falls from rest in one second.

Students will be grateful to the author for the two elegant and complete chapters on two-dimensional Motion of a Rigid Body, a great desideratum. A very large and valuable collection of illustrative examples are brought together, most of which are capable of experimental verification in our field of gravity; and in such cases it would increase the instructiveness to employ the gravitation measure of force, the only one capable of exact measurement.

"When, as in astronomy, we endeavour to ascertain (these) causes by simply watching their effects, we *observe*; when, as in our laboratories, we interfere arbitrarily with the causes or circumstances of a phenomenon, we are said to *experiment*" (Thomson and Tait).

In recording theoretical results of astronomical observation, absolute units are certainly appropriate, but they are all susceptible to the probable error in the determination of the gravitation constant γ.

The author has performed a useful service in § 277, in calling attention to the looseness of the ordinary school-book definitions, that "the weight of a body is the force with which it is attracted by the Earth."

But we must return to the charge again, and protest against the assumption that the addition of the word "weight" to "pounds" is required to connote the idea of force. Architects may measure the pressure on foundations in cwt/ft^2, but there is no such thing in existence as a pressure gauge graduated in lbs-wt/in^2; it is always in lbs/in^2; more than that, we doubt the existence of any gauge graduated in dynes/cm^2, or barads; and the stock of instruments at present in use is sufficiently large to resist this innovation. The centesimal measurement of time, required for the completeness of the metric decimal system, never came into use, if only because of the number of clocks, watches and chronometers in existence; so that the C.G.S. system is a mongrel one, involving the sexagesimal second of time.

In the careful examination of the ultimate axioms of Dynamics which he has set himself for reconsideration, the author has thrown down a challenge to the Metaphysicians, in the theory of the relativity not only of motion, of rotation as well as of translation, but also of time, matter, force, &c., which we trust will not pass unnoticed.

This minute survey of the foundations of Dynamics has, like a visit to the dentist, revealed so many unsuspected flaws, that it seems doubtful if Dynamics can remain an exact Science. Considering that the gravitation of a body varies with the velocity relative to the Earth, how are we justified in accepting the sacred definitions of the C.G.S. units, which may be affected by similar defects? A spirit of dynamical scepticism is in the air, as testified by the treatises of Mach and his disciples, Hertz, Boltzmann, and by Poincaré on Hertz in the *Revue générale des Sciences*. Maxwell's and Clifford's work does not appear to have influenced the author.

According to the Preface, "The foundations of Mechanical Science were laid by Newton"; but we think that the claims of Galileo are passed over, not to mention Archimedes. Galileo appears throughout this treatise as Galilei; both forms of the name are correct, according to the German student song—

"Auch ging er wohl mitunter
Zur Kirche als frumber Mann;
Doch beten und singen nicht kunnt er,
Schaut lieber zur Decke hinan:
Was sah er da in der Höhi?
Tschahi, tschaheia ho—
Die Ampel sah Galilei
Und auch der Galileo!" &c.

Some novelties in the way of nomenclature are welcome, such as "frame of reference" for "coordinate axes," "localised vector," "kinetic reaction" (due to Mr. Larmor, we believe) for d'Alembert's reversed effective force"; but when the writer proposes to upset the well-established use of common words, and teach us a new language of recent invention, he might as well set to work to change the names of the stars and planets; and we are compelled to protest, in the words of Biron,

"These earthly godfathers of heaven's lights,
That give a name to every fixed star,
Have no more profit of their shining nights
Than those that walk, and wot not what they are."

A. G. GREENHILL.

LONDON BIRDS.

Birds in London. By W. H. Hudson. 8vo. Pp. xvi + 339; illustrated. (London: Longmans, Green, and Co., 1898.)

AS a writer on the habits of animals and their natural surroundings, and one, moreover, gifted with an unusually facile and interesting mode of expression, Mr. Hudson has already established such a reputation that any new work from his pen is almost sure of meeting with a favourable reception. And, in our opinion, the present volume is as full of interest as the nature of the subject permits; many of his descriptions bringing into prominent notice the amount of attraction to be found in the open spaces in and around London if only we go about with our eyes open, and can snatch a few half-hours of repose from the business and pleasures of the great city. Most of us, who either live in the country, or spend our holidays there, quite fail to realise how gladsome must be the sight of the bird-life in our London parks to those who have little or no opportunities of escape from the wilderness of bricks and mortar; and Mr. Hudson, in his enthusiasm for his subject, says that not only do such glimpses brighten the existence of our toilers, but that they are almost essential to such existence. Be this as it may, his description of the delight afforded to our poorer neighbours by the contemplation of the birds kept in the little enclosure at the eastern end of the Serpentine is quite pathetic reading, and affords full justification for all that is being done to encourage the feathered denizens of our parks to remain and multiply.

From a scientific point of view the work, it must be confessed, cannot lay claim to a high place; and it was doubtless not intended so to do. The decimation of the species that formerly lived in and around London, and the introduction, either natural or artificial, of extraneous kinds, preclude it being considered as a manual of the avian fauna of the district. Still even the scientific ornithologist ought to find some interesting matter in regard to the persistence of some species and the disappearance of others; and more especially so when he finds that in some cases it is the apparently hardier and bolder forms that have disappeared, and the more delicate that have remained. Still more remarkable is the recent colonisation of certain spots by such apparently shy and retiring species as the dabchick and moorhen.

In some ways, perhaps, the author is inclined to take matters a little too seriously; and, personally, we fail to assent to his strictures concerning the rearing of wild ducks on the Serpentine. If we read him right, he would have them partly, if not entirely, disestablished in favour of his pet species the crow. But, to our own thinking, it is a far more generally interesting, and certainly a far less common sight to watch the evolutions of the flights of duck on our park waters, than it would be to observe the sedate manner of crows and rooks, which most of us, if so disposed, can see elsewhere. Still more uncalled for are the author's strictures on the annual battue held to keep the numbers of the ducks within proper limits. Somebody must undertake the duty; and if the duty be also a recreation, surely the Ranger or his deputies should not be debarred from enjoying it. But apparently Mr. Hudson is of opinion that nothing but outdoor natural history is worth anybody's attention, since he goes out of his way (p. 80) to attack the Government for the purchase of the Blenheim pictures.

Although there may have been reasons for their removal unknown to the general public, our personal sympathies are, however, decidedly with the author over the felling some years ago of the elms in Kensington Gardens, and the consequent total disappearance of the rooks.

Even to summarise the contents of the book would largely exceed our limits to space, but attention may especially be directed to the chapters devoted to the open spaces on the outskirts of London, and to the two on the protection of birds in our parks, and on those most suitable for encouragement or introduction. In the last of these the author is strongly of opinion that water-fowl, if properly protected, will return to their assigned haunts to breed, adding: "I believe that our ornamental water-fowl ought never to be pinioned except in the cases of a few rare exotic species. When a bird is pinioned its chief beauty and greatest charm are lost; it is then little more than a domestic bird, or a bird in a cage." With this commendable sentence we take leave of a very pleasantly written and charmingly illustrated little book. R. L.

OPTICAL ACTIVITY.

Das optische Drehungsvermögen organischer Substanzen und dessen praktische Anwendung. By H. Landolt, assisted by Drs. O. Schönrock, P. Lindner, F. Schütt, L. Berndt and T. Posner. Second Edition. Pp. xxii + 655. (Braunschweig: Friedrich Vieweg und Sohn, 1898.)

THE first edition of this book, which appeared nineteen years ago, has since its publication been the standard work on the rotation of the plane of polarised light by active substances. Since 1879, however, the number of active substances known has increased from 300 to over 700, the methods of determining the rotation have been much improved, and considerable advances have been made in the theory of the asymmetric carbon atom, to mention only a few of the directions in which progress has been made. All this necessitated a thorough revision of the "Drehungsvermögen"; and in order to cope, in reasonable time, with the mass of material, the author has called in the assistance of the specialists above named in writing several of the chapters. The writers must be congratulated on the way in which they have welded the different chapters into a homogeneous whole, the disjointedness which so often arises from such joint-authorship having been most happily avoided. Comparing the present edition with the former one, the progressive broadening and consolidation of our knowledge of optical activity is very apparent. Twenty years ago the main outlines of the subject were already sketched in, and these remain practically unchanged; how much has been done in the interval, in filling in details, can best be appreciated by reading the present work.

The arrangement of the material remains very much the same as in the former edition, but the revision has been very thorough; so far as we have been able to judge, nothing of importance has been omitted.

The first part contains a classification of all active substances known, and a succinct account of the theory of Van 't Hoff and Le Bel. The properties of the active, racemic and inactive modifications of a substance are then contrasted, and the methods of converting them into and separating them from each other described. A chapter by Prof. Lindner, on the micro-organisms employed in splitting up racemic compounds into their constituents, should be helpful to chemists. In the third part the rotation is considered from the physical point of view, the chapter on the influence of solvents on rotation being especially interesting. Many of the phenomena observed are still unexplained, and it would appear that a study of these should be capable of throwing some light on the nature of solutions. After a discussion of Guye's hypothesis, which is found to be insufficient, the author remarks that it will probably be impossible ever to discover the numerical connection between chemical constitution and rotation.

One hundred and forty-two pages are devoted to a very excellent account, by Dr. O. Schönrock, of polarimeters and saccharimeters, the subsidiary apparatus connected with them, and the methods of using them. Dr. Schütt contributes Part 5, on saccharimetry and the determination of several other active substances of technical importance, and the book terminates with a collection of the rotatory powers of all active substances known, which is complete up to the middle of 1896, and includes some of the data published since that date. A good index is added. T. E.

OUR BOOK SHELF.

The Span of Gestation and the Cause of Birth. By John Beard. Pp ix + 132. (Jena : Gustav Fischer, 1897.)

COMMENCING with the assumption that there is a "critical period" in the development of every mammal "when the embryo is first beginning to look like the form whose offspring it is," Dr. Beard proceeds, in this monograph, to point out the close connection existing between the extent of time, or "critical unit," which elapses before the "critical period" is attained and the ovulation and total gestation periods.

Dealing shortly with the probability of an alternation of generations in mammals, which he has so ably advocated in earlier communications, he reaffirms now his previous conclusion that the attainment of the "critical period" is coincident with the completion of all the important parts of the sexual generation, and with the commencing degeneration of the asexual generation or phorozoon. The length of the "critical unit" is, therefore, the length of the life of the phorozoon, and when it is completed, in the more primitive forms, *e.g.* the marsupials, the birth of the sexual generation occurs.

Obviously the simpler conditions prevailing in the lower forms have been altered in the higher mammals, and at first sight the alterations have not occurred along definite lines, for the "critical unit" is not a fixed quantity; on the contrary, it varies in length from $7\frac{3}{4}$ days, in the opossum, to 47 days, in man. Dr. Beard is convinced, however, that the variations can only occur in conformity with some discoverable law, and he shows that the "critical unit" is either slightly less than one, or than two combined ovular periods, which he proposes to term "ovular units." He suggests that if ovulation was not previously restricted it became impossible when gestation was established, and could only recur, in the most favourable circumstances, shortly after birth, and thus the "critical unit" came to govern the "ovulation unit." But the intimate correlation between the critical and ovulation units is not closer than that which exists between the "critical unit" and the gestation period, for the latter is always some multiple of the former, and the greater the number of the "critical units" contained in the gestation period the greater is the stage of the development of the fœtus at birth; nevertheless, the completeness of the development of a fœtus at birth is not dependent merely upon the length of its gestation period, but upon the number of critical units in that period, for the "critical unit" has probably been doubled or trebled in certain cases, and the author believes that such lengthening is associated not with increase of the development, but only with increase in the size of the fœtus.

The points raised in this interesting memoir are clearly stated, the evidence in their support is well arranged, and the author is to be congratulated on having thrown light on some obscure problems. It is to be hoped that he will push his observations further, and that he will eventually succeed in demonstrating "the cause of birth."

ARTHUR ROBINSON.

A New Astronomy. By Prof. David P. Todd, M.A. Ph.D. Pp. 480. (New York, Cincinnati, Chicago : American Book Company.)

ASTRONOMY is pre-eminently a practical science, yet instruction in it, and especially in the branch which pertains to geography, usually consists of a course of study of text-books. This is not as it should be. It is far better to observe the apparent movements of the stars and planets than to learn that they are hundreds of thousands of miles away from us; and to note the annual movement of the sun among the stars is more instructive than to learn the dimensions of some sun-spots and prominences. In astronomy, as in other sciences, the only firm conceptions are those obtained from direct observation. Prof. Todd's book marks a new departure by showing how the fundamental principles of the subject may be studied with the aid of tangible objects, somewhat as in physics and chemistry. The result is most successful. No book with which we are familiar contains a clearer account of astronomical geography, and certainly none show so well how to observe celestial movements or illustrate astronomical phenomena with simple appliances. The pupil who learns astronomy through Prof. Todd's book will have a real idea of the motions and measurements of the heavenly bodies instead of abstract conceptions concerning them.

The practical presentation of what may be termed the geometry of astronomy only forms, however, one commendable feature of the book. Other characteristics which call for just as much praise are the large number of illustrations—well reproduced and well chosen—and the attention that is given to the advances made in recent years in all branches of celestial science. Throughout the book the endeavour has been to present the subject in a way which will induce the student to think for himself, and not merely commit facts to memory. In other words, Prof. Todd shows how astronomy may be given an educational value, instead of being presented as a collection of isolated and imperfectly connected facts. Fortunate is the pupil whose teacher instructs him in astronomy on the sound methods described in this book.

Lessons in Domestic Science. Part i. By Ethel R. Lush. Pp. viii + 88. (London : Macmillan and Co., Ltd., 1898.)

THIS instructive little book has been prepared for use by children in public elementary schools. It contains simple information on food, clothing, and personal hygiene, and is well adapted for the purpose for which it is intended. Wherever possible, the principles described are illustrated by experiment.

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.*]

Liquid Hydrogen.

IN his letter published in your issue of the 9th inst., replying to mine published on May 26, Prof. Dewar does not question the accuracy of the following statements, which form the most important part of my letter: (1) That the combination which I described in that letter as constituting the self-intensive method of refrigeration was proposed by me at the Royal Institution to his chief assistant, Mr. R. N. Lennox, in November 1894; (2) that this combination had not been previously employed; (3) that it formed the chief novelty of Prof. Dewar's paper and experiments of December 1895; (4) that it is essential to the apparatus which has made the step from liquid air to liquid hydrogen. These facts make a sound claim on my part to the invention of the process and to recognition in historical or explanatory accounts of work which involves the use of the process. Prof. Dewar says: "My results would have been attained had Dr. Hampson never existed, just as they have been developed." On the other hand, at the Society of Arts (see *Journal*, March 11, 1898, p. 382), in speaking of Dr. Linde's process, which is admitted to be substantially the same as mine, Prof. Dewar said that "after some fourteen years' work he ought to know something about low temperatures, but he must confess that the practicability of such a mode of working had never struck him." In illustrating the paper of December 1895, after showing an apparatus in which my process is embodied, and which has since been manufactured and sold by a firm of which his assistant, Mr. Lennox, is a member, Prof. Dewar said in my hearing that the chief credit for persevering with the development of that apparatus to a successful issue was due to Mr. Lennox. In his account (published in your issue of May 19) of the hydrogen apparatus, which also employs my process, Prof. Dewar says that it was constructed by Mr. Lennox's firm, and afterwards, in recognising "the invaluable aid of Mr. Robert Lennox," says "it is not too much to say that but for his engineering skill, manipulative ability, and loyal perseverance, the present successful issue might have been indefinitely delayed." I must allow that it is unfortunate for Prof. Dewar that an assistant so very useful and helpful should have kept the source of his inspiration on the vitally important features of the new development from the knowledge of his chief, who, in discussing my paper of May 2 before the Society of Chemical Industry, stated that he had been quite unaware of my communication of plans and drawings to Mr. Lennox. He ought however, when he did learn the facts, to have done me justice; whereas he says in his letter of the 9th inst.: "My assistant has explained his position in the matter in letters addressed to *Engineering* within the last few weeks." I earnestly hope that all who care for the credit of science will read for themselves the series of letters to *Engineering* by "Arenel," Mr. Lennox, and myself, from March 25 to May 13, in which it will be difficult to find a satisfactory explanation of Mr. Lennox's position. As I fear, however, that few people will exert themselves to look up these letters, I shall be pleased to send a copy of the series to any one who writes for it to No. 20 Gower Place, W.C.

Prof. Dewar criticises my statement that I was the first in this country to liquefy air and oxygen without employing other refrigerants, on the ground that it had previously been done in experiments at the Royal Institution. Now Mr. Lennox has been given very great credit for the work in these experiments; and I do not admit that experiments by my method, developed in collaboration with a gentleman to whom I had explained the method embodied in them, and who had confessed that this method was a novelty to him, and had promised to help me to the appliances required to work it, can be quoted as anticipations of my own work; but to make my statement more correct literally, I will say that my method (as compared with that of Dr. Linde, which differs from it in details) was the first in this country to liquefy air and oxygen without employing other refrigerants.

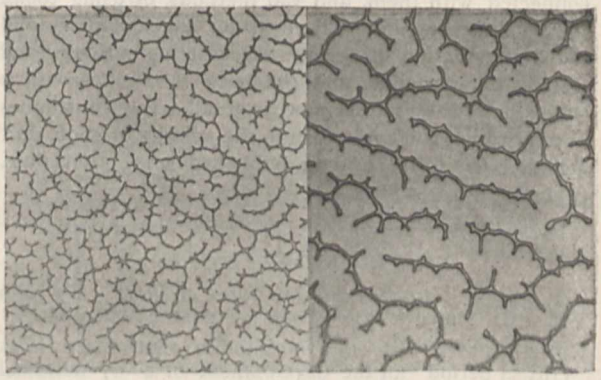
I may add that I mentioned my introduction to Mr. Lennox, not as an "excuse" for calling on him, a course which obviously needs neither excuse nor justification—but to show that I made my visit deliberately for a definite purpose, knowing that I was in possession of an invention of great value for work such as he was practically engaged in. W. HAMPSON.

June 11.

Dendritic Patterns caused by Evaporation.

I HAVE been much interested in Miss Raisin's Royal Society paper "On certain structures formed in the drying of a fluid with particles in suspension," of which an account appears in NATURE for June 2. In connection with this subject it may be worth while placing on record the fact that the presence of suspended particles is not essential for the production of dendritic forms.

Many years ago, when dabbling in microscopy, I mounted a number of objects in glycerine jelly, and was much troubled by the production of bubbles starting from the object and spreading in all directions, leaving a highly elaborate network of ramifications caused, no doubt, by the evaporation of water and consequent shrinkage of the jelly. Having called attention to this defect in a box of slides circulated by the Postal Microscopical Society, Mr. J. J. Wilkinson, of Skipton, very kindly sent me the two accompanying photographs taken with magnifications of 25 and 50 diameters respectively. An additional interest attaches to these from the fact that the slide from which they were taken belonged to the collection of the late Mr. Tuffen West. Needless to say, this slide was mounted for an entirely



× 25 × 50.

different object, and the specimen it contained was rendered worthless by the subsequent formation of these beautiful but troublesome vacuoles. It should be explained that it is the thin branches which are formed of the remains of the jelly, the air filling the broader species between them. G. H. BRYAN.

Bangor, June 10.

Iridescent Surf at Cromer.

CAN any of your readers account for what seems to me to be a singular phenomenon, as, although familiar with the beautiful sea-coast and clear green waves of many lands, I have never seen anything of the sort elsewhere.

The cliffs here, though fine when seen from a distance, are only composed of sand and earth, large quantities of which have been washed down by the recent rains, so that the sea is very dirty, each turning wave being dark with mud. This mud has apparently some curious property, which causes a very moderate surf to deposit long lines of foam all along the shore. Of this foam (which is in no hurry to disperse) each bubble is brilliantly iridescent, even on the dullest day of cold sea-fog, when there is not one gleam of sunshine to produce prismatic effects.

The inhabitants take this so entirely as a matter of course, that a lady whose attention I called to it, said that having always seen it, she had supposed it to be the natural condition of all sea-foam.

Beautiful in themselves as are these myriad rainbows of the shore, I am glad they are not universal, if they are only to be seen as compensation for a discoloured sea!

It would be interesting to learn what is the ingredient in the mud which, when combined with salt waves, produces such tints. CONSTANCE F. GORDON CUMMING.

Cromer, Norfolk, June 15.

Aquatic Hymenopteron.

IT may be of interest to some of your readers to know that, after years of unsuccessful search, I have at last bred *Prestwichia aquatica* (Lubbock) from eggs of Notonecta.

From one single egg there emerged no less than fourteen specimens, one male and thirteen females. This astonishing fact, besides proving that *Prestwichia* is an ovivorous parasite, beats all previous records of the number bred of allied species; but this record has since been put into complete shade. On Friday, from another egg, I bred six males and twenty-eight females; thirty-four parasites from a single egg.

After this astounding fact we must be prepared for something strange, now that the life-history of these marvellous ovivorous parasites is being worked out. FRED ENOCK.

13 Tufnell Park Road, N.

"A High Rainbow."

THE "rainbow" described by Mr. Moreland (in your issue of June 16) was evidently of the same character and origin as an inverted arc near the zenith, which occurred in connection with a mock-moon phenomenon at Birmingham, on May 31, 1895.

An illustrated description of this, by the writer, may be found in *Symons's Meteorological Magazine* for September 1895, p. 122. F. J. ALLEN.

Mason College, Birmingham, June 17.

THE ETIOLOGY AND PREVENTION OF MALARIAL FEVER.

THE study of the causes of intermittent or malarial fevers has received a marked impetus through the discovery by Laveran (*Traité des fièvres palustres*, 1884) of the presence in the blood of the affected persons of definite living bodies belonging to the protozoa. A large amount of important research has been carried on since, concerning these bodies or corpuscles of Laveran, which has yielded not only a clearer understanding of their morphological and biological characters, but has more accurately defined and placed on a firm basis the relation of these protozoa to the different known types of malarial fevers: febris quotidiana, tertiana, quartana—terms denoting the rhythm of the fever paroxysm. The researches of Laveran, of Marchiafava and Celli, of Golgi, of Celli and Guarneri, Grassi and Feletti, Councilman, Danilewsky, Mannaberg and others have definitely established that malarial fevers are characterised by and due to the presence, within the red blood discs of the patient, of parasites belonging to the group of protozoa known as sporozoa (gregarinida, coccidia and hæmosporidia); that is to say, of minute amœboid corpuscles, measuring not more than a sixth or an eighth or less of the broad diameter of a red blood disc, having entered into a blood disc pass their life cycle intraglobularly, growing in size at the expense of the blood disc, consuming the latter's substance till of the host nothing but a small mass of black pigment—the remnant of the blood pigment—is left. The final phase in the life-history of this plasmodium malariæ or hæmoplasmodium malariæ is reached when by a process of simultaneous fission its body produces a number of minute oval spores. These becoming free in the blood fluid are carried by the circulation into the different internal organs: marrow of bone, brain, and notably the spleen. Here at the proper time each spore germinates into an amœboid plasmodium, which passes as such into the general circulation, and, having invaded a red blood disc, goes through all the stages of its intraglobular growth and final sporulation. There is a good deal of evidence to show that the phase of sporulation and consequent dissolution of the central part of the parasite, not consumed by the spores themselves, is actually one of the direct causes of the fever paroxysm; at any rate, these events coincide with the commencement of the febrile attack. One of the most important amongst the many interesting facts elucidated is this, that the duration of the life cycle of the plasmodium malariæ stands in a direct ratio to, and determines the rhythm of the consecutive fever attacks in this way: in febris quartana the plasmodium finishes its cycle in seventy-two hours, in febris tertiana in forty-eight hours, and in febris quotidiana and perniciosa — so common and so virulent in tropical and subtropical regions—the whole process of development is very rapid, the plasmodia are conspicuously small and very numerous, very active, and sporulation takes place chiefly in the internal viscera, notably the spleen.

There are other details elucidated, by which the different types of plasmodium malariæ can be distinguished from one another; as by their size, the number of spores produced in each type, the character and intensity of the amœboid movement, &c., not the least important and fundamental detail being the artificial production by inoculation of the different types of fever: quartana, tertiana or quotidiana, according to whether for the inoculation one or the other or the third definite type of the plasmodium is employed. From all this it seems justifiable to assume that the different types correspond, if not to different species, at any rate to different well-defined varieties of the plasmodium malariæ. Whether or no these varieties have become "set" and permanent (form-constant), or whether they may in one or another generation, owing to alteration of the conditions of host, season, climate or other factors, undergo transition one into the other—as is maintained by some observers—remains to be seen. This, however, has become evident, that by careful microscopic examination of the blood the nature, type and severity of the fever paroxysms can be readily diagnosed and accurately determined. This is of particular value in those atypical and irregular forms of malarial fevers, where clinical diagnosis becomes difficult and indefinite, as, for instance, when there exist several generations of plasmodia in the same affected body, and when these different generations do not start at the same time, and do not finish at the same time their life cycle, as in quartana duplex and triplex.

Koch, in a recent lecture before the Colonial Society in Berlin, lays justly stress on the importance of systematic examination of the blood by experts, so as to determine the type and character of the parasite, because —and herein lies the chief burden of Koch's remarks—the accurate determination of the type of the plasmodium should guide the treatment of the case.

It is within common knowledge that the administration of quinine is invaluable in the treatment of ague, but it is equally known that in some cases its administration is either of no avail or has proved positively harmful.

Now, Koch insists on this, that since quinine has the power to arrest and inhibit the growth and development of the plasmodium, without killing it, the administration of the quinine should be so timed that it is capable of unfolding its effects at the proper phase in the life cycle of the plasmodium, that is about the time of sporulation—immediately before the onset of the fever paroxysm —or immediately after the germination of the spores into the plasmodia—that is immediately after the onset of the fever paroxysm. These phases can only be determined by accurate and systematic microscopic examination of the blood in each individual case.

Also in another direction Koch's remarks are of value, viz. in drawing renewed attention to the high probability of the view first expressed by Laveran, then maintained and expressed with ability by Dr. Manson, to the effect that, similarly to what has been proved in Texas fever of cattle for the tick, so also in human malarial fevers the mosquito (or gnat) plays an important part in the transmission and spread of the disease, being in fact the instrument by which natural inoculation is effected. Thus Koch mentions an island off the coast of German (malarial) East

Africa, in which the absence of the mosquito is associated with a conspicuous absence of ague. It would, however, be premature to sweep aside by such observations those of many previous writers, according to whom infection with the malarial poison occurs both by way of the alimentary canal (through drinking water) and of the respiratory organs (through air). However this may be, whether malarial infection under natural conditions is carried out to a large extent by way of inoculation through mosquitoes; whether the mosquito serves merely as the instrument of infection; or whether it is—as is maintained by Laveran, and notably by Manson—the host of the malarial plasmodium; whether artificial immunity against malarial fever is procurable and by what means, are some of the questions which, having a principal bearing on prevention, ought to receive an immediate answer.

It is for reasons of this kind that Koch's great authority and weighty opinion are welcome; they ought to stimulate to action those Governments whose possessions in tropical and subtropical countries impose on them the responsibility of better protecting the health and life of their civil and military subjects, a responsibility which hitherto, unfortunately, does not seem to have weighed heavily on them. Our own Indian Government has with laudable spirit initiated important work by appointing for specific research on malaria an able young military surgeon, Surgeon-Major Dr. Ronald Ross. While this is a beginning, it is small as compared with what is needed to meet the case; what is wanted is a staff of specialists, whose systematic and concerted work is required to elucidate the many problems connected with the subject. The Colonial Office also, with its sway over vast malarial territories in tropical and subtropical Africa, might do a great deal in the matter, considering that the health and life of their numerous civil and military servants is exposed continually in some of the most notorious hotbeds of deadly fevers to dangers which ought to, and with advancing exact knowledge might be prevented.

E. KLEIN.

THE UNIVERSITY OF LONDON COMMISSION BILL.

THE second reading of the University of London Commission Bill last week, without a division, should make its passage into law this Session certain. After the elaborate pains taken by the leaders of the irreconcileable graduates to personally instruct members of Parliament during the week preceding the debate, the feeble nature of the actual opposition came as something of a surprise. It is dangerous to treat Parliament as if it were a body of graduates with a vote to cast at a senatorial election, and methods suitable for the one kind of campaign are likely to fail in the other, as Sir John Gorst made plain, when he referred to the misstatements of fact which are inseparable from a contested election. But the danger is by no means altogether overpast. Having failed to persuade Parliament to reject the Bill, Sir John Lubbock and his friends are now preparing to do their best to wreck it and to ensure its passage in a form which will effectually prevent the University from adding to its present usefulness or doing anything to encourage learning and research. The member for the University has placed his name to two amendments, each of them, if accepted, calculated to stultify the labours of half a generation for the advancement of higher education in the metropolis. To begin with he proposes to abolish the thirty-mile limit, which is necessary if the reconstituted University is to be a seat of learning for London as well as of London. The effect of this would be to encourage those provincial Colleges at present unconnected with any University to apply for incorporation with London, to delay indefinitely the formation of a University for the Midlands—a foundation much to be desired, and to render impracticable the working of the Boards of Studies of the new University in London—a provision upon which a large part of its efficiency will depend. It would be difficult to imagine any single amendment which could reach further in its evil consequences, or be more destructive of the whole purpose of the Bill than this.

But Sir John is not content with making any unity of policy unattainable; he is anxious to ensure that as large a proportion as possible of the University scholarships and exhibitions shall help to maintain the students of other seats of learning. It has long been one of the anomalies of the present University that a large number of the scholarships are won by men and women who are studying elsewhere than in London, and very frequently at other Universities. Especially is this the case with mathematics, the rewards for which study are almost invariably taken by Cambridge men. In order to maintain and extend this condition of things, the member for the University proposes that external students shall be admitted to the examinations for internal students. Under the dual examination system which the Senate will have the power of establishing, by the terms of the Bill, should it seem advisable to do so, internal students will be admitted to the examinations for external students; and rightly, for these tests, like the present ones, will be open to all the world, irrespective of the manner or place of study. But this is no argument for reciprocity in regard to the internal examinations. Should an internal student win an external scholarship, the University funds will at least go to the encouragement of learning in London itself; but should an external student take an internal scholarship, the University chest will, in the large majority of instances, be depleted for the benefit of some other institution. And what is even more objectionable, this amendment would divest the internal degree of its chief value in the eyes of students and the public alike, the guarantee namely which it will give under the Bill as it stands, that its holders have undergone a definite course of training and study. This guarantee is far more valuable in the eyes of those who understand educational matters than the difficulty of the questions which a candidate may succeed in answering during a few days at the close of his studentship, under conditions which at best admit a large measure of chance.

It is hard to believe that the Colleges will consent to take a part in reconstitution on these lines, or that Parliament will play into the hands of the wreckers by accepting such amendments. The proposal to bind the hands of the Senate and force them willy-nilly to subject external and internal students to the same examination—a point to which so much attention was directed in the recent debate—is not worth serious argument; for apart from its inherent impracticability, the facultative dual examination was the basis of the compromise on which the present Bill rests, and to destroy this would be to render legislation ineffectual because unacceptable to all the teaching bodies interested.

THE SCIENCE AND ART BUILDINGS AT SOUTH KENSINGTON.

WE were able to print last week the text of the Memorial forwarded to the Government by the President of the Royal Academy, pointing out how disastrous it would be for the future of Art in this country if the new proposals regarding the buildings at South Kensington were carried out. As our readers will remember, the same course had already been taken by the President of the Royal Society with regard to the Science side of the question.

We are now enabled to give the names of those who have signed the Art Memorial.

Edward J. Poynter, P.R.A.
W. B. Richmond, R.A.
Fredk. Goodall, R.A.
G. W. H. Boughton, R.A.
Walter W. Ouless, R.A.
Ernest Crofts, R.A.
Thos. G. Jackson, R.A.
Hamo Thornycroft, R.A.
H. H. Armstead, R.A.
Harry Bates, A.R.A.
Alfred Gilbert, R.A.
Briton Riviere, R.A.
E. Onslow Ford, R.A.
William Holt, of Oldham.
John M. Jones.
W. P. Frith, R.A.
Frank Dicksee, R.A.
Phil. R. Morris, A.R.A.
George Frampton, A.R.A.
Hugh de T. Glazebrook.
Luke Fildes, R.A.
Val Prinsep, R.A.
Marcus Stone, R.A.
Colin Hunter, A.R.A.
G. F. Watts, R.A.
John R. Clayton.
Reginald Barratt.
Fredk. Smallfield.
Lewis F. Day.
Thos. J. Grylls.
Morant and Co.
L. Alma Tadema, R.A.
Andrew C. Gow, R.A.
Sydney P. Hall.
Alfred East.
John Charlton.
Oliver Murray, A.R.A.
C. E. Johnson.
J. Y. Hunter.
R. Phene Spiers, F.S.A.
Gordon Thomson.
John Tenniel.
Edmd. M. Wimperis.
Herbert Schmalz.
S. Melton Fisher.
Cyrus Johnson.
Frank Walton.
Ernest A. Waterlow, P.R.W.S.
Walter C. Horsley.
Charles Fowler.
J. D. Crace.
Edwin Bale, R.I.
M. R. Corbet.
Edith Corbet.
W. J. Hennessy.
H. R. Mileham.
James E. Grace.
Harold Rathbone.
H. R. Hope-Pinker.
H. Cecil Drane.
G. E. Wade.
Lionel Cust.
Walter McLaren.
Alfred Drury.
Fanny W. Currey.
W. Hounsom Byles.
L. Fairfax Muckley.
R. Falconer MacDonald.
Elinor Hallé.
J. Fitz Marshall, R.B.A.
May E. Gordon.
A. T. Yowell.
Mary Grace.
Henry T. Wells.
J. Calcott Horsley.
William F. Yeames.
Seymour Lucas.
Eyre Crowe, A.R.A.
G. D. Leslie.
Thos. Brock.
W. Holman Hunt.
Edward Burne-Jones.
Arthur Severn.
C. E. Hallé.
Thos. Stirling Lee.
Gleeson White.
Walter Crane.
Carlisle.
W. Q. Orchardson, R.A.

NOTES.

IN the presence of a brilliant and representative gathering of citizens, the freedom of the City of Edinburgh was conferred upon Lord Lister on Wednesday, June 15.

GERMANY owes most of her success in the commercial and industrial world to her readiness to act upon the advice of her men of science. The German Emperor has just given further evidence that he understands the value of scientific opinion in matters affecting national welfare, and recognises the importance of technical education, by nominating Prof. Slaby, of the Technical College at Charlottenburg, Prof. Launhardt, of the Technical College at Hanover, and Prof. Intze, of the Technical College at Aachen, to be life members of the Upper House of the Prussian Diet. The *Times* correspondent at Berlin states that while Prof. Slaby was delivering his lecture at Charlottenburg on Wednesday, he was interrupted by the receipt of a telegram from the Emperor, which he proceeded to read to his class. It was in the following terms :—"In recognition of the importance which technical knowledge has acquired at the end of our century, and in profound respect for the exact sciences in general, I wish to confer upon the Technical College of Charlottenburg a seat and a vote in the Herrenhaus, and I nominate you as the most fit person to be its representative.—William, I.R." Prof. Slaby, addressing the students, expressed his sense of the significance of the step which the Emperor had taken in conferring upon the technical colleges the right of representation in the Upper House of the Prussian Diet, a privilege which the Universities had long enjoyed.

THE preliminary programmes of the sections of the American Association for the Advancement of Science are beginning to be published. Section A (Mathematics and Astronomy) announces twenty-five papers, and reports of five committees. Section C (Chemistry) announces that on Tuesday, August 23, under the auspices of the American Chemical Society, the morning session will be devoted to the subject of analytical chemistry, led by Dr. P. De P. Ricketts, of Columbia University ; the afternoon to teaching of chemistry, Dr. F. P. Venable, University of North Carolina. On Wednesday, August 24, the Association will make an excursion to Salem as guests of the Essex Institute. On Thursday, August 25, the morning will be given to inorganic chemistry, led by Dr. H. L. Wells, Yale University ; the afternoon to organic chemistry, Dr. Ira Remsen, Johns Hopkins University ; and the evening to physical chemistry, Dr. T. W. Richards, Harvard University. On Friday, August 26 (Harvard Day), in one of the Harvard University rooms, the subject of physiological Chemistry will be opened by Dr. E. E. Smith, New York ; President Eliot will deliver an address to the Association at large in the evening. On Saturday, August 27, the morning will be given to agricultural chemistry, led by Dr. H. A. Weber, Ohio University ; and the afternoon to technical chemistry, Dr. N. W. Lord, Ohio University.

THE issue of the *Revue Scientifique* of June 11 contains an interesting critical notice of the Royal Society's International Catalogue scheme by M. Charles Richet, a well-known expert in such matters. M. Richet fears that the apathy which the public manifest towards all such enterprises may make it difficult to obtain the necessary funds from subscriptions. He cordially welcomes the proposal to issue the catalogue in two forms—as slips and in book form—but regards the preparation of slips of the character suggested as a work of great difficulty on account of its magnitude. Being an ardent advocate of the Dewey system, he naturally deplores the fact that it has been put aside ; but yet finally expresses his conviction that all advocates of the system will rally, without hesitation, to the system proposed by the Royal Society, which, being advocated by such a body, has the greatest chance of success. Of the scheme as a whole, M. Richet writes : "C'est une belle œuvre à accomplir : et le plan est excellent, dans son ensemble. Nous espérons donc fermement que tous les savants de France et de l'étranger prêteront leurs concours actif à cette magnifique publication." If all receive the proposals in the same generous spirit of appreciation and self-abnegation, there can be little doubt of the success of the enterprise.

PROF. O. C. Marsh, Yale University, New Haven, has been elected a Foreign Member of the Geological Society.

PROF. B. GRASSI, M. Hippolyte Lucas, and Dr. August Weismann have been elected honorary members of the Entomological Society of London.

THE death is announced, at the age of seventy-two, of Sir James Nicholas Douglass, F.R.S., late Engineer-in-Chief to the Hon. Corporation of Trinity House. During his tenure of this post he carried out many important engineering works both at home and abroad, such as the Wolf, Longships, Great and Little Basses, Eddystone, and Muricoy lighthouses, and he effected numerous technical improvements connected with lighthouses and their illuminating apparatus, as well as in buoys and beacons. He was elected a Fellow of the Royal Society in 1883, and retired from his post at the Trinity House in 1892.

THE *Times* reports that the Norwegian Geographical Society gave a banquet last Saturday to the expedition under Captain Sverdrup, which is on the point of leaving for exploration along the north and north-west coast of Greenland. Several of the Norwegian Ministers were present, as well as the Presidents of the two Houses of Parliament, Dr. Nansen, Prof. Mohn, and other distinguished men.

AN international fisheries exhibition, together with an exhibition of Norwegian industry, agriculture, art and home industries, is now open at Bergen. The directors of the Society for promotion of Norwegian fisheries are of opinion that besides the many various meetings which will take place during the exhibition, an International Fisheries Congress ought, if possible, to be arranged. They therefore invite Norwegians as well as foreigners interested in fisheries to join in such a Congress, to be held in Bergen on July 18–21.

ACCORDING to a report of the French Minister at Stockholm, referred to in the *Board of Trade Journal*, the industry of textiles made from peat-fibre has just been introduced into Sweden. The fibres, produced from peat by a mechanical process, can be mixed in the proportion of 75 per cent. with pure wool, for the manufacture of yarn similar in appearance to common woollen yarn.

THE Pilot Chart of the North Atlantic Ocean, issued by the United States Hydrographic Office for the month of June, shows that the ice season has now set in on the Grand Banks, and that the amount of icebergs is equal to the average of past years. In addition to the ordinary useful information there is a sub-chart showing the distribution of atmospheric pressure and the prevailing winds in the South Atlantic, taken, with some modifications, from the Meteorological Atlas of the Deutsche Seewarte. It shows that a belt of high pressure extends east and west along the parallel of 25° S. To the southward the pressure diminishes rapidly and with great uniformity, and the decrease is continuous as far towards the pole as observations have been carried. Some useful general remarks are made as to the system of winds to which this high pressure area gives rise in various seasons of the year.

IN the last annual number of the *Journal of the Scottish Meteorological Society* (vol. xi.), Dr. Buchan has published a most important paper on the mean atmospheric pressure and temperature of the British Islands, with twenty-six coloured maps and tables of monthly and yearly values for forty years, 1856–1895. Fifteen years ago similar data for twenty-four years were published, but since that date a large number of stations have been added, the total now reaching 400, and a more satisfactory inspection of stations has been brought about, chiefly by the valuable aid rendered by the Meteorological Council, so that better averages are now obtainable. This monumental work teems with interesting and strictly trustworthy results, but we can only briefly refer here to one or two general remarks pointed out in the author's instructive discussion. The most striking feature is the down-curving of the annual isobaric lines as they cross the Irish Sea and St. George's Channel. Another distinct feature of the isobars is the influence of the land in increasing the barometric pressure, and the opposite influence of the sea in depressing the isobars. In the discussion of the temperature observations the author arrives at a conclusion of great importance for invalids, viz. that where a winter climate is sought, offering, in the highest degree the combined qualities of mildness and dryness, anywhere afforded by the British Islands, such a climate is to be found on the shores of the Channel, from about Dover to Portland.

MR. W. ERNEST COOKE, Government Astronomer of Western Australia, has forwarded to us particulars received from Captain Odman with regard to a remarkably severe storm experienced off the north-west coast of Australia between March 30 and April 3. Captain Odman was commanding the S.S. *Albany*, and evidently passed right into the "eye" of the storm. Strong north-east winds were met on April 1, and the barometer fell until 10 a.m. of the following day, when the weather became calm. An hour later the barometer rose quickly, and south-west winds were experienced. The following extracts from the log are instructive, as showing the characteristics of wind and atmospheric pressure in a rotary storm:—April 1, lat. 19·00, 12 a.m., barometer 29·58, strong N.E. winds and clear; 3 p.m., barometer 29·48, blowing N.E. gale with heavy rains; 11 p.m., barometer 29·42, wind N.E., blowing and raining, the force of the wind being indescribable, and continuing with fearful hurricane force up to 10 a.m. on 2nd. April 2, lat. 20·00, 10 a.m., barometer 27·80, suddenly and without warning it became calm; in fact, we could not feel a breath of wind, or tell from which direction it came. The barometer then stood at 27·80, and continued stationary till 11 a.m., when it suddenly rose to 27·90, and the wind could be heard roaring and the sea boiling before we felt it, when it suddenly struck the ship from S.W., in an entirely opposite direction to that previously experienced, and, with the rain, became almost as dark as night, and continued to blow at much greater hurricane force than it had done before, the barometer still rising. The gale still continued with violent force up to midnight, the barometer still rising and the wind decreasing from then. Captain Odman states as a positive fact that the men's dungaree suits and his own canvas one were blown to ribbons during the storm. The barometer fell an inch between 6 and 10 a.m. on April 2, and rose an inch again by 6 p.m. Mr. Cooke informs us that the storm struck the towns of Cossack and Roeburne, and almost demolished them. Cossack registered 15·42 inches of rain, Roeburne 14·66, and a place called Whim Creek had 36·53 inches. Mr. Cooke failed, however, to trace the storm inland. He expected it to work overland towards Eucla, at the head of the Great Australian Bight, but no traces of it were perceptible at the inland meteorological stations.

IT may be remembered that in May of last year Dr. Le Neve Foster, F.R.S., nearly met his death by carbonic oxide poisoning while investigating the circumstances attending an underground fire at the Snaefell Lead Mine, Isle of Man (see NATURE, vol. lvi. p. 58). A detailed report upon this mine accident has just been published in a Blue Book, and it is not merely a statement of facts as to the condition of the mine and the method of working, but a document containing information which will prove of service to persons exposed to the risk of carbonic oxide poisoning, and also be of scientific interest to physiologists. Dr. Foster points out that although the gas occurs occluded in certain rocks and minerals, it has never been found as a natural constituent of the atmosphere of mines. He had, therefore, to seek for some artificial source of the poison when investigating the accident, and he found sufficient evidence to justify the conclusion that the deaths of the twenty victims of the Snaefell disaster were due to carbon monoxide produced by timber burning in the mine. It is startling to find how small a quantity of timber need be burnt to pollute to a dangerous extent the passages of a mine. By the combustion of a cubic foot of larch, which was the kind of timber employed at Snaefell, enough carbon monoxide is produced to occupy 417 cubic feet of space at a temperature of 60° F., and a pressure of 30 inches. Twenty-five cubic feet of timber contain carbon enough to produce sufficient carbon monoxide to give an atmosphere with 1 per cent. of the noxious gas all through the mine, which proportion is quite sufficient to cause almost immediate

loss of consciousness, followed speedily by death. Dr. Foster therefore recommends that the linings and fittings of all mine shafts and roadways in mines should be made fire-proof, or of fire-resisting materials, unless the shafts and roadways are decidedly wet or damp. The use of oxygen in restoring sufferers from carbonic oxide poisoning is referred to, and the suggestion is made that a supply of compressed oxygen should be available in every district, and also apparatus for penetrating into noxious gases. With Dr. Foster's report is a report by Dr. Miller upon physiological effects of carbon monoxide poisoning, and an appendix containing statements concerning the sensations, symptoms, and after-effects produced by breathing the gas.

DR. ISSATSCHENKO, of the bacteriological laboratory attached to the agricultural department of the Russian Government, has just made a preliminary communication on a new microbe pathogenic to rats which he has discovered. A disease, which assumed epidemic proportions, broke out amongst the rats kept for experimental purposes in the laboratory, and from the liver and spleen of affected animals a bacillus was isolated, which proved on inoculation to be extremely fatal as regards both rats and mice. Receiving food infected with this organism rats and mice invariably succumbed, the former after from eight to fourteen days, the latter after from four to eight days. Following Pasteur's example in the case of a bacillus similarly fatal to rabbits, attempts were made to turn this new microbe to practical account and utilise it as a living rat poison. The results so far have not been very encouraging, but further experiments are being made in this direction. It is apparently quite without effect upon pigeons and rabbits. As regards its artificial cultivation this microbe is very accommodating, growing luxuriantly upon all the customary culture media with the exception of potatoes. In microscopic appearance it varies, as is so often the case, according to the nature of the medium in which it has been previously grown. It is mobile, and is endowed with lateral flagella.

INCREASING attention is paid nowadays to the elevation and sub-soil by those who are in a position to choose their place of residence. It is true that many circumstances have to be taken into consideration in fixing upon a home, and not the least important is the construction of the house itself—more important, probably, than the question of a gravel or clay sub-soil. Elevation and surroundings, again, may confer advantages not to be had in a low-lying gravel area. To those, however, who are seeking for homes on particular sub-soils or in particular situations the handsome embossed model just published by Mr. E. Stanford, London, will prove an excellent general guide. If the more elevated regions of Shooter's Hill, Sydenham and Wimbledon, of Hampstead, Highgate and Harrow, appear to stand out in somewhat mountainous form, owing to the horizontal scale of one inch to a mile and the vertical scale of one inch to a thousand feet, the main features can nevertheless be readily grasped. The leading roads and railways are shown, the sub-soils are distinctly coloured, and along the margin of the model there are sections depicting the underground structure of the country. The model itself measures 2 feet by 1 foot 8 inches, including its frame, and it takes in Barking on the north-east, a part of Harrow on the north-west, Long Ditton on the south-west, and Orpington on the south-east. The model is made of tinned steel plate, enamelled in colours, and its price is 15*s*. It has been prepared by Mr. James B. Jordan, the geology being compiled from the maps of the Geological Survey, the work chiefly of Mr. Whitaker. House-hunters who consult it will see at a glance the advantages to be gained from certain localities, and also the districts that should, if possible, be avoided. For educational purposes in schools the model may prove of considerable service.

AN interesting address entitled "Types of Scenery and their Influence on Literature," recently delivered at Oxford by Sir Archibald Geikie as the Romanes Lecture, has been published by Messrs. Macmillan and Co., Ltd. The object of the address was to point out the leading types of scenery that distinguish the British Isles, and to show that it is possible to trace from each of them an influence upon the growth of English literature. For instance, Sir Archibald points out that the English lowlands have had a distinct influence upon our literature. They are washed by the sea along the whole of their eastern and northern borders. Moreover, the coastline is indented by numerous bays, creeks, and inlets, which furnish many admirable natural harbours. There can be no doubt that this feature in our topography has powerfully fostered that love of the sea which has always been a national characteristic. To the same cause may be traced that appreciation of the poetry of the sea so noticeable in our literature. For a century after Milton's time poetry became with each generation more polished and artificial. When at last a reaction set in, the impulse that led to the most momentous revolution in the history of English poetry came in large measure from the writings of three poets, each of whom drew his inspiration from lowland scenery—Cowper, Thomson, and Burns. The uplands, which include the border country of England and Scotland, produced the Border ballads, and the highlands of Western Argyleshire are portrayed in Macpherson's "Ossian"; while the Lake District, also mountainous, claims attention for its influence on the progress of national literature, for it was amidst its scenery that William Wordsworth was born and spent most of his long life. Towards the end of his interesting address Sir Archibald Geikie remarks:—"It is curious to remember that three of the poets whom I have singled out as illustrations of the influence of our lowland, upland, and highland scenery upon our literature have held up the geologist to ridicule. Cowper put that votary of science into the pillory among the irreligious crowd, about whose ears the poet loved to 'crack the satiric thong.' Wordsworth treated the geological enthusiast with withering scorn. Scott, with his characteristic good humour, only poked fun at him. It was reserved for a poet of our own day to look below the technical jargon of the schools, and to descry something of this wealth of new interest which the landscape derives from a knowledge of the history of its several parts. But Tennyson only entered a little way into this enlarged conception of nature. There remains a boundless field for some future poetic seer, who, letting his vision pierce into the past, will set before the eyes of men the inner meaning of mountain and glen."

THE twenty-sixth annual report of the Board of Directors of the Zoological Society of Philadelphia has been received. The number of visitors to the Gardens of the Society during the year covered by the report was 173,999. In addition to this, 125,000 free tickets were issued to the Board of Education for the admission of pupils of the public schools. The Society's collection of animals numbers 1019, of which 339 are mammals, 421 birds, 238 reptiles, and 21 batrachians. Among the additions to the collection were two young West Indian seals (*Monachus tropicalis*). Although the existence of a peculiar species of seal in the Caribbean Sea has been known for several centuries, no detailed description has been given of it until very recently, and no living specimens had been procured until a schooner was sent out last spring by a firm of merchants for the purpose of capturing some, which was finally effected on a small coral reef off the Campeachy coast of Yucatan. These animals were distributed among various zoological collections, and three were secured by Philadelphia. It was hoped that observations might be made upon the habits of this almost unknown species, but unfortunately, in all these cases, the animals were induced to take food with difficulty and in small quantity, and they lived

only a short time. The genus *Monachus* includes the present species and one other found in the waters of the Mediterranean, these seals being the only ones belonging to the *Phocidæ*, or the group without external ears, which are found in subtropical regions of the Atlantic. Referring to the death of a male orang belonging to the Society, it is noted that though it has more than once been pronounced by high authority to be anatomically impossible for the orang to maintain an erect attitude without touching some means of support, this animal was repeatedly observed walking about his cage in an absolutely erect position without having his hands in contact with any fixed object.

WRITING in the annual volume of the *Sitzungsberichte der physikalisch medicinischen Societät in Erlangen*, Prof. E. Wiedemann and Dr. G. C. Schmidt give some noteworthy observations on the electric properties of gases. In the first of their papers the authors discuss the absorption of electric oscillations by gases, and arrive at the somewhat remarkable result that gases which are excited to incandescence by electric discharges will absorb electric waves falling on them, even when they would not do so if unexcited; but the dark space surrounding the kathode is only feebly absorbent of such oscillations, thus behaving like a non-conductor. Prof. Wiedemann and Dr. Schmidt also discuss the effects of Goldstein's rays ("kanalstrahlen") on electric oscillations, and find that the oscillations emanating from a Lecher condenser are absorbed by gases which have been excited by these rays.

IN a second paper, Prof. Wiedemann and Dr. Schmidt discuss the view that the conduction of electricity through rarefied gases is an electrolytic phenomenon. This view is negatived by their present observations. In some cases, as with chloride, bromide and iodide of mercury, no products of electrolysis appeared at the electrodes; in other cases, where decomposition did take place, the amounts liberated were found not to follow Faraday's Law. In a further communication to the same journal, Dr. G. C. Schmidt discusses the relation between fluorescence and photo-electric susceptibility; the results of these observations do not altogether favour the hypothesis of Elster and Geitel as to a parallelism between the two phenomena.

SOME of the catalogues published by many photographic firms, besides containing useful information on photographic lenses, cameras, shutters, &c., are really works of art of no mean merit. We have just received the fourth edition of Messrs. Newman and Guardia's catalogue, which quite falls into this category if one examines the series of illustrated specimens of the work done with their so-called "N. and G." cameras. The beauty of these reproductions will be fully appreciated by all who peruse this book, the half-tone blocks having been produced by the Swan Electric Engraving Company.—Messrs. Ross, Ltd., have also forwarded to us their catalogues for the present year, containing a mine of information about lenses, cameras, &c., of every conceivable kind, and many other optical instruments which this firm manufactures.

IN the *Bollettino della Società Sismologica Italiana* (vol. iii. No. 8) a list of earthquakes observed in Greece during the year 1897 (January–June) is given by S. A. Papavasiliou, in continuation of the catalogue compiled by the author before his retirement from the observatory at Athens. The number of shocks recorded during the six months is about 130. Other papers are:—A new contour-map of the central crater of Etna, by A. Riccò; seismoscope with clock, by C. Guzzanti, describing an arrangement for starting mechanically a clock, previously set at a known time; seismology and palæography, by E. Oddone; notices of earthquakes recorded in Italy (May 23–June 11, 1897), by G. Agamennone, the most important being the Ionian Sea earthquake of May 28–29, and earthquakes of distant origin on May 23–24, 24–25, and June 3.

A NEW part (vol. ii. Isopoda, part ix. x.) of Prof. G. O. Sars' monograph on the "Crustacea of Norway" has just been issued by the Bergen Museum. The Munnopsidæ are concluded in this new part, which also contains descriptions of members of the tribe of Oniscoida, four families of which are represented in the fauna of Norway.

THE second volume of the Cape Photographic "Durchmusterung," by Dr. David Gill, F.R.S., and Prof. J. C. Kapteyn, has just been published as vol. iv. of the *Annals of the Cape Observatory*. The arrangement of the stars in the catalogue is precisely similar to that of vol. i., recently reviewed in these columns (p. 513). The new volume contains the positions of stars in the zones $-38°$ to $-52°$.

MR. T. CHALKLEY PALMER has an interesting note in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, on the peculiar movements of the diatom *Eunotia major*, which he considers to be connected with an actual process of assimilation or elimination of oxygen, and to be produced by special pseudopode-like organs; these he calls "coleopodia," and he believes them to be present also in other diatoms belonging to the Fragilarieæ.

THE fourth German edition of Dr. A. Classen's work on "Quantitative Chemical Analysis by Electrolysis" differs from the previous editions in several respects, among which may be mentioned the insertion of a section devoted to theory, and the addition of descriptions of various measuring instruments and electrolytic experiments. The revision was carried out with the assistance of Dr. W. Löb; and the authorised English translation of the revised and enlarged edition, prepared by Prof. W. H. Herrick and Dr. B. B. Boltwood, has been published by Messrs. J. Wiley and Sons (London: Chapman and Hall, Ltd.). The book is a more complete, scientific and logically arranged work than heretofore, and is altogether a useful manual on electro-chemical analysis. The illustrated account of the Electro-chemical Institute at Aachen, where Drs. Classen and Löb are at work, should lead to the foundation and equipment of similar institutions here for purposes of instruction and research in this most important branch of science. It should not be left to Germany to extend and apply the principles discovered by Davy and Faraday.

REPORTS of papers read before the Royal Society of Edinburgh regularly appear in the columns of NATURE shortly after the papers are read, so it is unnecessary to do more now than briefly refer to the papers which appear in their complete form in the *Transactions* of the Society for the sessions 1895–96, 1896–97. Among the subjects and authors of papers in the volumes are the following:—Observations on the phonograph, by Prof. J. G. M'Kendrick; the strains produced in iron, steel, and nickel tubes in the magnetic field, by Prof. C. G. Knott; the temperature variation of the magnetic permeability of magnetite, by Dr. E. H. Barton; the weather, influenza, and disease, by Dr. A. Lockhart Gillespie; torsional oscillations of wires, by Dr. W. Peddie; the meteorology of Edinburgh (two papers), by Mr. R. C. Mossman; some nuclei of cloudy condensation, by Mr. John Aitken (in this paper Mr. Aitken shows, by experiments on the effect of sunshine on the gases in the atmosphere, that it is possible for cloudy condensation to take place in the absence of dust); the fossil flora of the Yorkshire coal-field, by Mr. Robert Kidston; and the automatic linear transformation of a quadric, by Dr. Thomas Muir. The *Proceedings* of the Society (vol. xxii.) contain several papers by Lord Kelvin; notes on specimens of rock from the Antarctic Regions, by Sir Archibald Geikie; observations of instrumental disturbances at the Colaba Observatory during the Indian earthquake of June 12, by Mr. N. A. Moos; the velocity of graded actions, by Dr. James Walker, and other papers.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, presented by Captain C. C. Wyatt; three Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Colonel A. H. Maclean; two White-tailed Gnus (*Connochætes gnu*, ♂ ♀) from South Africa, presented by Mr. C. D. Rudd; a Cape Zorilla (*Ictonyx zorilla*), a Little Ichneumon (*Helogale parvula*), a Spotted Eagle Owl (*Bubo maculosus*) from South Africa, presented by Mr. J. E. Matcham; two South African Kestrels (*Tinnunculus rupicolus*) from South Africa, presented by Mr. C. Southy; a Naked-footed Owlet (*Athene noctua*), European, presented by the Hon. Mrs. Barrington; two Senegal Parrots (*Pæocephalus senegalus*) from West Africa, presented by Miss E. L. Barford; four Fieldfares (*Turdus pilaris*), a Black Guillemot (*Uria grylle*) from Christiansund, North Norway, presented by Dr. R. B. Sharp; an Indian Python (*Python molurus*) from India, presented by Mr. Percival F. Tuckett; a Four-lined Snake (*Coluber quatorlineatus*), European, presented by Mr. J. W. Temple; twelve Algerian Skinks (*Eumeces algeriensis*) from Algeria, presented by Mr. Robert S. Hunter; a Malabar Squirrel (*Sciurus maximus*, var. *dealbatus*) from India, two Forster's Ceratodus (*Ceratodus forsteri*) from Australia, deposited; a Crowned Partridge (*Rollolus cristatus*) from Malacca, four Common Cormorants (*Phalacrocorax carbo*) from Holland, two Cereopsis Geese (*Cereopsis novæ-hollandiæ*), two Forster's Ceratodus (*Ceratodus forsteri*) from Australia, purchased; three Triangular-spotted Pigeons (*Columba maculosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMETS NOW VISIBLE.—Last week it was noted in these columns that Mr. Coddington had discovered a comet in the position R.A. 16h. 24m. 45·9s., and Declination (South) 25° 14′ 20″. Circular (No. 7) of the *Centralstelle* gives the elements and ephemeris of the comet, based on the positions observed on June 11, 13 and 15, and calculated by Prof. A. Berberich. The former are as follows:—

T = 1898 August 4·478 Berlin M.T.

$$\left.\begin{array}{ll} \omega = & 206^\circ\ 8'5 \\ \Omega = & 73\ 58'7 \\ i = & 76\ 48'3 \end{array}\right\} 1898{\cdot}0$$

$\log q = 0{\cdot}31850$

As the comet is moving rapidly south, and has now a Declination (South) of about 32°, we do not give the ephemeris. This comet was independently discovered by Dr. W. Pauly in Bucharest on June 14.

We have received two telegrams from Kiel concerning another comet, Perrine (June 14). The former gives the observation made on June 14 at Lick mean time 15h. 16·0m., giving the position Right Ascension 3h. 29m. and Declination + 58° 36′, the latter showing the position to be Right Ascension 3h. 34m. 58s. and Declination + 58° 24′ 2″ at Lick mean time 14h. 12m. on June 15. A Circular (No. 5) from the *Centralstelle* gives us the elements and ephemeris calculated by Perrine and Aitken from the observations made on June 14, 15 and 16. These are:—

Elements.

T = 1898 August 17·40 Greenwich M.T.

$$\left.\begin{array}{ll} \omega = & 196^\circ\ 46' \\ \Omega = & 260\ 6 \\ i = & 69\ 42 \end{array}\right\} 1898{\cdot}0$$

$q = 0{\cdot}7418$

Ephemeris for 12h. Greenwich M.T.

1898.	R.A. h. m. s.	Decl. ° ′	Br.
June 20 ...	4 2 52 ...	+57 15 ...	1·18
24 ...	4 25 24 ...	55 56	
28 ...	4 48 48 ...	54 20	
July 2 ...	5 10 0 ...	+52 27 ...	1·72

The comet will thus gradually brighten as July is approached, but takes a somewhat southerly course.

Another Kiel telegram, dated June 18, tells us that Perrine found Wolf's comet on June 16, at 15h. 5·3m. Lick mean time, in position—

R.A. 2h. 16m. 19s., and Declination + 19° 42′ 44″.

Still another and last telegram from Kiel, dated June 19, informs that comet Giacobini was seen on June 18 at 13h. Nice mean time in the position of Right Ascension 20h. 36m. 30s. and Declination − 21° 14′ 0″.

THE 40-INCH YERKES REFRACTOR.—Prof. Barnard, writing in the *Astronomical Journal* (No. 436) with respect to a series of measures of the satellite of Neptune, gives an interesting account of the behaviour of the Yerkes telescope. Actual observation was not possible until the best season was essentially over, but it was found that even a part of this unfavourable weather permitted the power of the telescope to be tested. On one or two occasions, when observing double stars, he was able to use powers of several thousand diameters, and on one date he employed a power of 3750 with good success. The object-glass he finds entirely free from any form of ghost, and the definition is at times very good, showing, as he says, that "this last great work of Alvan Clark is one of his noblest monuments." The driving clock moves the great tube with such perfect steadiness that he was astonished at the result, and so stable is the mounting of the instrument that the effect of the clock, rewinding itself automatically at periods of 1h. 48m., does not in the least interfere with micrometer work. Very satisfactory also are the electrical contrivances at the eye end for clamping and slow motion; the clock takes up the tube upon the application of the electric clamp in Right Ascension perfectly instantaneously, and the slow movement is so exact that a star can be brought from the edge of the field and stopped instantly behind the micrometer-wire, the motion being about 1′ in 8 seconds. Prof. Barnard further mentions the ease with which the instrument can be handled; as an instance, he says that he placed the telescope on the west side of the pier in position of + 50° declination, and by means of the electric motors he moved it on the other side of the pier to the same Declination in 1m. 50s. An important addition to the dome is the wind-break. This consists of two curtains working on endless chains, one rising from the base of the slit, and the other passing through the zenith from the rear. With these, excepting at low altitudes and right in the face of the wind, the tube is always perfectly protected even on the windiest nights.

VARIABLE STARS OF SHORT PERIOD.—Prof. E. C. Pickering describes in a *Harvard College Observatory Circular* (No. 29) a very simple means of detecting variables whose periods are short if the observer is provided with a telescope mounted equatorially and a fairly good driving clock. The method is so simple and complete that it has probably been tried before, although, so far as we know, no mention of it has come under our notice. The idea is to expose a photographic plate in a telescope, the clock of which is working somewhat fast, and at intervals of ten and fifty minutes to alternately expose and cover the lens by an electrical attachment. Prof. Pickering describes one of the plates so exposed. An 8 × 10 plate was exposed in a telescope with a Cooke anastigmatic lens, aperture 2·6 cm. and focal length 33·3 cm. and eight successive images of each star were obtained in the period of about eight hours, The plate covered a region of about 33° square, and a portion of it, shown in the *Circular*, indicates the variable intensity of the images of the star U Cephei, while those of the neighbouring stars show no such variations.

On this scale forty plates would cover the whole sky from north to south pole, and Prof. Pickering proposes to undertake this work as soon as the best method of taking the plates has been determined. By the above plan it is hoped to secure a complete list of all variable stars of short period brighter than the ninth magnitude at maximum, whose variation exceeds half a magnitude, and whose period is less than a day. In such a sweep, probably, many other variable stars of longer period, and stars of the Algol type will be discovered.

The beauty of the above method lies in the simple equipment that is necessary to obtain results of considerable value. It will be noticed that the method is a differential one, clouds passing across the field of view during an exposure affecting all the photographic images alike.

THE OXFORD UNIVERSITY OBSERVATORY.—The twenty-third annual report of the visitors of the University Observatory appears in a recent number (June 14) of the *Oxford University Gazette*. The report refers to the period from June 1, 1897, to May 31, 1898, and exhibits the state of the observatory on the last-named day. One of the main points referred to by Prof. Turner in the report, is that of the necessity of completing the observatory by attaching to it a residence. This, he points out, is urgent, since it is most imperative that the official staff should be as near their work as possible when both routine observational work and students have to be dealt with. Prof. Turner refers to a very curious accident that occurred to the level belonging to the Barclay transit circle that is used for time determinations, which is well worth repeating. "The striding level, weighing 19 lbs., which was suspended over the instrument by means of a cord, pulley and counterpoise, fell (from its usual position when not in use near the roof) a distance of three or four feet on to the instrument, owing to the snapping of the cord. It was found the next morning standing upright, with its feet on the pivot covers as if in position for an observation. The blow had thus been received by the pivot covers, and no other part of the instrument had apparently been damaged or even struck. The brass-tube of the level itself was shattered, but the glass-tube inside was not broken!" Surely this is quite a unique accident?

The measurement and reduction of the plates for the Astrographic Catalogue seem to be proceeding apace, an average of 3951 measures of the star positions and magnitudes being made every week, the total number for the year being 205,443. The main result of the year's work is that the prospects of achieving the object aimed at are brighter than previously: this was, as Prof. Turner states, that by the middle of 1901 we may be ready to furnish, or demand, the positions and magnitudes of the brighter stars in zones + 24° to + 32° to the number of something like a quarter of a million. The speed at which these measures can be made, can be gathered from the statement that "whereas at first thirty or forty star-measures an hour was thought fair work, the more skilful can now measure 150 per hour or more." The new photographic transit circle has involved much experimental work, and is proceeding satisfactorily.

THE SUPPOSED VARIABLE Y AQUILÆ.—In the series of measures to determine the light curves of variable stars of short period north of −40° Declination with the meridian photometer, the curve of the star +10° 3787 was not found to be smooth. This star had previously been catalogued by Chandler as varying from 5·3 to 5·7 in a period of 4·986 days. It was also suspected by Gould, confirmed by Chandler 1894, and also by Yendell. Mr. Wendell has recently made some observations (*Harvard College Observatory Circular*, No. 30) with the photometer attached to the 15-inch equatorial telescope, on six nights in May last, eighty sittings being made each night, the comparison star employed being +10° 3784. The mean of the differences of magnitude showed very little variation, and, as Prof. Pickering states, fails to show any evidence of variation, since deviations of a tenth of a magnitude may be ascribed to errors of observation. Since it is "impossible to prove that the light of a star never changes, this star may still be an Algol variable with a short time of variation, or the period may be entirely wrong."

COMPANIONS OF ARGON.[1]

FOR many months past we have been engaged in preparing a large quantity of argon from atmospheric air by absorbing the oxygen with red-hot copper, and the nitrogen with magnesium. The amount we have at our disposal is some 18 litres. It will be remembered that one of us, in conjunction with Dr. Norman Collie, attempted to separate argon into light and heavy portions by means of diffusion, and, although there was a slight difference[2] in density between the light and the heavy portions, yet we thought the difference too slight to warrant the conclusion that argon is a composite substance. But our experience with helium taught us that it is a matter of the greatest difficulty to separate a very small portion of a heavy gas from a large admixture of a light gas; and it therefore appeared advisable to re-investigate argon, with the view of ascertaining whether it is indeed complex.

In the meantime, Dr. Hampson had placed at our disposal his resources for preparing large quantities of liquid air, and it was a simple matter to liquefy the argon which we had obtained by causing the liquid air to boil under reduced pressure. By means of a two-way stopcock the argon was allowed to enter a small bulb, cooled by liquid air, after passing through purifying reagents. The two-way stopcock was connected with mercury gas-holders, as well as with a Töpler pump, by means of which any part of the apparatus could be thoroughly exhausted. The argon separated as a liquid, but at the same time a considerable quantity of solid was observed to separate, partially round the sides of the tube, and partially below the surface of the liquid. After about 13 or 14 litres of the argon had been condensed, the stopcock was closed, and the temperature was kept low for some minutes in order to establish a condition of equilibrium between the liquid and vapour. In the meantime the connecting tubes were exhausted, and two fractions of gas were taken off by lowering the mercury reservoirs, each fraction consisting of about 50 or 60 cubic cm. These fractions should contain the light gas. In a previous experiment of the same kind a small fraction of the light gas had been separated, and was found to have the density 17·2. The pressure of the air was now allowed to rise, and the argon distilled away into a separate gas-holder. The white solid which had condensed in the upper portion of the bulb did not appear to evaporate quickly, and that portion which had separated in the liquid did not perceptibly diminish in amount. Towards the end, when almost all the air had boiled away, the last portions of the liquid evaporated slowly, and when the remaining liquid was only sufficient to cover the solid, the bulb was placed in connection with the Töpler pump, and the exhaustion continued until the liquid had entirely disappeared. Only the solid now remained, and the pressure of the gas in the apparatus was only a few millimetres. The bulb was now placed in connection with mercury gas-holders, and the reservoirs were lowered. The solid volatilised very slowly, and was collected in two fractions, each of about 70 or 80 cubic cm. Before the second fraction had been taken off, the air had entirely volatilised, and the jacketing tube had been removed. After about a minute, on removing the coating of snow with the finger, the solid was seen to melt, and volatilise into the gas-holder.

The first fraction of gas was mixed with oxygen, and sparked over soda. After removal of the oxygen with phosphorus it was introduced into a vacuum-tube, and the spectrum examined. It was characterised by a number of bright red lines, among which one was particularly brilliant, and a brilliant yellow line, while the green and the blue lines were numerous, but comparatively inconspicuous. The wave-length of the yellow line, measured by Mr. Baly, was 5849·6, with a second-order grating spectrum. It is, therefore, not identical with those of sodium, helium, or krypton, all of which equal it in intensity. The wave-lengths of these lines are as follows:—

Na (D_1)	5895·0
Na (D_2)	5889·0
He (D_3)	5875·9
Kr (D_4)	5866·5
Ne (D_5)	5849·6

The density of this gas, which we propose to name "neon" (new), was next determined. A bulb of 32·35 cubic cm. capacity was filled with this sample of neon at 612·4 mm. pressure, and at a temperature of 19·92° it weighed 0·03184 gram.

Density of neon ... ... 14·67

This number approaches to what we had hoped to obtain. In order to bring neon into its position in the periodic table, a density of 10 or 11 is required. Assuming the density of argon to be 20, and that of pure neon 10, the sample contains 53·3 per cent. of the new gas. If the density of neon be taken as 11, there is 59·2 per cent. present in the sample. The fact that the density has decreased from 17·2 to 14·7 shows that there is a considerable likelihood that the gas can be further purified by fractionation.[1]

[1] "On the Companions of Argon." By William Ramsay, F.R.S., and Morris W. Travers. Paper read at the Royal Society, June 16.

[2] Density of lighter portion, 19·93; of heavier portion, 20·01 (Roy. Soc. *Proc.*, vol. 60, p. 206).

[1] June 21.—After a preliminary fractionation, the density has been still further reduced to 13·7.

That this gas is a new one is sufficiently proved, not merely by the novelty of its spectrum and by its low density, but also by its behaviour in a vacuum-tube. Unlike helium, argon, and krypton, it is rapidly absorbed by the red-hot aluminium electrodes of a vacuum-tube, and the appearance of the tube changes, as pressure falls, from carmine red to a most brilliant orange, which is seen in no other gas.

We now come to the gas obtained by the volatilisation of the white solid which remained after the liquid argon had boiled away.

When introduced into a vacuum-tube it showed a very complex spectrum, totally differing from that of argon, while resembling it in general character. With low dispersion it appeared to be a banded spectrum, but with a grating, single bright lines appear, about equidistant through the spectrum, the intermediate space being filled with many dim, yet well-defined lines. Mr. Baly has measured the bright lines, with the following results. The nearest argon lines, as measured by Sir William Crookes, are placed in brackets:—

Reds very feeble, not measured.		
First green band, first bright line	5632·5	(5651 : 5619)
First green band, second bright line	5583·0	(5619 : 5567)
First green band, third bright line	5537·0	(5557 : 5320)
Second green band, first bright line	5163·0	(5165)
Second green band, second bright line ...	5126·5	(5165 : 5065) brilliant.
First blue band, first bright line	4733·5	(4879)
First blue band, second bright line	4711·5	(4701)
Second blue band, first bright line	4604·5	(4629 : 4594)
Third blue band (first order)	4314·0	(4333 : 4300)
Fourth blue band (second order)	4213·5	(4251 : 4201)
Fifth blue band (first order), about	3878	(3904 : 3835)

The red pair of argon lines was faintly visible in the spectrum.

The density of this gas was determined with the following results:—A globe of 32·35 c.c. capacity, filled at a pressure of 765·0 mm., and at the temperature 17·43°, weighed 0·05442 grams. The density is therefore 19·87. A second determination, made after sparking, gave no different result. This density does not sensibly differ from that of argon.

Thinking that the gas might possibly prove to be diatomic, we proceeded to determine the ratio of specific heats:—

Wave-length of sound in air	34·18
,, ,, gas	31·68
Ratio for air	1·408
,, gas	1·660

The gas is therefore monatomic.

Inasmuch as this gas differs very markedly from argon in its spectrum, and in its behaviour at low temperatures, it must be regarded as a distinct elementary substance, and we therefore propose for it the name "metargon." It would appear to hold the position towards argon that nickel does to cobalt, having approximately the same atomic weight, yet different properties.

It must have been observed that krypton does not appear during the investigation of the higher-boiling fraction of argon. This is probably due to two causes. In the first place, in order to prepare it, the manipulation of air, amounting to no less than 60,000 times the volume of the impure sample which we obtained was required; and in the second place, while metargon is a solid at the temperature of boiling air, krypton is probably a liquid, and therefore more easily volatilised at that temperature. It may also be noted that the air from which krypton has been obtained had been filtered, and so freed from metargon. A full account of the spectra of those gases will be published in due course by Mr. E. C. C. Baly.

University College, London.

ON THE STABILITY OF THE SOLAR SYSTEM.[1]

ALL persons who interest themselves in the progress of celestial mechanics, but can only follow it in a general way, must feel surprised at the number of times demonstrations of the stability of the solar system have been made.

Lagrange was the first to establish it, Poisson then gave a new proof; afterwards other demonstrations came, and others will still come. Were the old demonstrations insufficient, or are the new ones unnecessary?

The astonishment of these persons would doubtless be increased if they were told that perhaps some day a mathematician would show by rigorous reasoning that the planetary system is unstable. This may happen, however; there would be nothing contradictory in it, and the old demonstrations would still retain their value.

The demonstrations are really but successive approximations; they do not pretend to strictly confine the elements of the orbits within narrow limits that they may never exceed, but they at least teach us that certain causes, which seemed at first to compel some of these elements to vary fairly rapidly, only produce in reality much slower variations.

The attraction of Jupiter, at an equal distance, is a thousand times smaller than that of the sun; the disturbing force is therefore small; nevertheless, if it always acted in the same direction, it would not fail to produce appreciable effects. But the direction is not constant, and this is the point that Lagrange established. After a small number of years two planets, which act on each other, have occupied all possible positions in their orbits; in these diverse positions their mutual action is directed sometimes one way, sometimes in the opposite way, and that in such a fashion that after a short time there is almost exact compensation. The major axes of the orbits are not absolutely invariable, but their variations are reduced to oscillations of small amplitude about a mean value.

This mean value, it is true, is not rigorously fixed, but the changes which it undergoes are extremely slow, as if the force which produces them was not a thousand times, but a million times smaller than the solar attraction. One may, therefore, neglect these changes, which are of the order of the square of the masses. As to the other elements of the orbits, such as the eccentricities and the inclinations, these may acquire round their mean value wider and slower oscillations, to which, however, limits may easily be assigned.

This is what Lagrange and Laplace pointed out, but Poisson went further. He wished to study the slow changes experienced by the mean values—changes to which I have already referred, and which his predecessors had at first neglected. He showed that these changes reduced themselves again to periodic oscillations round a mean value which is only liable to variations a thousand times slower.

This was a step further, but it was still only an approximation. Since then further advance has been made, but without arriving at a complete definitive and rigorous demonstration. There is a case which seemed to escape the analysis of Lagrange and Poisson. If the two mean movements are commensurable among themselves, at the end of a certain number of revolutions, the two planets and the sun will be found in the same relative situation, and the disturbing force will act in the same direction as at first. The compensation, to which I have referred, will not any more be produced, and it might be feared that the effects of the disturbing forces will end by accumulating and becoming very considerable. More recent works, amongst others those of Delaunay, Tisserand, and Gyldén, have shown that this accumulation does not actually occur. The amplitude of the oscillations is slightly increased, but remains, nevertheless, very small. This particular case, therefore, does not escape the general rule.

The apparent exceptions have not only been dispensed with, but the real reasons of these compensations, which the founders of celestial mechanics had observed, have been better explained. The approximation has been pushed further than was done by Poisson, but it is still only an approximation.

It can be shown, in certain particular cases, that the elements of the orbit of one planet will return an infinite number of times to very nearly the initial elements, and that is also probably true in the general case; but it does not suffice. It should be shown

[1] Translation of a paper, by M. H. Poincaré, in the *Annuaire du Bureau des Longitudes*, 1898.

that these elements will not only regain their original values, but that they will never deviate much from them.

This last demonstration has never been given in a definite manner, and it is even probable that the proposition is not strictly true. The statement that is true, is that the elements can only deviate extremely slowly from their original values, and this after a long interval of time. To go further, and affirm that these elements will remain not for *a very long time*, but *always* confined within narrow limits, is what we cannot do.

But the problem does not take this form.

The mathematician only considers fictitious bodies, reduced to simple material points, and subject to the exclusive action of their mutual attractions, which rigorously follows Newton's law. How would such a system behave, would it be stable? This is a problem which is as difficult as it is interesting for an analyst. But it is not one which actually occurs in nature. Real bodies are not material points, and they are subject to other forces than the Newtonian attraction. These complementary forces ought to have the effect of gradually modifying the orbits, even when the fictitious bodies, considered by the mathematician, possess absolute stability.

What we must ask ourselves then is, whether this stability will be more easily destroyed by the simple action of Newtonian attraction or by these complementary forces.

When the approximation shall be pushed so far that we are certain that the very slow variations, which the Newtonian attraction imposes on the orbits of the fictitious bodies, can only be very small during the time that suffices for the complementary forces to destroy the system; when, I say, the approximation shall be pushed as far as that, it will be useless to go further, at least from the point of view of application, and we must consider ourselves satisfied.

But it seems that this point is attained; without quoting figures, I think that the effects of these complementary forces are much greater than those of the terms neglected by the analysts in the most recent demonstrations on stability.

Let us see which are the most important of these complementary forces. The first idea which comes to mind is that Newton's law is, doubtless, not absolutely correct; that the attraction is not rigorously proportional to the inverse square of the distances, but to some other function of them. In this way Prof. Newcomb has recently tried to explain the movement of the perihelion of Mercury. But it is soon seen that this would not influence the stability. It is true, according to a theory of Jacobi, that there would be instability if the attraction were inversely proportionate to the cube of the distance. It is easy by rough reasoning to account for this; with such a law, the attraction would be great for the small distances and extremely feeble for great distances. If therefore, for any reason, the distance of one of the planets from the central body were to increase, the attraction would diminish rapidly until it would not be capable of retaining the planet in its orbit. But that only takes place with laws very different from that of the square of the distances. All laws, near enough to that of Newton's to be acceptable, are equivalent from the stability point of view.

But there is another reason which opposes the theory that bodies move without ever deviating much from their original orbits. According to the second law of thermodynamics, known by the name of Carnot's Principle, there is a continual dissipation of energy, which tends to lose the form of mechanical work and to take the form of heat. There exists a certain function called entropy, which it is unnecessary to define here; entropy, according to this second law, either remains constant or diminishes, but can never increase. When once it has deviated from its original value, which it can only do by diminishing, it can never return again, as it would have to increase. The world consequently could never return to its original state, or to a slightly different state, so soon as its entropy has changed. It is the contrary of stability.

But the entropy diminishes every time that an irreversible phenomenon takes place, such as the friction of two solids, the movement of a viscous liquid, the exchange of heat between two bodies of different temperatures, the heating of a conductor by the passage of a current. If we observe, then, that there is not in reality a reversible phenomenon, that the reversibility is only a limiting case—an ideal case which nature can more or less approach but can never attain—we shall be led to conclude that instability is the law of all natural phenomena.

Are the movements of the heavenly bodies the only ones to escape? One might believe it by seeing that they move in a vacuum, and are thus free from friction. But is the interplanetary vacuum absolute, or do the bodies move in an extremely attenuated medium of which the resistance is extremely feeble, but nevertheless is capable of offering resistance?

Astronomers have only been able to explain the movement of Encke's comet by supposing the existence of such a medium. But the resisting medium which would account for the anomalies of this comet, if it exists, is confined to the immediate neighbourhood of the sun. This comet would penetrate it; but at the distances at which the planets are, the action of this medium would cease to make itself felt, or would become much more feeble. As an indirect effect, it would accelerate the movements of the planets; losing energy, they would tend to *fall* on the sun, and by reason of Kepler's third law the duration of the revolution would diminish at the same time as the distance to the central body. But it is impossible to form an idea of the rapidity with which this effect would be produced, as we have no notion of the density of this hypothetical medium.

Another cause to which I am now going to refer must have, it seems, a more rapid action. It had for some time been imagined, but was first more especially brought to light by Delaunay, and afterwards by G. Darwin.

The tides, which are direct consequences of celestial movements, could only stop if these movements ceased. But the oscillations of the seas are accompanied by friction, and consequently produce heat. This heat can only be borrowed from the energy which produces the tides—that is to say, to the *vis viva* of the celestial bodies. We can therefore foresee that, for this reason, this *vis viva* is gradually dissipated, and a little reflection will enable us to understand by what mechanism. The surface of the seas, raised by the tides, presents a kind of wave. If high tide took place at the time of the meridian passage of the moon, this surface would be that of an ellipsoid, the axis of which would pass through the moon. Everything would be symmetrical in relation to this axis, and the attraction of the moon on this wave could neither slow down nor accelerate the terrestrial rotation. This is what would happen if there were no friction; but in consequence of this friction, high tide is late on the moon's meridian passage; symmetry ceases; the attraction of the moon on the wave no longer passes through the centre of the earth, and tends to slow down the rotation of our globe.

Delaunay estimated that, for this cause, the length of the sidereal day increases by one second in a hundred thousand years. It is thus he wished to account for the secular acceleration of the moon's motion. The lunation would seem to us to become shorter and shorter, because the unit of time to which we ascribed it, the day, would become longer and longer.

Whatever we may think of the figures given by Delaunay, and the explanation which he proposes for the anomalies of the moon's movement, it is difficult to dispute the effect produced by the tides.

It is just this that may help us to understand a well-known but very surprising fact. It is known that the period of rotation of the moon is exactly equal to that of its revolution; in such a way that, if there were seas on this body, they would have no tides—at least, tides due to the attraction of the earth; because for an observer situated at a point on the surface of the moon, the earth would be always at the same height above the horizon. It is also known that Laplace tried to explain this curious coincidence. How can the two velocities be *exactly* the same? It is exceedingly improbable that this strict equality is due to mere chance. Laplace supposes that the moon has the form of an elongated ellipsoid; this ellipsoid behaves like a pendulum, which would be in equilibrium when the major axis is directed along the line joining the centres of the two bodies.

If the *initial* velocity of rotation differs slightly from that of revolution, the ellipsoid will oscillate about its position of equilibrium without ever deviating much from it. A pendulum which has received a slight impetus behaves in this way. The *mean* velocity of rotation is then exactly the same as that of the position of equilibrium round which the major axis oscillates; it is, therefore, the same as that of the straight line which joins the centres of the two bodies. It is therefore strictly equal to the velocity of revolution.

If, on the contrary, the initial velocity differs considerably from the velocity of revolution, the major axis will not oscillate any more round its position of equilibrium, like a pendulum which under a strong impulse describes a complete circle.

It suffices, therefore, that the velocity of revolution should be

almost equal to the *initial* velocity of rotation, in order that it may be exactly equal to the *mean* velocity of rotation. A strict equality being no longer necessary, the paradox does not exist any more. The explanation is nevertheless incomplete. What is the reason of this approximate equality, of which the probability is no longer zero, it is true, but still very small? And, especially, why does not the moon undergo slight oscillations about its position of equilibrium (if we eliminate, of course, its numerous librations, due to other well-known causes)? These oscillations must originally have existed; they must have become extinct by a kind of friction, and everything tends to make us believe that the mechanism of this friction is that which I have just analysed with respect to the ocean tides.

When the moon was not yet solid, and formed a fluid in the form of a spheroid, this spheroid must have experienced enormous tides, by reason of the proximity of the earth and of its mass. These tides could only have ceased when the oscillations became almost entirely extinct.

It seems that Jupiter's satellites, and the two planets nearest the sun, Mercury and Venus, have also a rotation, the duration of which is the same as that of their revolution; it is doubtless for the same reason.

It might be thought that this tidal action has no connection with our subject. I have as yet only spoken of rotations, and in the studies relative to the stability of the solar system the movements of translation are only dealt with; but a little attention shows that the same action makes itself equally felt on the latter.

We have just seen that the attraction of the moon on the earth does not act exactly through the centre of the earth. The attraction of the earth on the moon, which is equal and exactly opposite, would not pass either through this centre; that is to say, through the focus of the lunar orbit. A disturbing force is the result, very small in reality, but sufficient to make the moon increase in energy. The active force of translation thus gained by the moon is evidently smaller than that of rotation, lost by the earth; because a part of the energy must be transformed into heat in consequence of the friction engendered by the tides. The period of revolution of the moon lasting about twenty-eight sidereal days, a very simple calculation shows that this body gains twenty-eight times less *vis viva* than the earth loses.

I have already explained the action of a resisting medium; I have shown how, by making the planets lose energy, their movements are accelerated; on the contrary the action of the tides, by increasing the energy of the moon, retards its movements; the month lengthens therefore as well as the day. Now if this cause acts alone, what is the final state towards which the system will tend? Obviously this action would only stop when the tides have ceased—that is to say, when the rotation of the earth would have the same duration.

This is not all: in the final state the orbit of the moon must have become circular. If it were otherwise, the variations of the distance of the moon to the earth would suffice to produce tides. As the movement of rotation would not have changed, it would be easy to calculate what angular velocity would be common to the earth and to the moon. One finds that, at the limit, the month, like the day, would last about sixty-five of our actual days.

Such would be the final state if there were no resisting medium, and if the earth and the moon existed alone.

But the sun also produces tides, the attraction of the planets likewise produces them on the sun. The solar system therefore would tend to a condition in which the sun, all the planets and their satellites, would move with the same velocity round the same axis, as if they were parts of one solid invariable body. The final angular velocity would, on the other hand, differ little from the velocity of revolution of Jupiter. This would be the final state of the solar system if there were not a resisting medium; but the action of this medium, if it exists, would not allow such a condition to be assumed, and would end by precipitating all the planets into the sun.

It must not be thought that a solid globe which was not covered by seas would, by the absence of tides, find itself free from actions analogous to those just mentioned, even by admitting that the solidification had reached the centre of the globe. This body, which we suppose solid, would not on that account be an invariable one; such bodies only exist in text-books on rational "mechanics." It would be elastic and be subject, by the attraction of neighbouring celestial bodies, to deformations analogous to tides and of the same order of magnitude.

If the elasticity were perfect, these deformations would occur without loss of work, and without the production of heat. But perfectly elastic bodies do not exist. There would be in consequence development of heat, which would take place at the expense of the energy of rotation and translation of the bodies, and which will produce absolutely the same effects as the heat engendered by the friction of the tides.

This is not all: the earth is magnetic, and very probably the other planets and the sun are the same. The following well-known experiment is one which we owe to Foucault: a copper disc rotating in the presence of an electromagnet suffers a great resistance, and becomes heated when the electromagnet is brought into action. A moving conductor in a magnetic field is traversed by induction currents which heat it; the produced heat can only be derived from the *vis viva* of the conductor. We can therefore foresee that the electrodynamic actions of the electromagnet on the currents of induction must oppose the movement of the conductor. In this way Foucault's experiment is explained. The celestial bodies must undergo an analogous resistance because they are magnetic and conductors.

The same phenomenon, though much weakened by the distance, will therefore be produced; but the effects, being produced always in the same direction, will end by accumulating; they add themselves, besides, to those of the tides, and tend to bring the system to the same final state.

Thus the celestial bodies do not escape Carnot's law, according to which the world tends to a state of final repose. They would not escape it, even if they were separated by an absolute vacuum. Their energy is dissipated; and although this dissipation only takes place extremely slowly, it is sufficiently rapid that one need not consider terms neglected in the actual demonstrations of the stability of the solar system.

ON THE USE OF METHYLENE BLUE AS A MEANS OF INVESTIGATING RESPIRATION IN PLANTS.

IT has long been known that methylene blue is capable of being decolorised by reducing agents, and the object of the present communication is to point out its use as a means of demonstrating in a striking manner the reducing power possessed either by living protoplasm or at any rate by substances intimately associated with the exercise of its vitality. Its employment is not new to animal physiologists, but botanists appear not to have recognised the possibilities latent in the method, perhaps because some ten years ago Pfeffer ("Oxydationsvorgänge in Lebenden zellen") stated that although fermenting yeast would decolorise the blue solution, green plants would not do so. Doubtless this was true under the conditions of Pfeffer's experiments, but nevertheless many green plants are, as a matter of fact, found to give admirable results.

If germinating seedlings of barley or peas be placed in test tubes filled with a 0·0005 per cent. solution of methylene blue, which has been boiled in order to expel air, it will be found that in the course of a few hours the liquid around them will have lost its colour. The most striking way of performing the experiment is to suspend the peas in the solution, then a decolorised zone is formed between the upper and lower parts of the liquid, each of which still retain its blue colour. Gradually the clear zone extends until the entire mass of the liquid, except just at the surface where it is in contact with the air, becomes decolorised. At first the radicles of the seedlings are strongly stained; they finally again become white.

If some of the decolorised liquid be drawn off by means of a pipette, and shaken up with air, the blue tint speedily returns. If some of the seedlings be removed from the now colourless liquid, and be rinsed in boiled water and then exposed to the air, they soon become blue, and the stain gradually extends into the internal tissues as these become gradually aerated. The "development" of the blue can readily be seen in sections, quickly made, under the microscope.

Cress seedlings are far more active than either barley or peas, just as would have been expected from the relations which they exhibit towards oxygen.

But perhaps the most remarkable results are those obtained from a plant like *Chara*. This alga is suspected to possess peculiar properties in regard to its connection with

oxygen (*Annals of Botany*, vol. x. p. 288), and I have since ascertained in several ways that the plant is nearly as greedy for oxygen as are many seedlings. A branch of *Chara* placed in the methylene blue and *put in the dark*, will decolorise the surrounding liquid in a few hours; but if the tube containing it be exposed to the action of bright daylight the colour soon returns when the plant is alive, owing to the evolution of oxygen consequent on its splitting up the carbon dioxide which has been evolved by it, and which has been accumulating in the water, during the plant's stay in darkness. (Of course it is hardly necessary to state that the carbon dioxide is not itself the cause of the loss of colour in the liquid.) The experiment can be repeated several times with the same *Chara* plant, and we have succeeded in keeping it alive (as proved by the continuance of the protoplasmic movement) for four days. Naturally if the experiment is performed in continuous daylight no decoloration is effected.

Many other plants fail to give such quick results; thus *Elodea* requires about two days in darkness to obtain the reaction. All the plants experimented on give a result much more quickly if they have previously been starved of oxygen. And this indicates that under these conditions, as also under those of the experiments above described, the oxygen is not directly utilised either by the protoplasm, or some of the normal combustible bodies present in the cell, but by some dissociation product formed during the metabolic activity of the protoplasm. Of course decoloration of the blue does not occur when the plants are exposed to the action of free oxygen; this element can then be obtained more cheaply than by reducing the aniline dye. But this is not the place in which to discuss the meaning of the reaction or the nature of the substance which primarily reduces the methylene blue. The facts have been arrived at during an investigation, which is still proceeding, into the respiratory processes of plants. The method here detailed is, however, so simple, and seems likely to prove useful to teachers and others as a demonstration-experiment, that it appeared worth while to make it generally known. J. B. FARMER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In connection with the extracts printed last week (p. 165) from the reports of the delegates of the University Museum, referring to the want of accommodation and equipment for research in certain branches of science, it may be worth while directing attention to the leading article in *Literature* of June 11, regretting that little original work is being done in the domain of letters. The opinion is expressed that the Royal Commission which sat on the Universities rather more than twenty years ago, "made Oxford and Cambridge much more effective places for teaching and examining than they had been before, while at the same time it helped to ruin them as places for study." The leader concludes with the words:—"Englishmen are by nature somewhat too much inclined to look for an immediate advantage; to bring all things to a common-sense, even a commercial, test; to distrust theory; to despise action for an abstract end. One of the functions of a University is to keep alive a higher faith by giving an example of thorough and devoted work done without a commercial object. Our Universities, as they are at present managed, do no such thing."

The research degree of Bachelor of Science was conferred upon Mr. A. E. Tutton in Congregation on June 16. Mr. Tutton is the first recipient of a degree for research in natural science or natural philosophy, the only other research degree yet conferred being for mathematical work. In order to qualify for the degree eight terms must be kept, and one or more original theses presented. Mr. Tutton presented two theses—one his paper on the crystallography of the selenates of potassium, rubidium and cæsium, and the other on the new interference dilatometer exhibited by him at the recent conversazioni of the Royal Society. The B.Sc. research degree ranks with the B.C.L. immediately after the M.A. degree, and before the B.A. degree. It is hoped that, by requiring a high standard of qualification for the new degree, research will be encouraged, and the scientific work of the University will be increased in value and amount.

CAMBRIDGE.—Among the ten recipients of honorary degrees on June 15 were the Italian Ambassador (General Ferrero) and Mr. F. C. Penrose. General Ferrero early distinguished himself in mathematics, and, after an active military career, he became connected with the military and geographical Institute of Florence, editing all its publications from 1873 to 1893, and being at its head from 1885 to 1894. He organised the general topographical and cadastral survey of Italy, which led to the publication of important maps of the country, in the preparation of which valuable aid was derived from photography. In 1883 General Ferrero was made a Member of the Accademia dei Lincei, and in 1892 a Senator of Italy. Since 1874 he has taken an important part in the International Commission for the measurement of the earth's surface, and in this respect (amongst others) he has a European reputation.

Mr. Penrose has not only made valuable contributions to archæology, but also to astronomy, and his papers on the orientation of Greek temples exhibit the rare combination of archæological and astronomical knowledge.

The following are the speeches delivered by the Public Orator, Dr. Sandys, in presenting General Ferrero and Mr. Penrose for the honorary degree of LL.D. and Litt.D. respectively:—

Olim in hoc ipso loco Italiae legatum belli et pacis artibus illustrem salutavimus; hodie eiusdem adiutorem atque adeo successorem insignem non minus libenter salutamus. In Academia Taurinensi scientia mathematica excultus, et rei militaris et geographiae studiis deditus, Italiae toti accurate dimetiendae et describendae summa cum laude est praepositus. Huic imprimis debemus regionum Italiae tabulas depictas, partim lucis ipsius auxilio in lucem emissas; hunc non modo Linceorum Academia Romana sociis suis, sed etiam Italia tota senatoribus suis merito adscripsit; huius fama ultra patriae fines a se ipso tam diligenter descriptos etiam in alias Europae partes latissime diffusa est. Asiae regiones pulcherrimae (Vergilio si credimus) Italiae cum laudibus certare nequeunt; Europae gentes maximae Italiae legatum insignem certatim laudant. Belli certe et pacis artes feliciter consociatae sunt Italiae in legato illustri, ANNIBALE FERRERO.

Hodie reducem salutamus alumnum nostrum qui abhinc annos fere septem et quinquaginta Thamesis inter undas e certamine nautico cum Oxoniensibus commisso semel tantum victus, plus quam semel victor evasit. Olim Academiae nomine in Italiam et Graeciam missus, de Atheniensium templis opus egregium edidit, in quo Parthenonis et columnas et epistylium columnis impositum lineis non rectis sed leviter curvatis contineri primus omnium ostendit, et ordinis Dorici maiestatem artificio tam minuto adiuvari demonstravit. Idem nuper de templis Graecis ad stellas quasdam orientes conversis ingeniose disputavit. Illud vero felicitatis conspicuae documentum Nestori nostro contigit, quod et Athenis et Londinii architecturae studiis diu deditus, non modo Sancti Pauli ecclesiae cathedralis in culmine sed etiam Iovis Olympii columnarum in fastigio solus omnium mortalium constitit. Viro ad tantam altitudinem evecto non sine reverentia quadam in hoc templo honoris lauream nostram laeti decernimus.

Duco ad vos Collegii Magdalenae socium, Britannorum Scholae Archaeologicae Atheniensi et Regio Architectorum Instituto nuper praepositum, FRANCISCUM CRANMER PENROSE.

THE vote of 8,520,175*l.*, for public elementary education in England and Wales, was passed by the Committee of Supply of the House of Commons on Friday. To this sum of money, contributed towards elementary education by the Imperial Government, must be added the sums derived from voluntary subscriptions and the rates. Last year the former amounted to 845,000*l.*, and the latter to 2,325,801*l.* There is no reason to believe that in the coming year these sums will substantially decrease; therefore it may be assumed that in the coming financial year a total sum of no less than 11,690,762*l.* will be spent by England and Wales upon elementary education.

THE annual Commencement at Columbia University on June 8 was noteworthy as the first to be held in the new and permanent home of the University on Morningside Heights. The number of degrees conferred was greater than on any previous occasion, amounting to 485 in cause, and four honorary. An unusual feature was the presentation of the Loubat prizes for the best works on the history, geography, archæology, ethnology or numismatics of North America. These prizes, amounting to 1000 dollars for the first and 400 dollars for the second, are to be awarded every five years, beginning with the present year; and are not to be less than the amounts named, but may hereafter exceed those amounts. The first prize was awarded to William Henry Holmes, for his book

on "Stone Implements of the Potomac-Chesapeake Tide-water Provinces." The second prize was awarded to Dr. Franz Boas, for his work on "The Social Organisation and Secret Societies of the Kwakiutl Indians." Honourable mention was made of work by Dr. Carl Lumholtz, Mr. Frank H. Cushing, and Mr. Walter Hoffman, of America; and Mr. Alfred P. Maudslay, of London.

SCIENTIFIC SERIALS.

American Journal of Science, June.—A theory to explain the stratification of the electric discharge in Geissler tubes, by H. V. Gill, S.J. The phenomenon of stratification is a form of Kundt's experiment in which the heaps of powder which accumulate at the nodes are replaced by the strata of molecules between which the discharge is taking place in a luminous form.—Orthoclase as a gangue mineral in a fissure vein, by Waldemar Lindgren. During the examination of Silver City mining district, in southern Idaho, a vein was encountered containing a gangue of unusual character, consisting of quartz and orthoclase, the latter sometimes preponderating. It occurs as large, irregular milk-white grains, intergrown with vein quartz. This occurrence, together with various other forms, demonstrates the aqueous origin of the mineral. The analysis indicates typical adularia. The artificial production of orthoclase in the wet way, by heating powdered muscovite with a solution of potassium silicate, has a direct bearing upon its natural occurrence. The reason why orthoclase is not more frequently found on mineral veins lies possibly in the abundant presence of carbon dioxide in thermal waters, which would rapidly attack orthoclase and form more stable compounds, such as muscovite or sericite.—Notes on rocks and minerals from California, by H. W. Turner. The rocks discussed include a peculiar quartz-amphibolite-diorite, a new amphibole-pyroxene rock, a quartz-alunite rock, gold ores containing tellurium, selenium, and nickel, and gravels containing zircons.—A psychrometer applicable to the study of transpiration, by Robert G. Leavitt. The psychrometer consists of four nickel-plated tubes which can be kept at various temperatures by a mixture of hot and cold water. The dew point is indicated immediately by noting which of the tubes bears a deposit, and by varying the temperatures within narrow limits it may be found within 0·1° C. The apparatus was employed to determine the effect of light on the transpiration of plants, and a decided fall of the dew point was noticed as accompanying a diminution of light.—Comments on *Bulletin* No. 21, "Solar and terrestrial magnetism in their relations to meteorology," by F. H. Bigelow. The *Bulletin* attempts to overthrow two positions held in terrestrial magnetism: (1) that the sun is not a magnetic body because it is too hot, and (2) that the variations of the terrestrial magnetic field can be accounted for by electric currents in the cirrus cloud region. The earth is immersed in an external magnetic field of such a direction and strength as to make the inference necessary that its seat is in the sun. Else it will be necessary to assert that the earth's changes are sufficiently strong to disturb the sun's state, which is absurd.

Bulletin of the American Mathematical Society, May.—Concise abstracts are given of nine papers read at the third regular meeting of the Chicago Section of the Society, held on April 9. At the afternoon meeting Prof. Michelson exhibited the workings of his new harmonic analyser, a description of which was published in the *Philosophical Magazine* for January 1898.—Prof. M. Bôcher finishes his paper on the theorems of oscillation of Sturm and Klein. In the present portion Prof. Bôcher proves two simple theorems of Sturm's, and uses these to throw Sturm's theorem of oscillation into a slightly generalised form; he then proves Klein's theorem in a very general form. He proposes, in a subsequent paper, to come back to some more general cases which do not seem to present any serious difficulty.—The construction of special regular reticulations on a closed surface, by Prof. H. S. White, was read, in part, at the January 1897 meeting of the Society, and in final form at the recent April (30) meeting. The reticulations here discussed are called regular for two reasons: the number of termini of edges (r) assembled in one vertex is the same for all vertices (V) of the reticulation, and the number of edges (s) in the boundary of a face (F) is the same for all faces. The writer remarks that the regularity of these reticulations is not the same as that defined by Dyck and Klein in function-theoretic investigations; the two definitions overlap, but neither includes the other. The points discussed are (1) the mutual derivations of two dual reticulations from each other (dual when r, s, V, F of the first are equal respectively to s', r', F', V' of the second, and when each face of the one corresponds to a vertex of the other in such a way that the succession of vertices about each face corresponds exactly to the succession of faces about the corresponding vertex). (2) Two processes for multiplying the number of vertices or faces; and (3) the dissection of a Riemann surface into a fundamental polygon.—Dr. L. E. Dickson, in systems of simple groups derived from the orthogonal group, continues previous work (*Bulletin*, February number).—A proof of the theorem $\frac{d^2u}{dxdy} = \frac{d^2u}{dydx}$ follows, by Mr. J. K. Whittemore (read at the April meeting). This is short and neat.—Miss Frances Hardcastle contributes an interesting article entitled, "Some observations on the modern theory of point groups," in which she indicates some of the converging lines of the German and Italian work. In her first section she discusses some of the technical terms, and in the second section she starts from the Riemann-Roch equations by the suggestion of certain lines of inquiry which may prove useful in the classification of algebraic curves. A useful bibliography is appended.—A note on contact transformations is intended, by Prof. E. O. Lovett, to correct some misapprehensions that a reader of a note in the *Zeitschrift für Mathematik und Physik* (vol. xxxvii., 1892) to a paper by Dr. Mehmke may carry away.—Dr. Staude's "die Focaleigenschaften der Flächung zweiter ordnung" is reviewed; and Mr. J. E. Campbell, in a note, admits the validity of an objection brought by Prof. E. O. Lovett (in the November 1897 *Bulletin*) against a statement in his paper (*Proc. L.M.S.*, vol. xxviii.—incorrectly xxiii. in the *Bulletin*—pp. 381–390), and expresses his meaning more clearly.—"Notes" and "publications" close the number.

Wiedemann's Annalen der Physik und Chemie, No. 5.—Susceptibility of water and aqueous solutions, by H. du Bois. Determinations of the molecular susceptibilities of the salts of some paramagnetic metals, such as the chlorides of Ce, Cu, Ni, Fe, and Mn, go to confirm the rule observed by Jäger and Meyer that the atomic susceptibilities of the metals Ni, Co, Fe, and Mn are in the ratios 2 : 4 : 5 : 6.—Magnetic after-effect, by C. Fromme. The "magnetic creeping" or after-effect diminishes when the reduction of the field to zero takes place rapidly. This may be explained by supposing that the molecular magnets are thereby thrown into a more violent commotion, and are better able to attain stable positions. A similar effect may be brought about by heat or mechanical stress.—Magnetisation of hollow and solid iron rings, by F. Kirstädter. To determine whether the outer parts of a rod or ring screened the inner portions against magnetisation, the author split a ring in two halves, and bored round holes so that on recombination a hollow ring was formed. By boring the holes larger and larger the surface of the ring was given various thicknesses. It was found that the inner layers acquired the same magnetisation as they would have done had they been exposed to the immediate action of the magnetising field.—The function of the condenser in an induction apparatus, by P. Dubois. There is a certain maximum spark length obtainable in any given induction coil circuit by means of a condenser. When the capacity of the condenser exceeds that maximum, the effect diminishes. For a resistance of some 200 ohms in the circuit, the maximum useful capacity for the condenser is 3 microfarads.—On the rays proceeding from thorium compounds and some other substances, by G. C. Schmidt. These rays differ from uranium rays in not being polarised by tourmaline, and from Röntgen rays in being refracted. But like uranium and Röntgen rays, they impart a temporary conductivity to air and other gases.—Potential gradients at electrodes discharged by X-rays, by C. D. Child. When the discharge passes between two plates with air between rendered conducting by means of X-rays, the gradient is steeper near the plates and less steep in the middle, as may be proved by a Kelvin water-dropping electrometer.—Proof of the existence of the thin Zenker's plates in colour photographs taken by Lippmann's method, by R. Neuhauss. The layers of metallic silver to which, according to Zenker's theory, the colour effects in Lippmann's photographs are due, have been actually seen and photographed by the author under a microscope magnifying 4000 times in a cross section of a film taken by a very good microtome and operator. The distance between the lamellæ for red light is, as postulated, equal to the wave-length of the light.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 26.—"Contributions to the study of 'Flicker.'" By T. C. Porter (Eton College). Communicated by Lord Rayleigh, F.R.S.

The first part of the paper describes experiments made to ascertain the exact relative rotations at which the flicker of a disc, half black, half coloured, vanishes in the different colours of the spectra of sun- and lime-light, formed by a diffraction grating of 14,434 lines to the inch. The main precautions which must be taken are briefly stated, with a short discussion of the results, which may be summed up as follows.

The rate of rotation of the disc that the flicker may just vanish is highest for the yellow, decreasing for the succession of colours on either side of this one, being the same for the deepest visible crimson and full green; from the full green to the violet end of the spectrum the rate continues to fall off, till in the last visible rays it is very nearly one-half its maximum for the yellow.

When the intensity of the different spectra is varied, the greater the intensity the more rapid is the rate of rotation necessary for flicker just to vanish; thus, as the stimulus applied to the retina increases in intensity, the impression produced retains its maximum value for a shorter and shorter time. That a brighter illumination of the disc does produce a greater stimulus (*i.e.* that neither the contraction of the pupil, nor any other cause, overcomes the effect of brighter illumination) is proved by the fact that the brighter the light, the brighter on the whole is the disc, when flicker has just vanished. Research was made to discover in what way the rotation of a black and coloured disc must be varied for flicker to vanish, when the proportion of the coloured to the black sector varied by stages of 10° at a time, the experiments being carried out in each of the main colours of the lime-light spectrum.

Throughout this series of experiments the intensity of the illuminant was kept constant. The results are expressed in a series of rather remarkable curves, the rate of rotation rising rapidly with the instalments of 10° to the coloured sector, then remaining at its maximum, and constant within the errors of experiment, from a coloured sector of about 150° to one of about 240°, after which the rate of rotation falls off somewhat more rapidly than it rose when the coloured sector was small.

The remainder of the paper is devoted to the discussion of these curves, and it concludes by proving from a series of points, taken at random on one of them, that the duration of the impression on the retina undiminished is inversely proportional to the time during which the retina is stimulated. Some other conclusions of interest are arrived at; but for the reasoning and description of experiments necessary, we must refer to the paper itself: *e.g.* (1) When flicker has just vanished, the effective stimulus at any point of the retina is to the maximum stimulus the coloured sector can produce, as the angle of the yellow sector is to the angle of the whole disc (*i.e.* 360°), the illumination being supposed constant. (2) The coloured sector always requires a finite time in order to produce its maximum effect on the retina. (3) When the width of the white or coloured sector is increased in steps of 10° at a time, the increment in the apparent brightness in the rotating and flickerless disc follows, within the errors of experiment, the series of 1/0, 1/1, 1/2, 1/3, 1/4, &c., as it should. The paper is the first of a series on the subject.

"Aluminium as an Electrode in Cells for Direct and Alternate Currents." By Ernest Wilson. Communicated by Dr. J. Hopkinson, F.R.S.

This paper deals with the apparent great resistance which aluminium offers to the passage of an electric current when coated with a film and used as an anode in cells containing, for instance, such an electrolyte as alum in water.

Part i. deals with experiments made on aluminium-carbon cells with direct currents, the electrolytes used being alum solution, dilute sulphuric acid, and sodium hydrate in water.

After making a preliminary experiment in which an exploring electrode inserted between the plates was used to allocate the distribution of potential difference in the cell, the author describes a series of experiments made with a view to finding the effect of variation of current density and temperature upon the potential difference between the Al and C plates. Two cells were constructed and, during the forming process, which consisted of passing a current of ·005 ampere per square inch of the Al anode for forty-seven hours, one of them contained a dilute H_2SO_4, and the other a saturated potash alum solution. The apparent resistance was not nearly so marked in the H_2SO_4 solution cell as in the other.

The H_2SO_4 solution was then replaced by a saturated alum solution, and the two cells submitted to a further forming process for thirteen hours. The two cells were then experimented upon at approximately constant temperature, but the current density varied. The potential difference in the two cases rose from 1·89 to 34·5 volts as the current density varied from ·00006 to ·12 in the case of the H_2SO_4-formed plate, and from ·00011 to ·041 in the other. With about 39 volts directly applied to each the current rapidly increased in the two cells, accompanied by rapid increase of temperature from its final value of about 20° C.

The cell containing the alum-formed plate was next heated; the current density of the Al anode kept approximately constant at ·019 ampere per square inch, and the temperature raised from 13° to 70° C. The potential difference fell from 30 to 3 volts under these conditions.

The potential difference was not materially increased by cooling a cell in a freezing mixture of carbonic acid snow and ether.

One of these films was examined under a microscope and analysed by Mr. Herbert Jackson, of King's College, London, who states "that the skin over the plate is seen to be full of minute cracks, giving the impression of a dried gelatinous pellicle; not an unexpected appearance if the plate had been covered when wet with a thin coating of the gelatinous aluminium hydroxide. The analysis of the film over the metal shows it to consist of basic aluminium sulphate."

An experiment was made upon a film which was formed without the passage of current by first submerging a bright Al plate in alum solution, and then exposing it to the atmosphere. The author concludes that this film has the same effect as another formed during the passage of current.

Part ii. deals with alternate currents. Experimenting first with Al-C plates in potash alum solution, the frequency was varied from 16 to 98 periods per second, and the current density varied from ·0396 to ·583 ampere per square inch of the Al plate. The results show that small currents are accompanied by large phase difference; but the effect looked for, namely a large ratio between the maximum coulombs in the two halves of a period, has not time to properly develop at the frequencies tried.

The next set of experiments deals with a "rectifier" for alternate currents proposed by Graetz, in which Al-C cells are employed. It is shown that a uni-directional current can be produced by the Graetz arrangement, and the efficiency of such a system is discussed.

The concluding portion of these experiments deals with aluminium plates only for the purpose of forming the electrodes of a condenser for alternate currents. Soda, ammonia, and potash alums, both saturated and non-saturated, are employed as electrolytes. The frequency is varied from 7·5 to 100 periods per second, and the current density from ·0139 to ·6. The results show that phase differences of the order of 60° and 70° (360° = 1 period) can be obtained by a suitable choice of current density and temperature. Maximum phase difference develops with small currents at low temperature. With regard to frequency, both saturated and non-saturated solutions give a higher efficiency at the higher frequency. The conclusion is that the metal aluminium is suitable for use as the plates of condensers if due regard be given to current density and temperature.

Royal Microscopical Society, May 18.—Mr. E. M. Nelson, President, in the chair.—The President exhibited a simple form of student's microtome, suitable for cutting soft sections. It was made by Messrs. Reynolds and Branson, of Leeds, and was on the principle of the Williams microtome, but consisted only of a plate of glass and an adjustable casting carrying the razor. The chief point of interest was its low cost. —The President read three short papers which had been received from Mr. Jourdain. The first was on a new apochromatic objective constructed without the use of fluorite. This objective is made by the Bausch and Lomb Optical Company, who have promised to send examples to Mr. Jourdain for examination. The other papers by Mr. Jourdain were on a method of adjusting the sizes of coloured images yielded by the Cooke lens, and on the construction of the planar lens and its use in

low power photomicrography.—The President read a note on the optics of photographic lenses.—A paper by Mr. F. W. Millett, which was a continuation of his "Report on the Foraminifera of the Malay Archipelago," being of a highly technical character, was taken as read.—There was a very interesting exhibition of microscopic aquatic life by members of the Quekett Microscopical Club and Fellows of the Society.

Anthropological Institute, May 24.—Mr. F. W. Rudler, President, in the chair.—Prof. E. B. Tylor, F.R.S., having exhibited lantern photographs of the great totem-post from Queen Charlotte's Island, sent over by Mr. Bertram Buxton, and now erected in the grounds of Fox Warren, near Weybridge, the residence of Mr. Charles Buxton, took this as the text for a critical examination of totemism in general, as regards both its real importance and the somewhat extreme ideas of its place in anthropology and theology, which have been gaining ground ever since J. F. McLennan brought it into notice in his "Primitive Marriage." This writer at first looked at it purely in its legal aspect, the group of clans named after animals—as Wolf, Bear, Tortoise, Snake, &c.—being used as a means of dividing tribes, so as to regulate their exogamy or marrying-out; a Wolf man, for instance, not being allowed to marry a Wolf, though he might marry a Bear. Later McLennan wrote papers on the worship of animals and plants in the *Fortnightly Review*, which he did not republish, but which have served to model public opinion since. As bringing the subject into scientific view, these papers were admirable; but they plunged into somewhat reckless theories which have held their own, notwithstanding incompatibility with evidence. Especially the word totemism, originally referring to exogamous human clans named from animals, was used in the large and complex sense of animal-worship, to only a fraction of which the totem-clans really belong. This discrepancy became serious when, for instance, in Fiji a god who embodied himself in serpents, was treated as if his worshippers formed a serpent-clan; in such a case the serpents being regarded as totems, and it being further supposed that the superior gods of the land were evolved out of such totem-animals. When this notion was later expanded in the works of Frazer and Jevons, it gradually produced a theory of totem-animals having been the origin from which a rude form of monotheism arose in the religion of mankind. As an instance how misleading such reasoning may be, it was pointed out that the great Heaven-god Tangalsa, whose veneration extends over the islands of the Pacific, is in Samoa incarnate in a species of snipes. According to this totemic theory of gods, the vast Sky-god would be a developed and exaggerated snipe. It was argued also that attempts to support Robertson Smith's doctrine of the Slain-god, with its further sacramental implications, by certain supposed piacular sacrifices of totem-animals to the totem-god, were not to be depended on, the few instances alleged being cases of animals put to death for reasons not necessarily sacrificial. As to the real meaning and origin of totemism, Prof. Tylor pointed out that modern information has thrown considerable light on the annuistic processes by which totems probably came into existence. The evidence of Wilken and Codrington, from the Malay and Melanesian region, shows the prevailing doctrine of transmigration of soul to convert an ordinary form of animal-worship into what hardly wants more than the name to become a totem. An influential native on his death-bed will announce to his family the animal into which his soul will migrate, perhaps a crocodile or shark by preference; taking him at his word, his kinsfolk will worship the creature—above all, not killing or eating it—and the crocodile or shark species becomes their protector. Such a family multiplying, and being called after sacred animals, will become crocodiles or sharks, clans whose totem is the crocodile or the shark.

Entomological Society, June 1.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. P. B. Mason exhibited a specimen of the rare *Lathridius filum* from his own herbarium. It had been previously taken at Edinburgh by McNab, and he understood that an example had been found in a sealed envelope containing *Marchantia* from Franz Josef Land.—Mr. J. J. Walker exhibited a singular blue variety of *Carabus monilis*, Fabr., resembling in colour *C. intricatus*, and taken at Iwade, Kent, in flood-rubbish in May.—Mr. F. Merrifield forwarded for exhibition from Riva on the Lago di Garda larvæ of the "Corsican form," var. *ichnusa*, of *Aglais urticæ*.—Mr. G. C. Champion called attention to Mr. A. Somerville's recently-published sheet of the county and vice-county divisions of the British Isles for biological purposes, and a discussion ensued thereon.—Papers were communicated by Sir G. F. Hampson, Bart., on "The Moths of the Lesser Antilles," and by Mr. J. H. Leech on "Lepidoptera Heterocera from Northern China, Japan, and Korea."

Chemical Society, June 2.—Prof. Dewar, President, in the chair.—The President announced the death of the Right Hon. Lord Playfair, the senior past President, and last surviving founder of the Society.—The following papers were read:—The boiling point and density of liquid hydrogen, by J. Dewar. Liquid hydrogen boils at about $-238°$ C., and its density at the boiling point, determined by measuring the gas obtained by evaporating 10 c.c., is about 0·07. Since the hydrogen occluded by palladium has the density 0·62, it cannot be associated with the metal in the liquid state.—The action of hydrogen bromide in presence of ether on carbohydrates and certain organic acids, by H. J. H. Fenton and Mildred Gostling. The formation of ethylic dihydroxymaleate by the interaction of the acid with dry ether and hydrogen bromide is generally applicable to the preparation of alkylic salts. On applying the reaction to carbohydrates and polyhydric alcohols, it is found that an intense purple or red coloration is sometimes obtained with ether and hydrogen bromide; the coloured matter produced resembles the metafurfurol of Stenhouse and others.—Production of some chloropyridinecarboxylic acids, by J. N. Collie and W. Lean.

Linnean Society, June 2.—Mr. Albert D. Michael, Vice-President, in the chair.—The Chairman announced that the President had nominated Messrs. William Carruthers, Frank Crisp, Albert D. Michael, and Dr. D. H. Scott to be Vice-Presidents for the ensuing year.—Dr. St. George Mivart, F.R.S., contributed a paper entitled "Notes on Lories." Referring to a recently published paper by Captain Hutton on the value of specific characters (*Linn. Soc. Journ., Zool.* xxvi. p. 330), in which the writer had stated the results of his examination of a large number of pigeons belonging to the genus *Ptilopus*, and his reasons for concluding therefrom "that the specific characters of these species could not have arisen as 'recognition marks' or from any other mechanical mode of origin," Dr. Mivart adduced other examples in support of this view from the family *Loriidæ*, or brush-tongued parrots. From the facts collected he expressed his conviction that the cause of specific characters still remained an unsolved enigma, the solution of which would probably not be achieved until the higher psychological problems of biology were more widely understood, and the light thus gained had been reflected on questions of ordinary physiology.—Mr. E. S. Salmon read a paper entitled "A Revision of the Genus *Symblepharis*." This genus of mosses, he said, as founded by Montagne in 1839, had proved too narrow, through the limits imposed by certain peristome characters, and he was of opinion that Mitten's later emended description should be accepted.—Surgeon-Captain Cummins read a paper on the food of the Uropoda. The nature of the food of these mites, which belong to a highly specialised genus of the *Gamasinæ*, had long been a puzzle even to those who have paid particular attention to their organisation. From careful experiments and observation, the author of the paper had come to the conclusion that amongst the organisms on which the Uropoda live were many species of bacilli, including the potato bacillus and the earth bacillus. Wild yeast-cells were rapidly devoured, as also were *Micrococci*. He had little doubt that they consumed the gonidia of Fungi, for species of *Penicillium* and *Mucor* never appeared in the boxes which contained mites in large numbers; otherwise they were commonly present. Mr. A. D. Michael, in criticising the paper, pointed out the distinguishing characters of the Uropoda as compared with others of the *Gamasinæ*, and especially the peculiar form of the mandibles, which suggested a different mode of feeding to that adopted by other mites.—Mr. C. B. Clarke, F.R.S., gave a summary of a paper on the subdivision of biological areas in India, and in the course of his remarks mentioned some interesting facts in connection with plant distribution in the Indo-Oriental region. Dr. Otto Stapf, in commenting on the paper, expressed the opinion that the limits of the subdivisions proposed were natural, and might well be accepted by botanists.

Geological Society, June 8.—W. Whitaker, F.R.S., President, in the chair.—On the discovery of natural gas in East Sussex, by C. Dawson. Inflammable natural gas was first recorded by Mr. H. Willett in his thirteenth quarterly report of

the Subwealden Exploration. Another discovery was in a deep artesian boring in the stable-yard of the New Heathfield Hotel. In 1896, at a site about 100 yards distant from the last-mentioned locality, a boring was put down by the London, Brighton and South Coast Railway Co., the details of which are given in the paper, together with those of the earlier Heathfield boring. From this boring gas has been escaping for the last eighteen months, with a pressure of not less than 15 lb. to the square inch, and at the rate of about 12½ cubic feet per hour (with a pressure of 20 tenths maintained), although the ube is stopped up, and is partially filled with water (see NATURE, ol. lii. p. 150). Though deficient in illuminating quality, the gas burns well when mixed with air, and gives a good bunsen-flame. The author considers that it is probably derived from the lower beds pierced, that is, the Purbeck strata, or by percolation from the still lower Kimeridge beds, which were not reached by the borings. The borings pierce the southern slope of the great anticline which runs from Fairlight into mid-Sussex, and is joined at Heathfield by another considerable anticline running through Burwash.—Note on natural gas at Heathfield Station (Sussex), by Dr. J. T. Hewitt. A sample of natural gas from the boring described above was taken in December 1897, and analysed with the following result: Methane, 91·9; hydrogen, 7·2; nitrogen, 0·9. Oxygen, carbon dioxide, carbon monoxide, olefines, and hydrocarbon vapours were altogether absent.—On some high-level gravels in Berkshire and Oxfordshire, by O. A. Shrubsole. The high-level gravels are divided by the author as follows, beginning with the oldest: (1) Pebble-gravel, composed very largely of flint or chert; (2) the Goring Gap gravel; (3) quartzose gravel, with only a small proportion of flint-pebbles; (4) quartzite-gravel, with purple and brown quartzite-pebbles; (5) local flint-gravels.—The *Globigerina*-marls of Barbados, by G. F. Franks and Prof. J. B. Harrison, with an appendix on the Foraminifera by F. Chapman. After a reference to previous publications on the island by one of the authors and Mr. Jukes-Browne, an account is given of the tectonic structure of Bissex Hill, on which the principal exposures of the *Globigerina*-marl occur. In the appendix a list of 146 species of foraminifera is given. Fifteen of these occur only in strata ranging from the Cretaceous to the Pliocene Period. The rocks bear some resemblance to the limestones and marls of Malta and to the *Globigerina*-beds of Trinidad; the recent foraminifera indicate that the deposit was formed at a depth of about 1000 fathoms and at some distance from land.

Zoological Society, June 7.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—Mr. L. A. Borradaile read the second part of a paper on Crustaceans from the South Pacific. In this part twenty-one species of *Macrura anomala*, examples of which had been collected in the islands of Rotuma and Funafuti by Mr. J. Stanley Gardiner, were enumerated, and notes were given on several of them. Under the head of *Petrolisthes lamarcki* the author proposed to unite a number of forms previously considered as specifically distinct.—A communication was read from Mr. A. E. Shipley containing an account of the gephyrea or unsegmented worms collected by Mr. J. Stanley Gardiner at Rotuma and Funafuti. These comprised examples of two species of Echiuroidea and twelve of Sipunculoidea. Of the latter group two new species were described, viz. *Sipunculus rotumahensis* and *S. funafuti*, and *Physcosoma varians* was recorded for the first time from the Pacific.—Mr. G. A. Boulenger, F.R.S., read a fourth report on the additions to the Batrachian Collection in the Natural History Museum, containing a list of the species of this class (115 in number), new or previously unrepresented, of which specimens had been added to the collection since November 1894. Eight new species were described in this paper.—Mr. G. A. Boulenger, on behalf of Count Peracca, gave an account of a new species of newt (*Molge italica*), recently discovered in Southern Italy, and exhibited some living specimens of it.—A communication was read from Mr. L. W. Wiglesworth, entitled "Theories of the Origin of Secondary Sexual Characters," which contained arguments in favour of the theory of the stimulation of parts to higher development through use or external violence or irritation, as observed in birds.—A communication was read from the Rev. O. Pickard Cambridge, F.R.S. It contained an account of a collection of Araneidea from Savoy, comprising examples of twenty-four species, one of which (*Gnaphosa molesta*) was described as new.

Mathematical Society, June 9.—Prof. E. B. Elliott, F.R.S., President, in the chair.—The President briefly noticed the loss sustained by the Society owing to the recent deaths of Mr. H. Perigal (elected January 23, 1868) and of the Rev. Dr. Percival Frost, F.R.S. (elected December 9, 1869) (see NATURE, No. 1493, p. 131).—The following communications were made: Point-groups in a plane, and their effect in determining algebraic curves, by Mr. F. S. Macaulay.—On a regular rectangular configuration of ten lines, by Prof. F. Morley.—On the conformal representation of a pentagon on a half-plane, by Miss M. E. Barwell.—On the general theory of anharmonics, by Prof. E. O. Lovett.—On the calculus of equivalent statements (eighth paper), by Mr. H. MacColl.—On a continuous group defined by any given group of finite order (second paper), by Prof. W. Burnside, F.R.S.—On certain regular polygons in modular network, by Prof. L. J. Rogers.

Royal Meteorological Society, June 15.—Mr. F. C. Bayard, President, in the chair.—A paper by Mr. R. C. Mossman was read on the frequency of non-instrumental meteorological phenomena in London with different winds from 1763-1897. In previous papers the author has discussed the secular and seasonal variation of various phenomena, and he now gives the results of an analysis of the direction of the surface winds observed during the occurrence of snow, hail, gales, thunderstorms, lightning, fog, and aurora. Snow is of most frequent occurrence with north and east winds, and least common with S.W. winds. Hail showers occur most often with W., N.W., and N. winds. Gales are most frequent with W. and S. winds. The greatest number of both summer and winter thunderstorms occurs with W. winds, although the values in summer are high with E., S.E., and S. winds. The greatest number of fogs are recorded on calm days, closely followed by days on which the wind blew from the east.—A paper, by Mr. A. L. Rotch, was also read on the exploration of the free air by means of kites at Blue Hill Observatory, Mass., U.S.A. After giving a brief account of the use of kites for scientific purposes from 1749 to the present time, the author describes the various forms of kites which have been employed at Blue Hill Observatory, viz. the Eddy, or Malay tailless kite; the Hargrave cellular or box kite; and the Lamson aero-curve kite. The highest flight was on October 15, 1897, when, by means of four kites having a combined lifting surface of 150 square feet, the meteorograph at the end of 20,100 feet of wire was raised vertically 11,080 feet above the hill. About 200 records from kites have been obtained in the free air at heights from 100 to 11,000 feet in all kinds of weather. Mr. Rotch maintains that the kite can be made of the greatest importance for meteorological investigation. At the recent meeting of the International Aeronautical Committee at Strassburg it was recommended that all central observatories should employ kites as being of prime importance for the advancement of meteorological knowledge.

EDINBURGH.

Royal Society, June 6.—Lord McLaren in the chair.—Prof. C. G. Knott read a paper on magnetic strains, being a continuation of a paper already published in the *Transactions*. Iron, nickel, and cobalt tubes of various dimensions were studied in detail. As a rule each was the subject of four distinct experiments. The change of length in the magnetic field was first measured; then the change of volume of the material; thirdly, the change of volume of the bore; and finally the change of external volume of the tube when plugged up at both ends. From these the coefficients of strain of an element at both the internal and external surface were calculated. Many details of interest were touched upon, and the general conclusion arrived at that the system of stresses required to maintain the complicated state of strain indicated could not be accounted for in terms of any of the recognised theories connecting magnetism and stress.—Dr. A. T. Masterman read a paper on the further anatomy and the budding processes of *Cephalodiscus dodecalophus*. Among the chief features dealt with may be mentioned the following. The pharynx has special adaptations for the separation of food and water currents, *e.g.* hyper- and hypo-pharyngeal grooves, the peripharyngeal groove, the pharyngeal clefts, &c. The notochord of the *Chordata* may be primarily derived from this source as a channel for cloacal water. The pedicle or ventral sucker has a ventral nerve cord and two ventro-lateral cords, a dorsal and a ventral blood sinus and complete inner layer of longitudinal muscles. The buds arise usually in pairs ventrally. The pharyngeal clefts arise as endodermal diverticula, which break through the ectoderm to the exterior. The sexual development commences in the egg

capsule whilst attached to the inner wall of the cœnœcium, and results in the form of a larva segmented into two parts by an annular constriction.—Mr. Malcolm Laurie gave a description of a new Silurian scorpion from the Pentland Hills, the fourth that had been found in Silurian rocks. Regarding certain structures on the abdominal segments, the hypothesis was advanced that the new form was a water-breathing animal. A description was also given of some new Eurypterids, of which no fewer than twelve species had been found in this particular Pentland bed. —Dr. Masterman also communicated a paper on the theory of archimeric segmentation, considered in relation to the classification of the *Cœlomata*. This was a following up of a suggestion made in a recent paper that in the morphology of the *Cœlomata* there are two distinct types of segmentation : (*a*) a primitive or archimeric type, having in its constitution evidences of a radial origin, and (*b*) a secondary or metameric segmentation superposed upon the former, and bearing evidence of a bilateral origin.

Mathematical Society, June 10.—Dr. Mackay in the chair. —The following papers were read :—Notes on permutations, &c., by Mr. R. F. Muirhead.—Extension of the method of displacement-sequence, by Mr. R. F. Muirhead.—Converse theory of binomial theorem, by Mr. Sita Noth Chokrobarthy.— Elementary notes, by Mr. W. J. Butters.

DUBLIN.

Royal Dublin Society, May 18.—Prof. D. J. Cunningham, F.R.S., in the chair.—Dr. F. T. Trouton, F.R.S., communicated a method of measuring the surface tension of liquids which depends on the rate at which a column of liquid fills, or empties itself out of a tube of fine bore. The tube is placed horizontally and has one end bent downwards into a vessel of the liquid. By altering the level of the liquid it can be either arranged to measure the rate the tube fills, in which case the capillary forces draw the liquid up, or the rate it empties, the capillary forces retarding. Were the flow viscous the distance traversed would be proportional to the square root of the time. This was shown to be approximately true. Experiments were described using an inclined tube with a wide bent-down portion attached to the lower end. The rate of emptying could be made constant by making the height of the liquid in the wide part equal to the capillary elevation in the fine tube. Experiments were also described made with liquids such as soap solution, where surface tension varies with time.—The Rev. H. O'Toole exhibited and described a new hydrometer, which consists of a stem at the lower end of which is a weighted bulb, as in any of the common forms of hydrometer ; higher up on the stem is another bulb, which causes the instrument to float, and at the top is a dish in which weights may be placed. Between the floating bulb and the dish there is another bulb, which may be called the standard bulb. The method of use is as follows : the apparatus is immersed in a given liquid, and weights added to make it sink to a marked point between the floating and standard bulbs ; additional weights are then added to immerse the standard bulb to another marked point near the dish ; these additional weights are evidently the weight of a volume of the liquid equal to the volume of the standard bulb. The weight of the same volume of water may be similarly found, and thus the specific gravity determined.—Prof. D. J. Cunningham, F.R.S., and Mr. Joseph Welland exhibited an apparatus for lantern-photography of microscopic objects. This is of interest as affording a means of using an ordinary optical lantern, with or without a microscopic projector, for making enlarged photographs of transparent microscopic objects, the precise degree of enlargement wished for being readily obtained. It has been employed chiefly for photographing large sections of the brain, and it is particularly well adapted for this purpose. Further, by means of this apparatus, transparencies reproducing the different colours of stained and injected tissues can be readily obtained by the Joly process. Slides showing a section through a kidney injected in two colours (red and blue) and a picrocarmine specimen of hair follicles were exhibited.—Mr. Richard J. Moss exhibited an apparatus for drying bodies *in vacuo* at various temperatures. Steam or other vapour is passed through a flat coil of pipe in an inverted bell-jar, closed with a glass plate and rubber ring, and attached to a water vacuum pump. A flat-bottomed platinum capsule containing the substances to be dried rests on the coil of pipe, and any desired desiccant is placed in a tray above it.

PARIS.

Academy of Sciences, June 13.—M. Wolf in the chair.— Liquid air, by M. d'Arsonval. An account of the Linde process of liquefying air. An expenditure of rather less than three horse-power gives a litre of liquid air per hour.—Spectroscopic researches on atmospheric air, by MM. H. Moissan and H. Deslandres. A sealed note deposited May 11, 1896.—Remarks by M. H. Moissan on the above.—On the direct measurement of a quantity of electricity in electromagnetic units ; application to the construction of a current meter, by M. R. Blondlot. A coil in the form of a ring is hung on a vertical axis inside a long horizontal bobbin, the same current passing round both coils. The product of the intensity of the current into the time of oscillation, that is, the quantity of electricity which traverses any given section of wire during one swing, is a constant quantity, depending only on the construction of the two bobbins. By the application of a device for counting the vibrations of the small coil, a practical coulombmeter is obtained, which works equally well with continuous and alternating currents.—On differential equations of the second order at fixed critical points, by M. Paul Painlevé.—On the problem of integration from the point of view of real variables, by M. R. Baire.—On mixtures of gases, by M. Daniel Berthelot. A discussion of Dalton's Law of mixed gases. Starting with the assumption that the law of Avogadro is only true in the limiting case of infinite volume, an expression is developed for the constants in the Van der Waal equation to the mixture. The results found experimentally by MM. Leduc and Sacerdote are in perfect agreement with the theory.—On the study of the radiations of mercury and the measurement of their wavelengths, by MM. Ch. Fabry and A. Perot. A comparison of the green line and two yellow lines of mercury with the cadmium lines by means of the interferential spectroscope described in previous papers.—On the electrical resistance of steel, by M. H. Le Chatelier. The steels were examined in the form of well annealed bars, 20 cm. long and 1 sq. cm. in section. The resistance increases with increasing percentage of carbon, and similarly with silicon, 1 per cent. of the latter having double the effect of the same amount of carbon. Steels containing manganese, nickel, chromium, tungsten, and molybdenum were also examined.—Entoptic vision, and sensibility in the yellow spot, by M. Aug. Charpentier.—On the atomic weight of nitrogen, by M. M. Vèzes. From the densities of nitrogen and its compounds M. Daniel Berthelot has deduced an atomic weight of 14·005 for nitrogen, whilst the figure given by Stas is 14·044. This discrepancy cannot be accounted for, as MM. D. Berthelot and Leduc have assumed, by the systematic error introduced by oxygen dissolved in the silver, as M. Stas has himself carefully reconsidered the whole of his work in the light of this objection of Dumas, and has shown that the effect is practically negligible, the atomic weight in question being only lowered from 14·044 to 14·040. The cause of the difference still remains to be explained.—On the atomic weight of tellurium, by M. R. Metzner. The tellurium employed in this research was prepared by the decomposition of tellurium hydride at 500° ; it is certain that this metal must be free from antimony and bismuth. The reactions chosen were the conversion of the metal into its sulphate, and the reduction of tellurous acid with carbon monoxide. The mean result is 127·9.—Action of sodammonium in excess upon red phosphorus, by M. C. Hugot.—On the preparation and properties of a new carbide of tungsten, by M. Percy Williams. The carbide is produced by the interaction of tungstic acid, carbon, and iron at the temperature of the electric furnace. Its formula is WC, and is distinguished from the carbide W_2C, discovered by M. Moissan, in not being attacked by chlorine.—New method of separating geraniol and citronnellol, by MM. J. Flatau and H. Labbé. The essence is converted into phthalic ethers by heating with benzene and phthalic anhydride, and these separated by means of ligroin. The ethers are described in detail.—On the composition of fish, crustacea, and molluscs, by M. Ballard. Determinations of water, nitrogen, fat, extractives, and ash for a large number of fish, crustacea, and molluscs.—On the crystalline forms of quartz from Meylan, by M. Ferdinand Gonnard. —On the direct fertilisation in some plants in which the flowers would appear to be adapted to cross fertilisation, by M. C. Gerber.—On a remarkable fault between Brives, Périgueux and Angouléme, by M. Ph. Glangeaud.—On new sources of petroleum in the Caucasus, by M. Venukoff. Naphtha-bearing sand has been found near Anaclie, in the Eastern Caucasus.—

Atmospheric situation at the time of ascent of experimental balloons, by M. H. Tarry.—The registration of atmospheric electric discharges, by M. Ducretet. The registration was effected by the Hertzian waves set up; the recording instrument was a Branly radio-conductor.—International balloon ascent of June 8, by M. W. de Fonvielle. The ascents were made on the same day at Paris, Brussels, Strassburg, Vienna, Berlin, St. Petersburg, and Munich.—Short account of the results of the ascents of three captive balloons at Trappes, by M. L. Teisserenc de Bort.

NEW SOUTH WALES.

Linnean Society, April 27.—Mr. P. N. Trebeck in the chair.—Some new genera and species of fishes, by J. Douglas Ogilby.—On the affinities and habits of *Thylacoleo*, by Dr. R. Broom. The author reopens a much-debated question in the light afforded by the interesting little fossil marsupial recently described by him under the name *Burramys parvus* [P.L.S.N.S.W., 1895, p. 563]. This little form, which is evidently the representative of a sub-family of the *Phalangeridæ*, in most of its characters agrees with the phalangers, but it possesses the greatly enlarged and grooved premolars of the rat-kangaroos; and not only does it show evidence of a group which fills the only remaining gap between the kangaroos and the phalangers, but as a phalanger with the posterior premolars enormously enlarged, it comes nearer to *Thylacoleo* than does any extinct or living form hitherto discovered. The conclusions arrived at are—That *Thylacoleo* is descended from a phalangeroid form not very dissimilar from *Burramys*, and that it was almost certainly a purely carnivorous animal.—Descriptions of new Australian lepidoptera: with a note on the occurrence of *Deilephila livornica*, Esp., at Broken Hill, N.S.W., by Oswald Lower. The beautiful sphingid, *Deilephila livornica*, Esp., was noticed by the author to be common during the early part of March last, at the electric lights at Broken Hill. On one occasion individuals were literally swarming. The species occurs in Europe, Africa, and S. Asia. It was first recorded from Australia by Mr. Miskin from a Queensland specimen. It is also known from Adelaide, but has not yet been reported from Victoria, Tasmania, or West Australia; nor has it been recorded previously from New South Wales.—Descriptions of a new Australian grass, by Fred. Turner. The species of *Panicum* described is a capital forage plant from the Liverpool Plains, N.S.W., its nearest allies being *P. semitonsum*, F.v.M., and *P. antidotale*, Retz, from North Australia.—Mr. Hedley exhibited a specimen of fully developed *Gundlachia* recently taken by Mr. H. Leighton Kesteven from a pool in the Botanical Gardens, Sydney. This is the second instance of its occurrence in Australia, and the first in New South Wales. The genus has been treated of at some length in vol. viii. (2nd series) of the Society's *Proceedings*. Possibly no real *Ancylus* exists in Australia, and all those hitherto reported will ultimately be shown to assume occasionally and at rare intervals the Gundlachia form.—Mr. Ogilby exhibited the type of the new bathybial fish from Lord Howe Island, described in his paper as *Æthoprora perspicillata*, and remarked that it may be distinguished from the three Atlantic species by the presence of a pair of supernumerary photophores between the upper angle of the eye and the ante-orbital.

DIARY OF SOCIETIES.

FRIDAY, JUNE 24.

PHYSICAL SOCIETY, at 5.—Exhibition of an Apparatus illustrating the Action of Two Coupled Electric Motors: Prof. Carus-Wilson.—Exhibition of Weedon's Expansion of Solids Apparatus: J. Quick.—On the Theory of the Hall Effect in a Binary Electrolyte: Dr. F. G. Donnan.

SATURDAY, JUNE 25.

GEOLOGISTS' ASSOCIATION (Liverpool Street Station, G.E.R.), at 9.30 a.m.—Excursion to Sudbury. Director: Dr. J. W. Gregory.

MONDAY, JUNE 27.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—Plans for the Construction and Erection of a Terrestrial Globe on the Scale of 1:500,000: Prof. Elisée Reclus.

THURSDAY, JUNE 30.

LINNEAN SOCIETY, at 8.—A Revision of the Genus *Elæocarpus*, Linn.; Sir D. Brandis, K.C.I.E., F.R.S.—Observations on the *Membraniporidæ*, a Family of Marine Bryozoa: A. W. Waters.—On the Fruit of *Chnoospora fastigiata*, J. Agardh: Ethel S. Barton.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Essai Synthétique sur la Formation du Système Solaire: G. Lafouge, Part 1 (Paris, Gauthier-Villars).—Calculations in Hydraulic Engineering: Prof. T. C. Fidler, Part 1 (Longmans).—South American Sketches: R. Crawford (Longmans).—Twenty-first Annual Report of the Connecticut Agricultural Experiment Station, for 1897 (New Haven).—Catalogue of Earthquakes on the Pacific Coast, 1769 to 1897: Dr. E. S. Holden (Washington).—Report of the U.S. National Museum for the Year ending June 30, 1895 (Washington).—Leçons Elémentaires d'Acoustique et d'Optique: Prof. C. Fabry (Paris, Gauthier-Villars).—A Manual of Bacteriology: Dr. R. T. Hewlett (Churchill).—Lectures on the Geometry of Position: Prof. T. Reye, translated and edited by Prof. T. F. Holgate. Part 1 (Macmillan).—The First Philosophers of Greece: A. Fairbanks (K. Paul).—The Study of Man: A. C. Haddon (Bliss).—Year-Book of the U.S. Department of Agriculture, 1897 (Washington).—Cape Photographic Durchmusterung for the Equinox 1875: Drs. Gill and Kapteyn, Part 2 (Darling).—Text-Book of Zoology: H. G. Wells and A. M. Davies (Clive).

PAMPHLETS.—Contribution iii. to the Coastal and Plain Flora of Yucatan: Dr. C. F. Millspaugh (Chicago).—Medical Missions in their Relation to Oxford: Sir H. W. Acland (Frowde).—Advanced Exam. Papers in Book-Keeping, with Notes by J. Thornton (Macmillan).—Boron Food Preservatives, &c. (Perkins).

SERIALS.—Journal of the Franklin Institute, June (Philadelphia).—Proceedings of the American Philosophical Society, December 1897 (Philadelphia),—Proceedings of the Academy of Natural Sciences of Philadelphia, 1897, October-December (Philadelphia).—Transactions of the Wagner Free Institute of Science of Philadelphia, Vol. v., January (Philadelphia)—Annals of the Astronomical Observatory of Harvard College, Vol. xlii. Part 1 (Cambridge, Mass.).—Académie des Sciences de l'Empereur François Joseph I. Bulletin International (Sciences Mathématiques et Naturelles et Médecine) (Prague).—Memorie della Societa Geografica Italiana, Vol. vii. Parte Seconda (Roma).—An Account of the Crustacea of Norway: G. O. Sars, Vol. 2, Parts 9, 10 (Bergen).—Archives of the Röntgen Ray, May (Rebman).—American Naturalist, April (Ginn). Morphologisches Jahrbuch, 26 Band, 1 Heft (Leipzig).—Botanische Jahrbücher, Sechsr. Band, 1 Heft (Leipzig).—Journal of the Scottish Meteorological Society, third series, Nos. 13 and 14 (Blackwood).—Zoologist, June (West).—Jahrbuch der K.K. Geologischen Reichsanstalt, Jahrg. 1897, xlvii. Band, 2 Heft (Wien).—Die Gastropoden der Trias um Hallstatt: E. Koken (Wien).—Psychological Review Monographs, Vol. ii. No. 4 Macmillan).

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