ments of Prof. Haughton are more nearly represented by (3), but that they are in themselves more accurate, is, as will be seen, a matter of doubt. One of the deductions which Prof. Haughton makes from (3) is the determination of his so-called "angular velocity," $w = 0.666 \frac{\pi}{2} = 1.0472$.* The mean value of w as determined from several observations is 1.00. Hence (2) becomes—

$$\text{Total work} = a\left(w + \frac{a}{2}\right)t. \qquad (4).$$

Besides the difficulties already noticed, the conclusion arrived at in (4) is open to several fatal objections, a few of which I will detail.

1. In his reduction resulting in (3), Prof. Haughton assumes the truth of the following law (Prin. An. Mech., p. 442):—"When the same muscle (or group of muscles) is kept in constant action until fatigue sets in, the total work done, multiplied by the rate of work, is constant." By "rate of work" is meant the work per second. But in these experiments the muscles were not "kept in constant action," and even during the interval of work the action of the muscle constantly varies. The "rate of work" is therefore also entirely indefinite.

2. The method of experiment used by me, and which seems to have been followed by Prof. Haughton, I have found entirely unreliable, as will be hereafter shown.

3. Putting $\beta = \left(\frac{2\omega}{\pi}\right)^2$ in (3) and it may be reduced to the form—

$$\frac{n}{t} = A - \beta n t \qquad (3').$$

Anyone who will take the trouble to calculate and co-ordinate the values $\frac{n}{t}$ and nt from Prof. Haughton's observations, pp. 468, 474, will see that these co-ordinated values form a curve, instead of a straight line. This is much more plainly marked in an unpublished series now in my possession. These latter experiments were made with an apparatus and method to be described in the next paper. They are more accurate than those before published, but not as accurate as can be obtained. It is certain, however, that the value of w in (3) is not constant. Assuming it to be constant, however, and its value in the series referred to, lies between 0.30 and 0.50. This illustrates very forcibly the futility of attempting theoretical reductions on the basis of assumed "laws," until we have first made sure of our facts.

Another series of mine which was also reduced by Prof. Haughton consisted in raising a varying weight, w, through the length of the arm in a time $t = 1.164$ sec. The experiments were otherwise conducted as before described. Mr. Haughton makes use of the above-quoted law in this reduction, and finds the relation to be—

$$\left(w + \frac{a}{2}\right)n = \frac{A'}{\left(w + \frac{a}{2}\right)} \qquad (5).$$

For my right arm the constants are $A' = 1000$ and $a = 2.0$. The comparison of n (calc.) and n (obs.) is satisfactory, and for want of space it is omitted. Solving (5) for n and making $w = 7.0$, and making $t = 1.164$ in (3), and the values of n are evidently identical, or—

$$Z \frac{A'}{(7.0 + 1)^2} = \frac{A\, 1.164}{1 + \left(\frac{2\omega}{\pi}\right)^2 (1.164)^2}$$

where Z should equal unity. Solving for Z and introducing the values of the constants, and we find $Z = 1.41$. Although this discrepancy was pointed out to him, Prof. Haughton has transferred unreduced, from the observations leading to (5), the first value of n ($t = 1.164$) in Table I. It is to be regretted that Prof. Haughton did not leave unpublished the last 43 pages of his interesting and valuable work.

FRANK E. NIPHER.

(*To be continued.*)

* A few of these decimals might be dropped without impairing the accuracy of the result.

SCIENTIFIC SERIALS

THE current number of the *Journal of Anatomy and Physiology* commences with a suggestive description, by Dr. J. F. Goodhart, of three cases of malformation of the spinal column associated with lateral curvature, which lead him to the conclusion that cases of asymmetry of the two sides of the spinal column are due to original malformation of the bodies of the implicated vertebræ in the direction of a bi-lobed or double nucleus, and the subsequent unequal growth of the two halves.—Prof. Struthers has also a lengthy article on variations of the vertebræ and ribs in man, which will be read with interest in connection with that of Dr. Goodhart, and by all comparative anatomists, several very instructive abnormalities being described.—This paper is followed by one from the pen of Dean Byrne, on the development of the powers of thought in vertebrate animals in connection with the development of their brain; in which the author, by a comparison of the cerebral capacities of the different families of Mammalia with those of comparative anatomical structure and embryonic development, endeavours to prove that the functions of the anterior lobes of the brain belong to the act of thinking single objects of sense, those of the middle lobes to the act of thinking such objects with a sense of succession of them and as part of that succession, and those of the posterior lobes to the act of thinking a co-existence or succession of them as a case of a general principle.—Prof. M. Watson continues his contributions to the anatomy of the Indian elephant, describing the muscles and blood-vessels of the face and head. The same author also, with a drawing, describes a remarkable case of pharyngeal diverticulum, which opened on the free margin of the posterior pillar of the fauces, occupied the anterior triangle of the neck, and had a duct-like communication with its orifice, running between the internal and external carotids.—Dr. Arthur Ransome records the position of the heart's impulse in different postures of the body, from chest-rule measurements made by Mr. W. A. Patchett.—Baron A. de Watteville describes the cerebral and spinal nerves of *Rana esculenta*, from a series of dissections recently made.—Prof. Turner gives an account of the occurrence of *Phoca greenlandica* as a British species, from a specimen captured in Morecambe Bay and identified by Mr. T. Gough.—Mr. J. C. Ewart records notes on the minute structure of the retina and vitreous humour.—Mr. J. C. Galton also has a note on the Epitrochleo-anconeus or Anconeus Sextus (Gruber) as a supplement to Prof. Gruber's paper, giving drawings of it in *Tamandua tetradactyla, Cholopus didactylus, Phascolomys wombata*, and *Echidna setosa*.—The remaining short papers are by Mr. J. Reoch, on urinary pigments; by Dr. J. J. Charter, on abnormalities of the arteries of the upper extremity; by Mr. J. Harker, on a four-toed fœtus without head or upper limbs; and by Dr. J. Cantlie and Mr. Bellamy, on the absence of the quadriceps-femoris muscle, and on the presence of a sixth lumbar vertebra, the first rib being rudimentary.

THE *Scottish Naturalist* for January maintains the prestige of this interesting quarterly, now entered on its fifth year and third volume. It commences with an article of a more popular character than most:—"Illustrations of Animal Reason," by Dr. Lauder Lindsay, the authenticity of the anecdotes being vouched for by the writer. Among the botanical notes, the most interesting is that of the discovery in Aberdeenshire by Mr. Sadler, during an excursion of the "Scottish Alpine Club," of two plants new to Britain, *Carex frigida* and *Salix Sadleri*, the latter now described for the first time, and probably a hybrid between *S. reticulata* and *S. lapponum* or *lanata*. We have further instalments of "The Lepidoptera of Scotland," by Dr. Buchanan White, and "The Coleoptera of Scotland," by Dr. Sharp.

Poggendorff's Annalen der Physik und Chemie, 1874, No. 11.—The first paper is by W. Müller, of Perleberg, on the reduction of metallic oxides by hydrogen, and the application of this process for the quantitative determination of metals. The value of this method of quantitative determination depends on the fact that hydrogen reduces different metallic oxides at different temperatures. The results of Müller's experiments show that the quantities of several metallic oxides may be determined in this way, when the mixtures are heated in hydrogen, and care is taken with regard to regulation of temperature. The method proved successful for copper and zinc, copper and silver, copper and bismuth, copper and cadmium, copper and lead, copper and tin, copper and iron; also for copper, iron, and zinc, and pretty well for copper, cadmium, and zinc; but it was unsuccessful in the case of silver and iron, silver and lead, arsenic and antimony. The apparatus is simple enough, but the experiments take a very long time, and will not be of much general practical use.—The next paper records some thermo-electric studies by E. Budde.—Dr. Kurd

Lasswitz, of Breslau, contributes an article on the decay of the "kinetic atomic theory" in the seventeenth century.—Another communication is by Dr. H. Streintz, of Vienna, on torsion-oscillations of wires. It is followed by a paper on resistance in galvanic conductors, by H. Herwig. This paper was accidentally delayed, and should have been published before another one on the same subject, which appeared in Part 1874, No. 9, of these Annals.—The next paper, on fluorescence, by O. Lubarsch, is highly interesting. The author gives an account of elaborate investigations he made on the subject, with special reference to spectrum analysis; his general results seem to show (1) that for each fluorescent substance there are only certain rays of light causing fluorescence; (2) that the colour of the fluorescent light depends on the rays of incidence, and follows Stokes's law; and (3) that the most refrangible fluorescent rays, produced by sun-light, correspond to that place in the spectrum where the liquid shows its maximum of absorption, providing its fluorescence proves a simple one, when examined by prismatic analysis of the linear spectrum. In all three points Mr. Lubarsch differs from Pierre and Lommel, who investigated the subject before him.—On the expansion of mercury after Mr. Regnault's experiments, is a valuable communication from Mr. A. Wüllner.—The remaining papers are: On the influence of the temperature of air on the index of refraction, by M. V. von Lang; and on the oblique passage of rays through lenses with reference to a peculiarity of the crystalline lens, by L. Herman.—Besides these, there is a short note by H. Schneebeli, on Hipp's machine for determining the laws of motion.

Der Naturforscher (Nos. 49-52, Dec. 1874.)—Among the papers in this number we note the following:—On currents and temperatures in the Atlantic Ocean; observations made on board the German corvette *Gazelle*, by the commander Herr von Schleinitz, on a voyage to the Kerguelen Islands.—On carnivorous plants; researches made by Prof. Ferd. Cohn, of Breslau, with European species.—Note on the discovery of a new asteroid, 139, on Oct. 13, 1874, by Mr. J. Palisa, at Pola. It appeared of the 11th magnitude, under R.A. 2h. 7m. 19·39s.; Decl. +7° 29′ 50·7″.—On the native iron of Ovifak, Greenland; discussing the question whether this native iron is of meteoric or terrestrial origin.—On the influence of temperature upon the respiration of plants; researches made by Herren von Wolkoff and Mayer at Heidelberg, showing that the influence is not nearly so great as is generally accepted.—On the formation of urea in the animal organism, by Herr von Knieriem.—On attraction and repulsion by heat and light, by A. Bergner; account of experiments made, which led to different results than those obtained by Mr. Crookes.—On the decrease of intensity in the light of Jupiter's satellites when passing over the planet's disc. This was explained by S. Alexander as resulting from interference and absorption of the rays of light; H. J. Klein now gives a much simpler explanation.—On the inorganic cell and the phenomena of growth in the inorganic world, by M. Traube; giving a purely physical explanation for the origin and growth of the cell.—Besides many smaller notes of scientific interest, the last number contains a detailed account of the sledge journeys made by Oberlieutnant Jul. Payer while in polar regions with the Austrian Polar Expedition.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 21.—"On the Origin and Mechanism of Production of the Prismatic (or columnar) Structure of Basalt," by Robert Mallet, C.E., F.R.S., &c.

In this paper the author shows that all the salient phenomena of prismatic basalt as observed in nature can be accounted for as results of contraction by cooling in a homogeneous body possessing the properties of basalt, and that the theories hitherto advanced and repeated in text-books of the production of basaltic prisms are alike untenable and unnecessary. If a large level and tabular mass of homogeneous basalt cool slowly by loss of heat from one or more of its surfaces, the contraction of the mass while plastic will be met by internal movements of its particles; but when the temperature has fallen to a certain point of rigidity reached at between 900° and 600° F., splitting up commences, and that surface will begin to divide itself into similar geometric figures of equal area, which on mechanical principles must be hexagons, the diameter of which is shown to depend upon the relation that subsists between the coefficients of extensibility of the material and of its contraction by cooling down to the splitting temperature. These hexagons are the first formed ends of the future prisms, which split deeper into the mass as cooling down to the splitting temperature reaches deeper into it. When the prisms have split down to a certain distance, further cooling proceeds, not only from the ends of the prisms, which formed the surface of original cooling, but from the sides of the prisms. Now, as each prism is coldest at the end, and hottest where in the act of splitting, and is also hotter along the axis than at the exterior of each prism, so, by contraction, differential strains are produced in each prism, both parallel to the axis and transverse to it, which result in cross fractures at intervals along the length of the prism, the distances between which the author has assigned. Transverse fracture round the prism must commence in the outer *couche* in a plane normal to the resultant of the contractile strains longitudinal to and transverse to the axis of the prism; the fracture commences, therefore, oblique to the prismatic axis. This obliquity diminishes as the transverse contractile force diminishes, as the circumferential *couche* of cooling reaches nearer to the axis of the prism; the result is that the transverse fracture when completed is lenticular or cup-shaped, the convex surface always pointing in the same direction in which the cooling is progressing within the mass.

If the mass cool from the top surface only, the convex surfaces of the cup-shaped joints will all point downwards; if cooled from the bottom only, they will point upwards; and if from both surfaces, the convexity of the joints will be found pointing both upwards and downwards in the mass. As the splitting always takes place normal to the surface of cooling, so, if that surface be level and cool, uniformly, the prisms must be vertical and straight; also, if the cooling surface be a vertical or inclined one, the direction of the prisms will be normal thereto. If, however, the mass cool from its upper or lower surface, but of much greater thickness in one direction than in the opposite one, the prisms formed will not be straight, but have their axes curved, because the successive couches reaching the splitting temperature successively within the mass, and normal to which the splitting takes place, are themselves curved planes. These are a few of the principal points of this paper, which the author believes renders, for the first time, a complete and consistent account of all the phenomena observed in prismatic basalt. A considerable number of these phenomena were referred to and explained by the author. At the conclusion of his paper the author submits to rigid examination the notions which from 1804, the period of Mr. Gregory Watts's paper (Phil. Trans.), to the present time, have continued to occupy the text-books of geologists, and he points out how entirely these fail to account for the phenomena.

Linnean Society, Jan. 21.—Dr. G. J. Allman, F.R.S., president, in the chair.—Dr. Hollis read a paper on the pathology of oak-galls. Oak-galls may be divided into two classes, the unilocular or one-celled, which include the woody marbled oak-galls, the ligneous galls of Réaumur, and the currant leaf-galls; and the multilocular or many-celled, including the spongy oak-apple and the oak-spangles of the leaves. The author went with some detail into the structure and history of development of each of these kinds, taking a few examples of each. With the exception of the oak-spangles, all the different kinds appear to be formed during the growth of the leaf. The pathological differs from the healthy development in the more rapid growth of its cellular elements and in the larger size they attain; this is gained at the expense of the differentiation of the matrix of the bud. The author traced the origin of the different layers of the gall itself to the different layers of the leaf from which it is produced. A discussion followed, in which the President, Mr. Murray, Mr. Howard, Prof. Dyer, and others took part.—The following papers were then read:—Reports of the *Challenger* Expedition; On the Lichens, chiefly of Tristan d'Acunha, by the Rev. Dr. Stirton.—On the Lichen Flora of New Zealand and Chatham Island, by the Rev. Dr. Stirton.

Mathematical Society, Jan. 14.—Prof. H. J. S. Smith, F.R.S., president, in the chair.—Mr. J. W. L. Glaisher gave an abstract of a paper by Prof. Cayley, on the potentials of ellipses and circles. The potential of an ellipse of uniform density (in regard to a point not in the plane of the ellipse) was found by a process similar to that made use of in Gauss' memoir, "Determinatio attractionis quam exerceret Planeta," &c. (1818); the final result resembled in a remarkable manner the formula for the potential of an ellipsoid. The author then deduces a