

the three fundamental sensations, is made only for the sake of greater convenience in discussion.

Indeed there is still much for us to learn regarding the nature of colour sensation. Among the yet unexplained phenomena are those of simultaneous colour contrast. The fact that a small brightly-coloured area on a grey background appears surrounded by its complementary tint is familiar enough. For its explanation it has been common to assume that there is unconscious motion of the observer's eyes, incipient retinal fatigue, an error of judgment, or fluctuation of judgment. This has been tested by A. M. Mayer (*American Journal of Science*, July 1893), who ingeniously devised methods for showing these contrast phenomena on surfaces large enough to match the colours with those of rotating colour discs, and thus to arrive at quantitative statements of their hues. When viewed through a small opening in a revolving disc the subjective contrast colour was unmistakably perceptible when the duration of passage of the opening was less than $\frac{1}{1000}$ of a second. The same effect was obtained in a dark room with instantaneous illumination of the coloured surface by the strong spark of an electric influence machine. The duration of illumination is thus almost infinitesimal, certainly not more than $\frac{1}{100000}$ of a second. The hypothesis of fluctuation of judgment is thus shown to be wholly untenable. I have performed most of these experiments, either with Prof. Mayer or separately, and my testimony can therefore be united with his. The case is quite analogous to that of the perception of binocular relief, which was once explained as the product of a judgment, but was found to be always possible with instantaneous illumination. Prof. Mayer has devised a disc photometer based on colour contrast, with which the error of a single reading was found much less than with the Bunsen photometer.

The rotating colour disc has been applied by O. N. Rood (*American Journal of Science*, September 1893) to the determination of luminosity independently of colour, by taking advantage of the flickering appearance on a rotating disc upon which two parts have different reflecting powers. An extreme case of this is that of a white sector upon a black disc. At a certain critical speed the retinal shock due to momentary impression by white light becomes analysed into the subjective impression of spectral colours, the duration of the retinal sensation varying with the wave-length of the incident light. The law of this variation has been studied by Plateau ("Dissertation sur quelques propriétés des impressions produites par la lumière sur l'organe de la vue," Liège, 1829), Nichols (*American Journal of Science*, October 1884), and more recently with much precision by Ferry (*ibid.*, September 1892), who showed that retinal persistence varies inversely as the logarithm of the luminosity. For a given source of light separated into its spectral components, the yellow is the brightest. For this hue accordingly the retinal impression is shortest, and for violet it is longest.

Under appropriate conditions the after-effect on the retina has a certain pulsatory character, as first noted by C. A. Young (*Philosophical Magazine*, vol. xliii. p. 343, 1872) in 1872, and carefully studied within the last few years by Charpentier ("Oscillations rétinienne," *Comptes rendus*, vol. cxiii. p. 147, 1891) in France, and Shelford Bidwell ("On the Recurrent Images following Visual Impressions," *Proc. Royal Society*, March 27, 1894) in England. A disc with properly arranged black and white sectors, if brightly illuminated and looked at while revolving at a moderate rate, becomes apparently coloured, just as a momentary glance at the sun causes the perception of a succession of subjective spectral hues which may last a number of seconds. The phenomenon in relation to the disc was known as early as 1838 (Fechner, *Poggendorff's Annalen*, 1838), and explained by Rood (*American Journal of Science*, September 1860) in 1860. The re-discovery of what has been long forgotten arouses all the interest of novelty. The "artificial spectrum top," devised by Benham (*NATURE*, November 29, 1894, p. 113) last autumn, excited interest on two continents, and was promptly copy righted by a prominent firm of opticians (*ibid.*, March 14, 1895, p. 463) in England. It would perhaps be equally enterprising to copyright the solar spectrum.

The limits of a single address forbid my touching upon the large and practically important subject of colour blindness. Indeed, in both physical and physiological optics much has been omitted that is abundantly worthy of attention. In behalf of my hearers it may be wise to take heed, once more, of the fate of Tarpeia, who was overwhelmed with the abundance of her reward.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Technical Education Board of the London County Council has just awarded 278 minor scholarships, viz. 178 to boys and 100 to girls in Elementary Schools; 334 scholarships of the same class were awarded last spring, upon the results of examination, so that altogether the number awarded by the Board in 1895 was 612.

At a meeting of the Fellows of the Royal College of Surgeons, held on Thursday last in the theatre of the college, a resolution was carried, "that, in the opinion of the Fellows of this college, women should be admitted to the diplomas of the college," forty-seven Fellows voting for the resolution and only ten against. The Fellows alone form the electorate who vote for election to the council, and the effect of this resolution will probably cause the council (who are understood not to be unwilling) to open the examinations to women candidates. At a mixed meeting of Fellows and members, called by the President last November to consider an application from the Dean of the London Medical School for Women for this privilege, Mr. Clement Lucas's proposal to the same effect was negatived by the narrow majority of ten in a house of over a hundred.

IN connection with the new Technical Institute recently opened at Wandsworth, the London *Technical Education Gazette* recalls the interesting fact that the first technical school in this country was opened in Wandsworth. The third annual report issued by the Science and Art Department, in 1856, gives an interesting account of this first technical school, which was called the Wandsworth Trade School. The curriculum included partly subjects of general instruction and partly courses of trade instruction classified under three heads, according as they had relation to (1) the building trades, (2) the mechanical and engineering trades, and (3) the chemical and manufacturing trades. The new Technical Institute will, it is hoped, revive the traditions established by the pioneer school of 1856. In addition to an equipment grant of £500, the Technical Education Board has agreed to contribute £1000 to the maintenance of the institute for the current year, apart from any grants which it may make for the maintenance of the technical day school.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. ii. No. 2, November 1895.—Concerning Jordan's linear groups, is a paper by Prof. E. H. Moore, which was read before the Society in August last. It is a continuation of a paper read in November 1894, entitled "The group of holoedric transformation into itself of a given group" and is an exhaustive one supplemented by numerous bibliographical details.—Prof. A. S. Hathaway presented, at the same meeting in August, an elementary proof of the quaternion associative principle. Hamilton in his "Elements" writes: "The associative principle of multiplication may also be proved without the distributive principle, by certain considerations of rotations of a system, on which we cannot enter here." This note states that it is easy to see that such a proof is possible; but the details of it could not have presented themselves to Hamilton in an elementary form, or he would have seen that it was just the demonstration for which he was looking, simple in character, and direct in its application. We are not sure that we have not seen a proof somewhat similar to the Professor's, but we cannot recall it to our recollection. The proof given is a simple one.—The next article is a paper read at the October meeting of the Society, entitled "Moral Values," by Mr. R. Henderson. The author reminds us that the question of moral values in connection with the theory of probability has given rise to great diversity of opinion among mathematicians, and that Bertrand, in his classical work, dismisses it with contempt. More than the usual space is devoted to the notes and new publications.

American Meteorological Journal, December 1895.—Psychrometer studies, by Dr. Nils Ekholm. This article chiefly refers to the peculiar action of the wet-bulb thermometer near the freezing point of water. The author's observations and other investigations show that in an air saturated with water-vapour, the ice-covered bulb reads higher than the water-covered one, which, under those conditions, reads exactly as the dry bulb. These results are explained by Prof. W. Ramsay's experiments, which prove that there is a difference in the tension of water-

vapour and ice-vapour at the same temperature.—Meteorology as a University course, by R. de C. Ward, Instructor in Meteorology in Harvard University. The author's aim is to show the need of more instruction in meteorology, and to emphasise the fact that instruction is needed in general, rather than in the higher mathematical and physical meteorology; while the investigation of problems in the latter branches should be undertaken by eminent physicists who are fitted to do work of such an advanced character. The author considers that, at the present time, Germany takes the lead in the teaching and in the research of meteorology.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1895.—“Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part X. On the complete Skeleton of an Anomodont Reptile (*Aristodesmus Rüttimeyeri*, Wiedersheim), from the Bunter Sandstone of Reichen, near Basel, giving new Evidence of the Relation of the Anomodontia to the Monotremata.” By H. G. Seeley, F.R.S.

The author has examined the fossil described by Dr. Robert Wiedersheim in 1878 as *Labyrinthodon Rüttimeyeri*. The bones are differently interpreted:—

The reputed humerus is the interclavicle.

The reputed right and left coracoids are the pre-coracoid and coracoid of the right side.

The author regards the Labyrinthodont osteology as demonstrating close relationship with Ichthyosauria and Anomodontia. The group forms a branchiate division of the reptilian class.

The fossil now named *Aristodesmus* is identified as an Anomodont reptile chiefly on the basis of resemblances to *Procolophon* and *Pareiasaurus*.

The teeth are in sockets placed obliquely. The proportions of the vertebral column are those of *Echidna*, though the transverse processes are longer. The ribs are those of a Monotreme. The shoulder girdle resembles *Procolophon*, and the humerus does not show the peculiar lateral curvature seen in Monotremes. The ulna gives no evidence of an olecranon process; the pelvic bones are without acetabular or obturator perforations, are not ankylosed together, and the ilium is not expanded transversely. The femur is more slender than in *Echidna*. The fibula is prolonged proximally beyond the stout tibia, round which it may rotate. The proximal row of the tarsus is one large bone, the blended astragalus and os calcis.

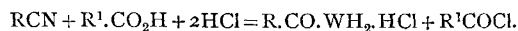
Monotreme mammals make a close approximation to this fossil and other Anomodontia. A group *Theroptida* may be made to include Monotremata and Anomodontia. *Ornithorhynchus* shows pre-frontal and post-frontal bones, and has the malar formed as in Anomodonts.

Aristodesmus is placed in the Procolophonina, which has two occipital condyles, with the occipital plate vertical, without lateral vacuities; and has the shoulder girdle distinct from Pareiasauria in the separate pre-coracoid extending in advance to the scapula.

PARIS.

Academy of Sciences, December 30.—M. Marey in the chair.—Development of the lymphatic vessels, by M. L. Ranvier. The author has examined the development of the lymphatic vessels in the embryo of the pig. By examining the mesentery, hardened in osmic acid and stained with picricarmin, no lymphatic vessels can be observed in embryos of less than 9 cm. in length, the first signs appearing in those of 10 cm. The conclusion is drawn that the lymphatic system may be considered as an immense vascular gland, having its embryological origin in the venous system, and throwing its secretory product, the lymph, into the veins.—On the second scientific expedition of the *Princesse Alice*, by Albert First, Prince of Monaco. (See pp. 223–225.)—Note on the history of seas, by M. Suess. From the results of geological explorations, by MM. Mojsisovics, Waagen, and Diener, undertaken with special reference to the Trias formation, the conclusion is drawn that at that period the Pacific Ocean possessed two great branches—one (the Arctic branch) stretching over Eastern Siberia as far as Spitzbergen, the other across Central Asia and the Alps up to the Western

Mediterranean.—On the acoustic analysis of mixtures of two gases of different densities, by M. E. Hardy. The method was capable of detecting one volume of illuminating gas in 1000 volumes of air.—Observations, made at the observatory of Algiers, of Brooks' and Perrine's comets, by MM. Rambaud and Sy.—Observations of Faye's comet and a minor planet, made at the Toulouse Observatory, by M. F. Rossard.—Observations of the sun, made at the observatory of Lyons, by M. J. Guillaume.—On some problems in variations, by M. G. Kœnigs.—On the summation of divergent series, by M. E. Borel.—On a new transformation of Taylor's theorem, by M. N. U. Bougaief.—On the unicursal varieties of three dimensions, by M. Antonne.—New properties of the cathode rays, by M. Jean Perrin. According to the views of Goldstein, Hertz, and Lenard, the cathode rays are due, like light, to a vibration of the ether; whilst Crookes and J. J. Thomson prefer to attribute the phenomena to matter charged negatively travelling with a high velocity. All the results of the extremely ingenious experiments of M. Perrier tend to show that the latter view is the correct one.—Observations on the zodiacal light, made at the observatory of the Pic du Midi, by M. E. Marchand.—On the elliptical refraction of quartz, by M. G. Quesneville. It is shown by a recalculation of Jamin's experiments, that the formula used by Jamin, calculated from Airy's theory, gives quite erroneous results in the neighbourhood of the axis.—The position in the solar spectrum of the calorific maximum, by M. Aymonnet. A comparison of the results obtained by various workers in this subject, shows that the position of this maximum depends not only on the composition of the prism, but also on the other parts of the spectroscopic which reflect or transmit the ray. The continual variation in the intensity of the solar radiation is also a source of grave error in these measurements.—On the mechanical production of extreme temperatures, by M. E. Solvay. Remarking on the liquefaction of air in quantity recently achieved by M. Linde, M. Solvay observes that he used the same principle, the successive expansions of the same quantity of gas, in 1886, but, having imposed on himself as practical conditions that the pressure must not exceed 5 atmospheres, and not take more than 15-horse power, the lowest temperature he actually reached in this way was -95° . It is further pointed out that inversely the same principle would serve to reach extremely high temperatures, were it not for the fact that these can be more easily attained by electrical means.—On the combustion of acetylene, by M. H. Le Chatelier. Mixtures of acetylene with air containing less than 7.7 per cent. of acetylene, burn completely to water and carbon dioxide, for proportions of acetylene between 7.7 per cent. and 17.4 per cent., the products consist of water, carbon monoxide and dioxide, water, and hydrogen, in mixtures containing more acetylene than this free carbon and unburnt acetylene are found. With oxygen, mixtures containing anything between 2.8 per cent. and 93 per cent. of acetylene will catch fire; with air the limits are 2.8 per cent. and 65 per cent. In tubes, these limits are narrowed down, until in tubes of 0.5 m. diameter or less it is impossible to propagate a flame.—On the fixation of nitrogen by the metals of the alkaline earths, by M. L. Maquenne. After referring to his earlier work on this subject, the author describes a simple lecture experiment illustrating the ease with which nitrogen is absorbed. A mixture of lime and magnesium powder heated in a hard glass tube over a Bunsen burner will, in five minutes, absorb 96 per cent. of a confined volume of air.—On crystallised titanium and the combinations of titanium and silicon, by M. L. Levy. A silicide of the composition Ti_2Si has been isolated.—On the rotatory power of rhamnose in a state of superfusion, by M. D. Gernez. The rotatory power of fused rhamnose diminishes regularly with rise of temperature; at 100° it is only 61 per cent. of its value at 0° , and is in all cases less than that deduced from the rotatory power of its solutions.—On some dithiazolic derivatives, by M. C. Lauth.—Syntheses of acid chlorides and amide hydrochlorides, by M. A. Colson. The following reaction is found to occur.



when R, R¹ may be methyl or ethyl. This reaction is suggested as a method for preparing acid chlorides without the use of the phosphorus chlorides. If the acid is replaced by its anhydride the yield is improved.—Action of the halogens upon formaldehyde, by M. A. Brochet. In the case of chlorine, the primary reaction is $CH_2O + Cl_2 = CO + 2HCl$. The $COCl_2$, previously observed, is a secondary product.—On essence of lemon, by