so small that it can be neglected, and that a spherical form is as good if not better than any other; and there is no doubt, for telescopes of about this ratio, Sir John Herschel is quite right when he makes the statement in "The Telescope," p. 81, "that is a good form that gives a good image; and that the geometrical distinctions between the parabola, sphere, and hyperbola, become mere theoretical abstractions in the figuring and polishing of specula." But in the case where the aperture of the mirror is about one-sixth of the focal length the distinction betwen the sphere and the parabola does exist and becomes a large quantity, which only the Foucault method of working allows to be dealt with properly. In enumerating the different plans used by opticians in getting the parabolic curve, the author is in error in stating that Lassell adopted the method of local polishing, as he always used a large tool, and got the figure by alterations of the stroke. Foucault was the inventor of the system of local polishing, and this was afterwards used by Draper, who finally rested on that as the best method of working.

The author considers that when the focal length exceeds 40 feet even with a theoretically perfect mirror the slightest touch or variation in temperature will be sufficient to destroy good definition with high powers, irrespective of the disturbing effects of the atmosphere, and he comes to the remarkable conclusion that "by decreasing the focal length the rays cross at a less acute angle, and small variations in the reflecting surface have not so detrimental an effect"—a statement that is entirely unsupported.

No actual tests of the work that the 18-inch mirrors will do are given. The experiments on the thickness of silver-on-glass films are interesting, as are also those on the effect of pressure or heat in altering the colours or colour-bands seen between two plane surfaces almost in contact. Dr. Draper, by actually weighing the amount of silver deposited on a large surface, came to the conclusion that it was about 1/200,000 of an inch thick; and the author, by comparing its thickness with the length of a wave of light, comes to about the same conclusion, and considers that by ordinary care in polishing no optical change will be produced in the reflecting surface by the film of silver deposited upon it.

The roads to success in making the mirrors of a reflecting telescope are many and various. Almost every maker in this fascinating pursuit had his own that gave to him best results. This was more particularly the case before Foucault published his most admirable memoir on the construction of silver-on-glass telescopes. In this memoir Foucault describes his method of local polishing, and the tests that can be applied to the concave surface, and a method of obtaining the true parabolic surface with absolute certainty, bringing the art of specula-making at once to a system of working by measurements in place of the old empirical process that had up to that time been in use; and everyone now uses Foucault's method of *testing* concave surfaces, and nearly everyone his plan of figuring by local polishing. Mr. Madsen gives a very interesting account of the road he took, an account that would have been much more valuable if the details of the processes used in making both the concave and the flat mirrors had been fully given, as it is now more in the improvements in these details that gain is to be looked for than in any of the main lines already known.

A. AINSLIE COMMON.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 2.—"On the Spectrum of the Oxyhydrogen Flame." By Profs. G. D. Liveing and J. Dewar.

In a former communication the authors described simultaneously with Dr. Huggins the strongest portion of the spectrum of water; subsequently they described a second less strong but more refrangible section of the same spectrum. M. Deslandres has noticed a third still more refrangible section. The authors now find that the spectrum extends, with diminishing intensity, into the visible region on the one hand, and far into the ultra-violet on the other. These faint parts of the spectrum they have photographed, using the dispersion of a single calcite prism and a lengthened exposure; and in the present communication they give a map of the whole extent observed, and a list of wave-lengths of upwards of 780 lines.

The spectrum exhibits the appearance of a series of rhythmical groups more or less overlapping one another, and the arrangement of the lines in these groups is shown to follow, in many cases, the law that the distances between the lines, as measured in wave-lengths, are in an arithmetic progression. M. Deslandres had previously announced that the succession of lines in several spectra, as well as in the telluric groups A, B and α of the solar spectrum, follow this law when their distances are measured in reciprocals of wave-lengths, and he has stated that the groups A, B and α have counterparts in the spectrum of water. The authors find a striking resemblance between those groups and certain parts of the water spectrum, but no exact correspondence.

Dr. Grünwald, of Prague, predicted on theoretical grounds that certain lines would appear in the spectrum of water, and the authors have found a considerable number of lines which tally closely with Dr. Grünwald's predictions, some of them, in the extremities of the spectrum, being the strongest lines observed in those regions.

February 9.—"True Teeth in the Young *Ornithorhynchus paradoxus*." By Edward B. Poulton, M.A., F.L.S., of Keble and Jesus Colleges, Oxford. Communicated by W. K. Parker, F.R.S.

This paper was a preliminary account of typical mammalian teeth developing beneath the site of the horny plates, which subserve mastication in the adult animal. In the upper jaw there are three teeth on each side: in the lower jaw two teeth, corresponding to the two posterior teeth of the upper jaw, were proved to exist, but the anterior one may be also present, for the jaws examined were not complete. The animal in which the teeth were found was about 8·3 decimetres long in the curled up attitude in which it had been received, and the larger hairs had alone appeared above the skin.

The anterior tooth of the upper jaw was long, narrow, and simple, as compared with the others; it was very fully developed, containing completely formed dentine and enamel, and its apex was nearly in contact with the lower surface of the oral epithelium. All the other teeth were broad and large, those of the upper jaw possessing two chief cusps on the inner side of the crown, and three or four small cusps on the outer side, while this arrangement was reversed in the lower jaw. Dentine was only formed upon the large cusps, and was not present upon all of these. The histological details and the manner of development appear to be precisely as in the higher Mammalia, a fact which strongly supports the identification of teeth with the placoid scales of Elasmobranchs. If teeth are so extremely ancient, then we should expect them to be unmodified in the ancestral Mammalia, although the other more recently specialized characters in the higher mammals are found in a more primitive condition in the former.

The teeth were found in some sections of the skull prepared for Dr. Parker by his son, Prof. W. Newton Parker. These sections, which had not been examined by Dr. Parker, were lent to the author, and Dr. Parker most generously encouraged the publication of the discovery, and assisted the investigation with other material.

Mathematical Society, February 9.—Sir J. Cockle, F.R.S., President, in the chair.—Messrs. A. E. H. Love and G. G. Morrice were admitted into the Society.—The following communications were made:—Further remarks on the theory of distributions, by Capt. Macmahon, R.A.—The free and forced vibrations of an elastic spherical shell containing a given mass of liquid, by A. E. H. Love.—On the volume generated by a congruency of lines, by R. A. Roberts.—Isoscelians, by R. Tucker.

EDINBURGH.

Royal Society, January 16.—Prof. Chrystal, Vice-President, in the chair.—Obituary notices of some former Vice-Presidents of the Society were read.—Prof. Tait communicated a paper by Prof. A. Macfarlane, on a problem in relationship.—Mr. W. Peddie read a paper on transition-resistance and polarization at platinum surfaces. He showed that transition-resistance increases greatly while polarization is proceeding. The ratio of the final to the initial resistance is in some cases as 2 to 1, when the electromotive force of polarization is equal to that of a Daniell cell. From his results regarding the time-rate of increase of polarization he deduced (10^{-9}) cm. as the value of the distance between the platinum and the layer of gas

condensed upon it.—Mr. Peddie also read a note showing that the phenomenon of "electric-absorption" must be exhibited if a dielectric has a film of gas condensed on its surface.—Prof. Tait communicated a paper by Mr. Albert Campbell on the change in the thermo-electric properties of tin at its melting-point. While the tin is solid its line on the thermo-electric diagram is inclined upwards. Liquefaction occurs before the line reaches that of iron. At this point the direction of the line changes and becomes nearly identical with that of iron. Thus the "specific heat of electricity" in tin changes sign at the melting-point. This shows that the loosening of molecular attraction, which occurs at the melting-point, produces the same effect in tin as is produced in iron, while still solid, at the higher of the two temperatures at which its magnetic and other properties suddenly alter.—Prof. Tait read a paper on the thermo-electric properties of Signor Battelli's iron; and showed from Mr. Omond's Ben Nevis observations that ice-crystals may, in the greater number of cases, have at least a share in the production of the observed phenomena.

PARIS.

Academy of Sciences, February 6.—M. Janssen in the chair.—Second note on the law of probabilities as applied to target-firing, by M. J. Bertrand. The paper deals specially with the objections urged by General Putz in the *Revue d'Artillerie* against the principle admitted by Poisson, and against the law of probability now generally adopted in schools of gunnery. Reference was also made by General Menabrea to the important researches of M. Siacci in this field of inquiry.—Remarks in reply to an objection raised by M. Khandrikoff to the theory of solar spots and protuberances, by M. H. Faye. During his observation of the recent lunar eclipse Prof. Khandrikoff noted some protuberances, the presence of which in the absence of spots for some days before the eclipse seemed to militate against M. Faye's well-known theory. To this objection M. Faye replied at some length, pointing out that it is partly based on a misunderstanding of the true character and bearing of his views.—On perfect numbers, by Prof. Sylvester. Recently M. Servais stated that a perfect number (if such exist) containing only three distinct prime factors is necessarily divisible by 3 and 5. It is here shown that no such number exists, the line of argument employed at the same time demonstrating the theorem that there exists no perfect number containing less than six distinct prime factors.—Observations made at the Observatory of Algiers during the total lunar eclipse of January 28, by M. Ch. Trépied. These observations comprise, among other matters, a study of the colours assumed by the lunar disk; a spectroscopic examination of the eclipsed portion of the disk; and the occultations of the stars contained in the list prepared by the Observatory of Pulkowa for the purpose of obtaining an exact determination of the apparent diameter of the moon. Communications were also received from the Observatories of Bordeaux and Nice on various phases of the same occurrence.—Ephemeris of the planet 252 for the opposition of the year 1888, by M. Charlois. The true positions, right ascension and declination, are given for the period from March 5 to March 19. At opposition (March 12) the magnitude will be 13·4.—Note on permanent deformations and thermodynamics, by M. Marcel Brillouin. Two propositions are established: (1) that for most elastics solids there exists no finite relation between the temperature t, the mechanic variable X, and the geometric variable x; (2) that for most solid bodies there exists a linear equation with total differentials between t, X, and x; or, more correctly, there exist as many equations of this class as there are independent geometric variables. In a future communication the theoretic results of this study will be announced.—Influence of diet in determining the fixation and elimination of carbon in man, by MM. Hanriot and Ch. Richet. The results are tabulated of mixed nitrogenous, fat, and feculent diets, including beef, bread, potatoes, butter, cheese, sugar, wine, and coffee, continued for a period of fifteen days.—On the presence of striated muscles in mollusks, by M. Raphael Blanchard. M. Hermann Fol's recent statement that true transversal striation of the muscular fibre is found in no mollusk, is shown to be erroneous and based on defective observation of these organisms, in some of which true transversal striation certainly occurs.—On the endomorphic modifications of the granulitic systems in Morbihan, Brittany, by M. Charles Barrois. This paper is devoted to a careful study of the remarkable endomorphic modifications and mechanical transformations of the Guéméné, Saint-Jean Brevelay, and Grandchamp granulitic formations, which traverse the Department of Morbihan in its entire length, and the typical constituents of which are: (1) zircon, apatite, black mica, oligoclase, orthose, and quartz; (2) orthose, microcline, quartz, tourmaline, and white mica.—On the Senonian and Danian systems of South-East Spain, by M. René Nicklès. Without attempting accurately to determine the respective limits of these formations, the author indicates the presence of extensive marine deposits in the Devonian containing fossiliferous limestones with several species of Hemipneustes associated with large banks of Hippurites and Pironea.—General Menabrea presented to the Academy the prospectus of a new edition of the works of Galileo, in about twenty-five volumes, which is about to be issued at the expense of the Italian Government, and copies presented to all the more important public libraries.—The Administrative Commission of the Academy announces that it has decided to supply Corresponding Members with the *Comptes rendus* free of charge from January 1, 1888. Correspondents are requested to acknowledge receipt of the first number, and notify their change of address to Messrs. Gauthier-Villars et Fils, publishers, Paris.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Treatise on Photography, 5th edition: Capt. Abney (Longmans).—The Story of Creation: E. Clodd (Longmans).—British Dogs, parts 15 and 16: H. Dalziel (U. Gill).—Beobachtungen der Russischen Polarstation an der Lenamündung, ii. Thiel, Meteorologische Beobachtungen: A. Eigner; II. Liefg. Beobachtungen vom Jahre 1883-84: R. Lenz.—Meteorological Observations at Stations of the Second Order for the Year 1883 (Eyre and Spottiswoode).—The Geographical Distribution of the Family Charadriidæ, H. Seebohm (Sotheran).—Annuario publicado pelo Imperial Observatorio do Rio de Janeiro, 1885-86-87 (Rio de Janeiro).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 4th Series, vol. i. No. 2.—(Manchester).—Proceedings of the Manchester Literary and Philosophical Society, vol. xxvi. (Manchester).—Zeitschrift der Gesellschaft für Erdkunde zu Berlin, Nos. 133 und 134 (Reimer, Berlin).

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