like that of the female. Young males appear to have a more powerful syrinx than adult females.

The chapter dealing with the development of song and other forms of display are full of thoughtful matter. Special mention is given to Rohweder's recent interpretation of the curious bleating or drumming of the snipe. This observer contends that this strange music is caused by the rapid vibration of the horizontally extended and half-closed wings, which drive a strong current of air against the stiffened outer tail feathers, setting them in rapid vibration, and causing the curious tremulous bleating sound. This explanation differs somewhat from that of Meeves and others, and is probably the most nearly correct explanation we have yet had.

We heartily commend the book to the notice of ornithologists. W. P. P.

Physikalisch-chemische Propädeutik. Zweite Hälfte, 1-3 Lieferungen. Von H. Griesbach. (Leipzig: W. Engelmann, 1896-1900.)

THIS book, the first part of which has already been reviewed in NATURE, is chiefly intended for those interested in medical science. In it Prof. Griesbach discourses of everything from the law of gravitation and the conception of potential to the chemical nature of disinfectants and the morphology and physiology of bacteria. There is no particular arrangement in the book; chapter xxiii, on molecular mixtures, occupies 232 pages, whilst chapter xxiv, on the factors of energy, occupies 4. It must not be supposed, however, that the book is on this account uninteresting—far from it; it is excellent reading, and is both wonderfully accurate and wonderfully complete. Indeed, the struggle after completeness seems to be the author's chief failing. In connection with semipermeable membranes, he happens to mention sugar. This at once prompts him to give the means of detecting sugar:—smell of caramel, "French word from Latin *canna mellis*, honey-cane, i.e. sugar cane," and reduction of Fehling's solution, which necessitates a short biography of Fehling. Exact instructions for the preparation and use of Fehling's solution are then given. This, of course, involves reference to Rochelle salt, whence "Pierre Seignette, born when and where? physician and apothecary in Rochelle, died at Rochelle, 11 March, 1719." After nearly two large and closely printed pages we get back once more to semipermeable membranes. This is propædæutic with a vengeance.

Despite its faults of method the book is a mine of valuable information, and can be cordially recommended to any medical man with a taste for the physical sciences.

Annals of Politics and Culture (1492-1899). By G. P. Gooch, M.A., with an introductory note by Lord Acton. Pp. 530. (Cambridge: University Press, 1901). Price 7s. 6d. net.

THE object of this work, as set forth in the preface, may at first-sight appear pretentious and impossible of achievement, viz., to present "a concise summary of modern times, embracing the life of mankind in its entire range of thought and action." As soon, however, as the reader has mastered the plan of the book it will be found that the author has carried out his object—originally suggested by Lord Acton—with remarkable skill and completeness. Politics occupy the left and culture the right hand series of pages. At the top corner of each page is the date in conspicuous type, and a further subdivision under the two headings enables the reader to pick out at once the particular subject or country. The political subjects are classified under countries and the culture subjects under various headings, such as art, science, philology, history, philosophy, literature, education, economics, archæology, social, deaths, &c. Of course it is

the scientific references that will chiefly appeal to our readers, and so far as we have tested these they appear to be both accurate and complete. The author has evidently been well advised in his choice of scientific events and due proportion as to the relative importance of discoveries in different branches of science which, under a chronological classification, have necessarily to be brought into juxtaposition, has on the whole been carefully observed throughout the long period of more than four centuries covered by the work. A very complete index, composed both of names and subjects, is correlated with the contents of the volume by reference numbers and not pages, ordinary numerals referring to politics and italicised numerals to culture subjects. As a book of reference, workers in the history of science will find Mr. Gooch's volume of great value. R. M.

The Child: His Nature and Nurture. By W. B. Drummond. Pp. 146. (London: J. M. Dent and Co.; no date.) Price, 1s. net.

IN the preface of this primer it is stated that the book is intended as an introduction to the study of the physical and mental development of the child, and it is admirably fitted for this purpose. It covers a wide range, but is concise, clear and interesting, and brings within a small compass the result of recent work in the study of children. It is a book which should be in the hands of every one who has to do with children, and besides being a practical help in dealing with the infant and growing child, we think it will stimulate further child-study.

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.)

The Smithsonian Solar Eclipse Expedition.

THE Smithsonian Institution has sent out a small party to Sumatra, under the immediate charge of Mr. C. G. Abbot, to continue certain of the observations described in NATURE of July 12, 1900, where these, on account of the narrowness of the eclipse track and the brevity of the time, were indeterminate.

The expedition sailed on February 16 in the Government transport *Sheridan*, and the Institution has learned of the arrival of the party at Padang, Sumatra, on the *General Alauz*, a United States naval vessel.

The objects principally sought are, such a thorough photographic search in the neighbourhood of the sun, for possible intramercorial planets, as may be apt to set the question of their existence at rest; and also a further and more complete study, by the bolometer, of the heat of the corona.

The observations of May 1900 were three in number:—

- (1) One on the radiation from the screen. This was arbitrary and may be called zero.
- (2) One on the dark moon, giving on the millimetre scale -18, showing that the bolometer was radiating to the moon.
- (3) One on the inner corona, giving -13, showing that the bolometer was radiating to it, though in a less degree than to the moon.

The algebraically increased reading for the coronal radiation then $(-13 - (-18)) = +5$ was probably due to this coronal radiation, together with possibly something from the different radiations of the closely neighbouring parts of the sky used in the two observations.

Since the Wadesboro experiments the bolometer has been set on a screen of its own temperature, giving zero; on the bright moon, giving +55, and on the night sky near the moon, giving -30.

From my study of the visual photometric observations made at Pike's Peak in 1878, and at other places, it appears that the average visual brightness of the portion of the corona covering the bolometer at Wadesboro was approximately equal to that of the full moon.

I infer, then, that the full moon being of the average brightness

of the observed portion of the inner corona, the bolometric effect of its visual radiation may be supposed to be equal to that of the latter; but the observations above recorded show that the total radiations from the moon being $55 + 30$, or eighty-five bolometric divisions, are seventeen times as great as the radiations from the inner corona, and hence it may be supposed that the corona lacks that large amount of infra-red radiation which is proper to the moon's spectrum.

The moon's spectrum, however, is that of a heated solid body, and all heated solid bodies, and heated gaseous bodies as well, send to the bolometer large amounts of infra-red radiation. So far, then, we might conclude that the inner corona has not the radiations of a hot solid or gaseous body, but, owing to the lack of a contemporary measure of the sky radiation just outside the corona, and of a full knowledge of the influences that the atmospheric radiations would have on our ability to discriminate this, the above conclusions seemed to me only probable, and worth verification at the forthcoming eclipse.

Smithsonian Institution, April 29.

S. P. LANGLEY.

The Persistence of the Spectrum of Carbon Monoxide.

THE letter of Dr. Carl v. Wesendonk (p. 29), which gives an account of the spectrum of carbon monoxide appearing in a vacuum tube containing silicon tetrafluoride, affords an instance of the extreme difficulty of obtaining vacuum tubes charged with perfectly pure substances. The case he cites of silicon fluoride being prepared from "pure" sulphuric acid, glass and fluor spar, without any but glass joints to connect the different parts of the apparatus, is one in which neither the perfect freedom of the sulphuric acid, nor of the glass itself, from carbon compounds can be relied upon. In experiments on the absorption spectrum of ozone made by me in 1881, it was found that strong sulphuric acid free from all the usual impurities was not absolutely clear, but by being kept in an atmosphere containing a large proportion of ozone it became perfectly brilliant and absolutely colourless when seen in volumes of half a gallon to two gallons at a time. It appeared from further experiments that the impurities were either carbon or some form of organic matter probably coming from dust or dirt. As to the purity of the glass used for vacuum tubes, it may be remarked that dust and condensed vapour from carbonaceous matter, such as the products of combustion from lamp oil or coal, adheres to its surface with much tenacity. It is probable that the fluor spar contained organic matter, for the reason that this substance is associated with limestone of a bituminous character in England and that it has been asserted that its colour is due to organic substances. By the action of sulphuric acid a gaseous carbon compound might easily be evolved which would contaminate the silicon fluoride even if there were no carbonates present. Next we have to consider the traces of air which may remain in the tube, and must not regard these as being absolutely free from hydrocarbons. M. Armand Gautier has shown that there are combustible gases in the atmosphere, one of which is a hydrocarbon, the other hydrogen, and there is also some carbon monoxide. The difficulty of removing these by ordinary chemical treatment is so great that special operations and reagents were provided for their removal.

In vacuum tubes it is known that carbon monoxide shows its spectrum brilliantly when the pressure is extremely low, and that subsequently it disappears. The very interesting research of Prof. Smithells on "The Spectra of Carbon Compounds," in the April number of the *Phil. Mag.*, illustrates this. Furthermore, it shows distinctly that the same spectrum is obtainable from both carbon monoxide and carbon dioxide (*loc. cit.* pp. 489 and 490). We know, too, from the experiments of Regnault and of Bunsen on the analysis of atmospheric air, that carbon dioxide is absorbed by glass. In view of the facts quoted by Prof. Smithells, the carbon monoxide spectrum is, in his opinion, really due to carbon dioxide, but this latter may easily be decomposed into carbon monoxide and oxygen under the influence of the spark discharge.

The Swan spectrum, attributed variously to a hydrocarbon and to the element carbon by previous investigators, is, according to Smithells, to be attributed to carbon monoxide. It appears also in Dr. v. Wesendonk's letter that when the glass tubes in which the electrodes were fused had become heated, the carbon monoxide spectrum was faintly visible. This would be quite in accordance with the probability that carbon dioxide was evolved from the glass.

A tube containing silicon hydride also showed the carbon monoxide and the Swan spectrum, as well as hydrogen and mercury lines, but no silicon lines were observable. Considering all the facts of the case, it is not conceivable that the spectra in question arise in any way from the decomposition or dissociation of the silicon in the compound, either in the state of vapour as fluoride, of gas as hydride, or in the solid state as glass.

W. N. HARTLEY.

April 25.

The Use of "Axis-vectors."

THE effort to popularise the elements of vector algebra is commendable. The power and the direct insight conferred by the use of vector quantities should be sought consistently in the study of physics; and it is true that the introduction of these methods has been needlessly postponed. But it lies in the very nature of such benefits that they are not to be secured except upon tenable grounds and as the result of a continuous argument. If a particular quantity is to be classed with vectors, that cannot be done upon a basis which is reducible to the bare statement: "This magnitude may be represented by a straight line of given direction and length; therefore it is a vector." Witness, for example, moment of inertia, which is not properly a vector, although its magnitude can be associated with a rotation-axis. Vector quantities must be subject to the process of "geometrical addition"; there is a total obtainable as the vector sum of constituent parts. This is equivalent to saying that there is a greatest value Q (resultant) for one direction, and that the law of orthogonal projection applies. Thus the value Q_1 for any other direction must satisfy the equation

$$Q_1 = Q \cos(Q_1, Q).$$

This projective property must be proved somehow in each case.

The conception of a vector is usually established as an elementary matter with the aid of instances like velocity and force. Velocity is so closely connected with linear displacement that the operations of geometrical addition and projection can be almost intuitively recognised as valid for both quantities. The graphical representation of forces, and the application to them of the "parallelogram construction," can be approached from the experimental side, furnishing a timely reminder that this procedure (as regards physical quantity) is ultimately justified by appeal to phenomena. The inclusion of "axis-vectors" (*e.g.* angular velocity and acceleration; moments of force and of momentum) in the class is a second step, of no less importance than the first. The proofs put forward to cover this extension of the thought afford fruitful material to the student of applied logic, through their variations of scope and emphasis. The analysis of some demonstrations now current prompts the remarks which follow.

First, linear vectors, like velocity, force, magnetic field, have what may be termed objective direction. But direction is assignable to axis-vectors by usage only, in the line of a (possible or actual) rotation-axis. Further, the sense in this line is arbitrary, being determined, for example, by the "rule of the right-handed screw." This double convention underlying the graphical representation of axis-vectors must be insisted upon.

Secondly, the theorem known as the "parallelogram of angular velocities" is really intended to prove that the linear velocities of all points in a rigid body satisfy the conditions of rotation in certain cases. The characteristic of rotation is a relation to the axis as regards the direction and the magnitude of all velocities, usually expressed as $v=r\omega$, v being perpendicular to both r and the rotation-axis. The proof of the theorem is only implicitly complete, if we content ourselves with showing that simultaneous angular velocities about intersecting axes produce zero linear velocity on a particular line. And the corollary covering the most important point is often not even mentioned. Similar considerations apply to angular acceleration.

Thirdly, the direct graphical representation of force-moment is connected with areas and not with lines. These areas are in general parallelograms, with adjacent sides representing the force and the distance of its point of application from a chosen point on the rotation-axis. The fundamental case is that in which the parallelogram is perpendicular to the axis, and its area shows the moment for a line through one vertex. For an oblique axis through the same vertex, the moment is obtained by projecting that area upon a plane perpendicular to the new axis. This follows easily from the definition of force-moment.