optical activity. Nierenstein has supposed tannin to be a mixture of digallic acid and optically active leucotannin; this does not agree with the slight acidity of tannin. The recently published researches of Emil Fischer in conjunction with Freudenberg throw a new light on the question. The authors show that carefully purified tannin contains about 8 per cent. of glucose in its molecule. They do not regard tannin as a glucoside of gallic acid, but consider that it is an acyl compound of glucose analogous to the penta-acetyl and penta-benzoyl derivatives of this sugar, in which the alcohol groups form esters with the acid. This novel conception of tannin as a penta-digalloyl glucose is in agreement with its chemical behaviour, but, as is his custom, Fischer has had recourse to synthesis to confirm his views. Digallic acid was not available, but a synthetic penta-galloyl glucose could be obtained without great difficulty, it sufficing to combine glucose with tricarbomethoxygalloyl chloride in presence of quinoline and remove the tricarbomethoxy-groups by cautious hydrolysis with alkali. The new compound has all the properties of the tannins, and there can be little doubt that the new conception is the correct one, and that synthetic tannin will shortly be added to the achievements of the organic chemist.

SUCCESSFUL trials have just been concluded of the first Clyde-built motor ship, *Jutlandia*. An illustrated article in *The Engineer* for May 17 gives some particulars of this ship, which is a sister ship to the *Selandia*. The builders, Messrs. Barclay, Curle and Co., Ltd., Whiteinch, have fitted Diesel engines of the four-cycle type. On the measured mile at Skelmorlie the vessel attained a mean speed of 12 knots, the engines developing 2700 indicated horse-power at 135 revolutions per minute. The fuel used on the trials was oil of specific gravity 0·855, but the engines are capable of using heavier oil, such as is obtainable from the Roumanian or American oil fields. The builders estimate that in regular service the quantity of fuel necessary will be about 10 tons per day of twenty-four hours' continuous running.

Engineering for May 17 gives an account of the system of ozone production and distributing plant installed for air purification and ventilation on the Central London Railway by the firm of Ozonair, Ltd. The system is a plenum one, and consists of Sirocco fans placed at each of the underground stations, excepting that at Shepherd's Bush. The total air supplied to the tubes is about 80,000,000 cubic feet per day. Each fan draws its air through a filter screen, and works in conjunction with an ozone-generating plant. The latter consists of mica sheets with metallic gauze on each side, stacked side by side, and energised by alternating current at about 5000 volts, in such connection that a silent discharge passes between the various plates, so that air flowing between them is ozonised. The ozone generator is supplied from a small transformer, which in turn is supplied with 380 volts alternating current from a small rotary converter. The converter is connected on its direct-current side to the 550-volt lighting circuit of the railway.

OUR ASTRONOMICAL COLUMN.

THE RECENT SOLAR ECLIPSE.—Many preliminary accounts of the solar eclipse of April 17 are given in the May number of *L'Astronomie*; the June number is to be devoted to a fuller discussion.

M. Flammarion—who is to receive the Cross of the Legion of Honour—gives, *inter alia*, a map on which he has drawn the central line derived from numerous observations. Going from south-west to north-east, it passes very slightly to the north of St. Nom-la-Breteche, rather further north of St. Germain-en-Laye, south of Maisons-Laffite, north of Sartrouville, over Franconville and Moisselles, north of Villiers-la-Sec and south of Luzarches.

Analysing the observations made from a dirigible near the last-named place, Comte de la Baume Pluvinel finds that the line is 1·8 km. north of that given by the *Connaissance des Temps*, and that the central phase occurred at the time given by the "American Ephemeris"; this was from fifteen to twenty-five seconds earlier than the times given by other ephemerides. The shadow of the moon, as seen from the dirigible, appeared as a greyish circle 3·5 km. in diameter travelling over the ground at about 800 metres per second. This shadow passed over the villages Belloy and Villiers-la-Sec at the same moment, the former lying near its northern limit.

At Sartrouville, M. Tramblay determined the interval between the appearance and disappearance of the cusps as four seconds. M. G. Renaudot, at Paris, made some very definite and interesting observations of the effects on birds and certain plants, which in every case behaved as they usually do at nightfall. As the eclipse was neither total nor annular, M. Flammarion suggests the designation *d'éclipse perlée*, which would describe the appearance of a collar of irregular pearls seen at maximum phase.

M. Simonin asks that observers will forward to him, at the Paris Observatory, the results of their observations of this eclipse.

SOLAR PROMINENCES IN 1910.—We have received amended tables of Prof. Riccò's summary of the prominences observed during 1910 at Catania, in which some of the values are essentially different from those previously given, which we briefly noted in these columns on May 9. The mean frequencies for the four trimestres should read:—N. hemisphere, 1·9, 1·5, 1·1, and 0·3; S. hemisphere, 1·7, 1·3, 1·2, and 1·4, the mean frequencies for the year being N. 1·2 and S. 1·4. Compared with 1909, the year showed a decrease in the frequency and the size of the prominences. Considering their distribution, there were two principal maxima at 25°–29° and 55°–59°, respectively, in the northern, and two at 15°–19° and 50°–54°, respectively, in the southern, hemisphere.

THE UNITED STATES NAVAL OBSERVATORY.—The superintendent's report of the work performed at the U.S. Naval Observatory for the year ending June 30, 1911, contains, among many other items, several interesting results of investigations of instrumental errors. A wide difference of opinion among the staff concerning the performance of the 6-in. transit circle has been settled, as the result of an investigation lasting over three years, by a declaration that the instrument is fit for the fundamental observations for which it is now to be employed. Another investigation was carried out to determine the cause of a periodic error of exactly four minutes, having a range of more than 5 seconds of arc, in the driving-clock of the 26-in. equatorial. No single cause could be found, so it was decided to correct the error by introducing one of opposite sign and having the same amplitude. This was done by scraping the driving

side of the bevel gears at those parts which were in mesh at the moment the error occurred, and the error was thereby reduced to about eight-tenths of a second.

The sun was photographed on 148 days, and showed spots on 88 days. In future, the "Nautical Almanac" publications are to be stored and distributed by the Naval Observatory librarian.

EPHEMERIS FOR BORRELLY'S COMET, 1911*e*.—To No. 4572 of the *Astronomische Nachrichten*, M. Schaumasse contributes an ephemeris for comet 1911*e*, which is at present about a degree north of 36 Lyncis, and is travelling in the direction of β Leonis Minoris. This comet is extremely faint, but an observation by M. Schaumasse, with the Nice equatorial *coudé* on April 19, showed that the error of the ephemeris was only $-3s.$, $0'$.

THE TEACHING OF MATHEMATICS.[1]

The Content of the School Course in Mathematics.

A SYSTEM of education designed on broad lines to prepare pupils for some particular occupation is not only the best training for that particular occupation, but it is better as a "general education" than a system which has been designed simply as a general education, and not as a preparation for any particular calling. For a boy willingly undertakes work which clearly leads up to the solution of a real and interesting problem, even if that problem is one that belongs to his neighbour's after-life and not to his own. But the course designed for "general education" tends to become a "mental discipline" lacking in interest, and such discipline deadens the mind and makes the boy a machine.

In Papers Nos. 15 and 16 of this series, Mr. Carson and Mr. Durell advocate the inclusion in a school course of certain methods of great beauty, which to a few boys will be a source of delight. But the authors of those papers have no criterion of the suitability of these subjects beyond their own love of them. To a certain point that is a true criterion; what has given pleasure to one person has a good chance of giving pleasure to another; and all the subjects which they advocate deserve a place in a system of recreations for the mathematician's leisure hour. But to determine which of these methods and subjects are to be thrust upon every boy of an ordinary degree of mathematical ability, some better criterion is necessary. I do not say that I would exclude any of these methods, but only that they have not yet been judged on a suitable criterion.

That suitable criterion must be a consideration of the needs in after-life of certain groups of boys. In many cases mathematics is a form of technical knowledge required for the after-career, *e.g.*, for the careers of engineer, mathematical schoolmaster, professor of mathematics. In such cases the content of the subject will be determined by a wide interpretation of the requirements of the career, the treatment of the subject being of the broadest and every problem viewed from many points of view. The boy to whom mathematics is merely a part of his general education will, so far as he goes, study along with the technical group with which he has most in common. It is not necessary that each boy's future career should be planned in advance; all boys, technical, semi-technical, and non-technical, will study together for a time; then gradually the non-technical boys will drop out, and the remainder will bifurcate according to their varying intellectual powers and their varying technical needs.

These are the views to which observation, experiment and reflection are leading students of education. Many a doubter will be converted by a study of Mr. Mercer's admirable account of the teaching at the naval colleges (Paper 17). It is a document which every mathematical master should have by him. Some small portions of the course are special to the requirements of the Navy, but the course as a whole makes an excellent starting point from which to lay out a scheme for any school.

In Paper No. 12 Mr. Usherwood provides further evidence in favour of our principles. The close correlation of mathematics with engineering has given his boys a breadth of mathematical knowledge and a real grasp such as would have been incredible a generation ago. Mr. Usherwood justifies his procedure by quoting Mr. Branford's classification of the impulses which urge towards mathematical study, a classification also held by Dr. Nunn. Of these impulses, the utilitarian is the chief one at the school stage, and every central truth should be made to arise in response to some demand arising from a practical problem. Mr. Usherwood holds that manual as well as mental dexterity should be involved in the practical problem from which an investigation sets out, and he petitions for a greater place in the curriculum for suitable manual training.

Further support to the principles enunciated above is given by Mr. Palmer's historical account of the teaching of arithmetic. It is an excellent account of the changes which have been made in the last quarter-century. A generation ago "general education" was the cry, and if any method had a "bread-and-butter" value that was sufficient reason for its exclusion. The course consequently contained such monstrosities as "true discount." The true criterion has now been adopted; in part, half unconsciously. More conscious application of the criterion will in time recognise that most fractions should be dealt with in decimal form, and will greatly reduce the time spent on vulgar fractions, greatest common factor, and least common multiple. We learn from Mr. Palmer how far removed the school treatment of stocks and shares is from business practice. The whole subject seems to us unsuited to the school. The difficulty lies in the realisation of the circumstances of the problem; the circumstances are far removed from a boy's experience, and the explanation of them profits him nothing. The circumstances once realised, the arithmetic is child's play.

The Methods of Mathematical Study.

The various methods of mathematical investigation have been added one by one at various times to our available stock of tools. On the historical principle that the development of the individual should copy the history of the race, it is appropriate that these various tools should be put in the pupil's hand in the order of their discovery. It is, however, the practice to follow the development of the race too closely, and to discuss by the more primitive method all the problems for which our ancestors used it, regardless of the fact that a later method is a more suitable weapon with which to attack many of these problems. Such exactness of recapitulation cannot be justified; it is the haphazard result of the successive

[1] Papers on the Teaching of Mathematics in the United Kingdom, published by the Board of Education:—
(12) "Mathematics with relation to Engineering Work in Schools." By T. S. Usherwood. (1912.) Price 2*d*.
(13) "The Teaching of Arithmetic in Secondary Schools." By G. W. Palmer. (1912). Price 2½*d*.
(14) "Examinations for Mathematical Scholarships." By Dr. F. S. Macaulay and W. J. Greenstreet. (1912). Price 3*d*.
(15) "The Educational Value of Geometry." By G. St. L. Carson. (1912.) Price 1½*d*.
(16) "A School Course in Advanced Geometry." By C. V. Durell. (1912.) Price 1½*d*.
(17) "Mathematics at Osborne and Dartmouth." By J. W. Mercer and C. E. Ashford. (1912.) Price 2½*d*.
Earli r papers were noticed in NATURE of March 14.