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Review

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Most schoolmasters in practice are content at first to illustrate algebraic laws and to show that they are reasonable—the consideration of the proofs as to the generality of algebraic operations is left to a later stage, when the student is more mature.

Mr. Cracknell defines the negative sign as implying both subtraction and “reversal”; he postpones to Chapter XIV. the explanation of the Laws of Signs with reference to negative “quantities,” but there states that no general proof can be given for Multiplication and Division.

The treatment of graphs and gradients is excellent, but the chapter on Variation would be improved if some of the graphical work had been included as definite illustrations of variation.

Besides a very large number of examples in the text, there are at intervals collections of excellent miscellaneous examples, numbering nearly 500.

The book has been compiled with great labour and care; it is not by any means of a revolutionary type nor is it, indeed, particularly original. It will probably be welcomed by many teachers who fight shy of some of the more modern text-books, but who require some advance on the older works which are becoming out of date.

R. C. F.

**The “Conway” Manual of Navigation: being a complete summary of all Problems in Navigation and Nautical Astronomy.** By J. MORGAN, T. P. MARCHANT and A. L. WOOD. Pp. 79. Price 5s. 1914. (J. D. Potter, London.)

The main purpose of this work is adequately expressed in the preface as “a collection of formulas and methods required for solving plane and spherical triangles.” In addition, some of the more special problems of Navigation are completely worked out, such as: latitude by meridian altitude of the sun; latitude by altitude of *Polaris*; longitude by altitude of sun or star, out of the meridian. Two fully worked-out examples of the so-called New Navigation complete the volume. These are the determination of the ship’s position, (1) by two observations of the sun and the run between the observations; (2) by the simultaneous observation of two stars. The former of these is perhaps the commonest method employed by modern navigators for finding their position, and it is the one which is taught to cadets before they leave the R.N. College, Dartmouth.

As a compendium of formulas the work is admirable, and consequently as a handy book of reference its value is very great. The authors disclaim any pretensions to having written a treatise on Navigation, and some of the criticisms given below may in consequence appear to be wanting in fairness.

The proofs are set out without any waste of words and with the barest minimum of explanation. Some would be unintelligible to a learner without a great deal of assistance from a teacher. The usual proof of the fundamental cosine formula in spherical trigonometry from the cosine formula in plane trigonometry is given.

The sine formula is deduced from the cosine formula by showing that  $\frac{\sin A}{\sin a}$  is a symmetrical function of  $a$ ,  $b$  and  $c$ , just as we might prove the sine formula in plane trigonometry by showing that

$$\frac{\sin A}{a} = \frac{\text{twice the area of the triangle}}{abc}.$$

Apart from the fact that an elegant geometrical proof is available, a proof of this kind seems quite out of place in a practical text-book. The geometrical proof is short and instructive; in addition, it goes back to first principles and definitions.

As already mentioned, two problems are worked out by the method of the New Navigation. This method is a development and improvement of the Sumner’s Line, which has been used for nearly a century by navigators, and is due to Marcq St. Hilaire, who published an account of it in 1880. The time-honoured independent observations for latitude and longitude had therefore been for many years discarded before St. Hilaire’s method was adopted. The principle of St. Hilaire’s method is the comparison of the *observed* altitude of a heavenly body with the *calculated* altitude obtained from the assumed dead reckoning position of the ship. This enables the navigator to put down on the chart a position line, on which the ship must be. A further similar observation when the heavenly body’s bearing has changed some  $25^\circ$  is made, and another position line is obtained which by

its intersection with the previous position line gives the ship's position. This mode of procedure enables all observations to be similarly dealt with, and the process is greatly facilitated by tables which give the azimuth or true bearing of the heavenly body. St. Hilaire's process may be readily combined with chart-work. Since in these days all dead reckoning is done graphically on charts, a position can frequently be fixed by a combination of a position line obtained from an observation with a position line obtained from a land fall or observation of a known landmark.

The amount of information condensed into the eighty pages of this work is remarkable. Each problem is worked out on a separate page, so that the whole scheme may be seen at a glance. The setting-out of the work in some definite, orderly system is insisted on, for it enables the computer to check his work readily at all stages. The examples are worked out for the *Nautical Almanac* of 1910. The *Nautical Almanac* of 1914 gives the declination of the sun and the equation of time for every two hours of the day, so that all interpolation can be done mentally. A great deal of the interpolating work in this manual is therefore now quite unnecessary.

The name of the publisher, Mr. J. D. Potter, the well-known agent for Admiralty charts, is a sufficient guarantee of the excellence of the figuring, printing and diagrams.

**Matriculation Mechanics.** By WILLIAM BRIGGS and G. H. BRYAN. Third Edition. Pp. viii + 363. Price 3s. 6d. 1914. (University Tutorial Press, Ltd.)

One cannot doubt from the success of this work that it serves admirably as a text-book for the London Matriculation Examination. At the same time it must be confessed that in some respects it is much behind the times. In their preface the authors state that one of their reasons for treating Statics without Trigonometry is because "the solution of most illustrative problems involving angles depends on the properties of *two* particular triangles." These two particular triangles are the ones with which we are familiar in the forms of the  $45^\circ$  and  $60^\circ$  set squares. Why illustrative problems should involve these angles we are not told. Nothing has tended more to make the subject of Mechanics unreal to beginners than the artificial importance given to the angles  $30^\circ$ ,  $45^\circ$  and  $60^\circ$ . R. M. M.

**Transcendenz von  $e$  und  $\pi$ .** By GERHARD HESSENBERG. Pp. 106. 3 marks. 1912. (Teubner.)

The object of this book is to explain how the coping stone was placed, within the lifetime of most of us, upon a mathematical structure which had been slowly rising for four thousand years, during which more than a hundred generations endured the lot of mankind.

Though familiar to all readers of such works as Klein's *Leçons sur certaines questions de Géométrie élémentaire*, Vahlen's *Constructionen und Approximationen*, Dr. Glaisher's articles in Vols. 2 and 3 of the *Messenger*, or Herr Rudio's Archimedes, Huygens, Lambert, Legendre, the following brief statement of the history may be worth giving:

1. In an Egyptian papyrus entitled "The Book of the Knowledge of all Dark Things," Ahmes states that the area of a circle is equal to that of the square on nine-tenths of the diameter ( $\pi = 3.1604$ ). Taking his date to be approximately 2000 B.C., some seventeen centuries elapsed before the second great step was taken by Archimedes.

2. Archimedes assumed (as is well known) that the circumference of a circle was intermediate between that of a regular circumscribed and a regular inscribed polygon of  $n$  sides. He employed Euclidean methods to show that, starting with the regular inscribed hexagon, the perimeters of inscribed and circumscribed polygons of 12, 24, 48, . . . sides could be calculated by extraction of square roots only.  $[3\frac{1}{4} < \pi < 3\frac{1}{2}]$

3. Yet another nineteen centuries elapsed before the Arabic notation enabled the method of Archimedes to be extended by Vieta (10 places of decimals), Adrian Romanus (15), and Ludolph van Ceulen (35).

4. Now followed, within a few years, the fourth great advance. The discovery of the calculus led to convenient series, whose evaluation required the operation