

logarithms as have been found to be of practical value in the shop, showing some of the better known applications and making the presentation as practical as possible." The statement is made that the course has proved to be "a good mathematical preparation for advanced technical study."

It has been of interest to the reviewer to note the ability with which the mathematical difficulties have been overcome by a clearness and simplicity of statement and style. Proofs are almost entirely absent. The purpose is to show how things are done. Formulas are given ex cathedra with a "this is so" accompaniment. The uses of algebra, geometry, and trigonometry are displayed to the reader, with the evident intention of arousing interest in one who has not pursued the usual elementary courses. It would seem, however, that the scope of the book would be inadequate as a basis for "advanced technical study."

As an example of text books intended for technical high schools, and as indicating the mathematical training which in the near future a number of candidates for admission to college will undoubtedly offer, the volume is of exceptional interest.

The direction to "scribe an arc" is novel and the construction given on page 84 for a flat circular arc results in an ellipse.

PERCEY F. SMITH.

*Wahrscheinlichkeitsrechnung.* Von E. CZUBER. Zweite Auflage in zwei Bänden. I. Band: *Wahrscheinlichkeitstheorie, Fehlerausgleichung und Kollektivmasslehre.* 1908. x+410 pp. II. Band: *Mathematische Statistik, Mathematische Grundlagen der Lebensversicherung.* 1910. x+470 pp. B. G. Teubner, Leipzig und Berlin.

THIS is the second edition of the well known work of Czuber on probability. If material for a course is wanted, possibly no better reference could be given than to these books. The first volume contains the general theory with such applications as are mainly of mathematical interest. At the end of this volume are four and seven place tables of the probability function and a four place table of its derivatives. The second volume contains the applications to questions of statistics and insurance with tables relating to those topics.

In the first volume occurs a series of problems continuously numbered and solved as applications of the theory. In this

list occur the most interesting of the classical applications. The volume begins with a discussion of probability in finite sets of events, illustrated by games of chance. This is followed by a section on geometrical probability, a subject to which the author has given considerable attention in another publication. To one who is mainly interested in the application of the theory to problems of physics the non-existence of any definite criterion for equal probability in these cases makes this the most questionable part of the subject. In games of chance the equally probable cases are fairly obvious and so one is not much surprised that the theory agrees with the average results of actual play. But in such cases as the needle problem of Buffon the agreement of experiment and theory seems mainly to prove that in the solution of the problem the choice of equally probable events has been a physically sound one. A theory justifying this choice on mechanical grounds would be interesting.

In the next section occur the theorems of Bernoulli and Poisson. In this part we would like to see applications using larger numbers, and thus approximating more nearly the conditions of atomic physics. Such illustrations as that given by Perrin, where the probable interval between two successive cases of a brick jumping of its own accord as high as the second story of a house is expressed in years by a number of billions of figures, show more clearly than these game problems how a universally observed occurrence (i. e., the failure of a brick thus to jump) may be the result of chance.

The second part of this volume contains the applications of the theory to the correction of observations. Here we have the usual discussion of the method of least squares well illustrated by tables of data.

A third part is devoted to a more recent topic, Kollektiv-masslehre. This subject developed by Fechner, Lipps, and Bruns, has for its object the study of Menge of similar objects which can be arranged relatively to some numerically expressible characteristic. In this study occur a distribution function showing the relative density of the ensemble at each value of the characteristic and a sum function giving the percentage of the objects whose characteristics fall below a given value. A series is obtained expressing the sum function in terms of the probability function and its derivatives, and means are given for the calculation of the coefficients in this

series. If all the coefficients after the first are zero, the distribution follows the law of Gauss. If some of them are not zero, there is a variation from this simple law. The series usually converges very rapidly.

H. B. PHILLIPS.

*Mathematical and Physical Papers.* By SIR WILLIAM THOMSON, BARON KELVIN. Volume IV. *Hydrodynamics and General Dynamics.* xv+563 pp., 1910. Volume V. *Thermodynamics, Cosmical and Geological Physics, Molecular and Crystalline Theory, Electrodynamics.* xv+602 pp., 1911. Volume VI. *Voltaic Theory, Radioactivity, Electrons, Navigation and Tides, Miscellaneous.* viii+378 pp., 1911. Arranged and revised with brief annotations. By SIR JOSEPH LARMOR. Cambridge (England): at The University Press.

THAT the works of Lord Kelvin are now available in collected form is a source of gratification to physicists, mathematicians, and especially to mathematical physicists including students of mechanics. Particular thanks are due to Sir Joseph Larmor, who for these editorial duties must have sacrificed a great deal of time that could otherwise have gone to his own researches. And in the present confused state of theoretical physics we sorely need those researches.

Varied as were Lord Kelvin's contributions to physics, he may well be ranked as a student of mechanics and of the mechanical explanation of the world. The central monument in his system is the Thomson and Tait, from which he looks deep into every surrounding structure, and which itself is, to the present time, the climax of the works begun in the *Principia*. It was this mechanical bent which led him to search so constantly for a mechanical, as opposed to a purely electromagnetic, ether; and it was this which caused his contributions to ether theories to be less vital than those of some others who kept closer in touch with the electromagnetic point of view and who have built up the idea of the electromagnetic theory of matter and mechanical actions. In these matters Lord Kelvin during the last thirty years of his life should be classed as conservative if not reactionary.

The three volumes before us are the continuation of the series which Lord Kelvin himself had started. In 1882 Volume I appeared with seventy-three papers chiefly of dates 1841-53; two years later Volume II showed papers numbered 74 to 91,