

Review

Source: *The Mathematical Gazette*, Vol. 7, No. 105 (May, 1913), pp. 123-124

Published by: Mathematical Association

Stable URL: <http://www.jstor.org/stable/3603328>

Accessed: 16-10-2015 17:09 UTC

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Calcul des Probabilités. By L. BACHELIER. Tome I. Pp. vii + 517. 4to. 25 fr. 1912. (Gauthier-Villars.)

M. Bachelier's treatise promises to be of a very exhaustive character, for questions of historical and philosophic interest are reserved for future volumes.

His chief object in the present volume is to concentrate attention on "continuous" probability, in which the expectation, say, of gain or of error is supposed to vary continuously. Thus, after considering in the first five chapters some of the classical problems on the duration of play and on discontinuous probabilities in general, the same problems are reconsidered and extended by the error-function methods. As no references are given, it is not easy, even with Todhunter's history at hand, to find in what cases a problem or its solution is due to the author himself or derived from earlier authority. In the later chapters the author's plan is to refer other problems to an analogous problem stated in terms of play. Thus, part of the mathematical requisites for the study of the migration of noxious insects, weeds, or epidemics* from a centre, are furnished by imagining three players staking on the x , y , and z of co-ordinates.

M. Bachelier finds something fresh to say of the St. Petersburg problem—in which we are asked to find the expectation of a man who is to receive 2^{n-1} pounds if he throws red at the n th throw of a coin *and not before*. The mathematical expectation is easily seen to be indefinitely large: while common sense is said to assert that no sane person would give fifty pounds for the expectation. M. Bachelier observes: 'Le bon sens ne peut être invoqué quand il s'agit de questions délicates. Il ne permet pas de reconnaître si l'aire comprise entre une courbe et son asymptote est finie ou non. . . . Le joueur doit recevoir à chaque partie ce qu'il eût reçu la partie précédente multiplié par deux: s'il devait recevoir la même somme multiplié par 1'999 son espérance serait finie: le bon sens ne fait cependant aucune différence entre les deux cas.'

At p. 427 there is a slight misprint, $\frac{1}{2}a^2t$ for $\frac{1}{2}a^2t^2$, and the problem solved does not appear to me quite to correspond with the problem stated.

The work, when completed, should provide a repertory of every type of problem in probability.

Wahrscheinlichkeitsrechnung. By A. A. MARKOFF. Translated from the Russian by HEINRICH LIEBMANN. 8vo. Pp. vii + 317. 12 marks. 1912. (Teubner.)

Professor Markoff's work is a treatise on probability in general, but its special interest to English readers will probably be that it contains an account not readily accessible elsewhere; of the researches of Russian mathematicians—Tchebycheff, Liapounoff, and Professor Markoff himself—on various problems of probability, particularly those associated with mean values.

The special purpose of these researches is usually the investigation of the limits of error of approximate formulae, and the extension to certain classes of aggregates whose elements are independent of theorems relating to the mean values of independent aggregates.

C. S. J.

Geometrical Optics. By A. S. PERCIVAL. Pp. ii + 132. 4s. 6d. net. 1912. (Longmans, Green & Co.)

This volume is intended to cover the requirements of medical students for their preliminary scientific examinations, but there is no reason why it should not be equally useful to the student of physics. It also contains, according to the author, almost all the Optics required by an ophthalmic surgeon. "As an introduction to mathematical analysis the subject of Geometrical Optics has no equal, for it insists on the importance of paying due attention to the meaning of algebraic signs, and it is also an easy introduction to several somewhat difficult mathematical conceptions. For instance, the vectorial significance of the line BA being equal to $-AB$, or AB taken in the reverse direction, opens up a new vista to the student of Euclid and elementary geometrical methods: equally novel is the conception of a virtual image. At the same time every student can verify for himself the results of his calculations so simply by experiments that it will convince him of the reality of the analytical methods employed." The book seems to be admirably adapted to its purpose. Special attention may be drawn to the treatment of

* Brownlee, *Proc. R.S. Edin.*, 31. 262, and references there.

Cardinal Points, and to Professor Sampson's graphic method on pp. 105-107. We may note *en passant*, that Mr. Percival, in the *Proceedings of the Optical Convention* last year, describes an interesting method of tracing Caustic Curves.

Magnetism and Electricity. A Manual for Advanced Classes. By E. E. BROOKS and A. W. POYSER. Pp. viii+633. 7s. 6d. net. 1912. (Longmans, Green & Co.)

This volume replaces Poyser's *Advanced Electricity and Magnetism*, originally published in 1892. It hardly comes within the province of the *Gazette*, but none the less we venture to recommend it to the attention of our readers as an admirable volume, based almost entirely upon experiment, and brought up to date. It is notable for the insistence upon Faraday's ideas, for the prominence given to the conception of the electric current as the flow of electrons, and for the success with which the authors have accomplished their entirely laudable aim of investing mathematical expressions "with a tangible physical meaning." Each chapter is brought to a close with a considerable selection of questions bearing on its subject matter.

We hope we have said enough to induce such of our readers who are also teachers of science to look at the book, and form their own opinion of its merits. It is certainly the work of teachers of skill and experience.

Annuaire pour l'an 1913, publié par le Bureau des Longitudes. Avec des Notices scientifiques. Pp. vi+707+28+52+16+25+55. 1 fr. 50 c. net. 1912. (Gauthier-Villars.)

This hardy annual contains full tables relative to geography, statistics, metrology, money, and meteorology. For tables of chemical and physical data we must depend on the *Annuaire* for last year or wait till next. The astronomical sections include tables relative to deviation from the vertical in France, varying weight, calculation of altitudes by barometric observations, stellar parallaxes, double stars, proper motions, and stellar spectroscopy. For other tables on seismology, solar physics, minor planets, etc., we must refer to 1912 or the volume for 1914.

The notices referred to in the title are by M. Bigourdan and M. le Commandant Ferrié. They deal respectively with observations on the eclipse of the sun, April 17th, 1912, and the application of wireless telegraphy to the transmission of time to various centres. The orations delivered at the funerals of MM. Radau and Poincaré complete the Notices. There is a full index. We may remind our readers that the first number of the *Annuaire* appeared in 1796.

Key to Prof. W. W. Johnson's Differential Equations. By T. A. LE MESSURIER. Pp. 125. 1·75\$. 1911. (Wiley; Chapman & Hall.)

There is little doubt that the above will be found of considerable use to the student who has to tackle his Differential Equations unaided by the advice of a teacher. Even when he has solved correctly the set of examples at the end of a chapter he cannot be sure that after all he has done them in the shortest and most elegant manner, or that his solutions are complete. Such a key as this if wisely used can do no harm, and in many cases will encourage a private student to persist where without such aid he might be daunted even at the outset. The solutions are clear and concise.

Memoranda Mathematica. A Synopsis of Facts, Formulae, and Methods in Elementary Mathematics. By W. P. WORKMAN. Pp. v+272. With **Five-figure Logarithmic and Trigonometrical Tables.** Arranged by W. E. PATERSON. Pp. 28. 5s. net. 1912. (Clarendon Press.)

This will be found an extremely useful volume of reference for mathematical scholarship candidates and first year men reading for Honours at the University, as it covers almost all the ground for such students. Special attention may be drawn to the admirable manner in which "formulae with their deductions and applications are presented . . . enabling a reader to perceive analogies which he would possibly miss if dependent solely on text-books." Differences of type distinguish between the more and less important sections; notes, shortened proofs, and cross references are to be found in plenty, and there is a full index. With Mr. Workman's skill and experience as a teacher at his back, the student who uses this for revision or other purposes will find himself in safe hands.