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THE "SCIENCE" TALENT SEARCH

THE "Science" Talent Search is in its fourth year. As a teacher of science (and a worker in plant pathology), the writer has regularly brought it to the attention of all science students, has complied with the rules of the contest and has sent the papers of the contestants to the examination committee. During these years, the writer has shared with others the feeling that this may not be a science talent search.

The implications for science teaching of this venture of Westinghouse is such that the methods which are being used, and the conclusions which are being derived, deserve the careful examination of every scientist and of every teacher of science.

Some thought has been given the matter.[1, 2, 3, 4, 5] One fact remains outstanding. The sponsors of the examination persist in calling this a "Science Talent Search" and are apparently heralding this far and wide in what appears to the writer to be a remarkable amount of advertising, in spite of the fact that no one yet knows (within the bounds of scientific method and scientific certainty) just what science talent is.

The sponsors of the examination have an excellent opportunity to gain for science a quantity of data which may determine just what makes a scientist. Assumptions have been made that if a student passes the complete examination (consisting of written examination, essay, interview and review of record) to the satisfaction of the examiners, he has science talent. As a matter of fact, by calling the contest "Science Talent Search," the sponsors seem to have accepted this assumption as a conclusion.

Is this conclusion valid?

Is it possible that students who can not succeed in the written examination and who were successful in the other parts, if given the publicity and opportunities afforded the winners, might make equally good scientists? Is it possible that students who are not among those who "pass" the written examination and who have poor "personalities" (as recorded by teachers), but who have a marked ability to work in high-school science, as shown by an actual undertaking of such work, might still become successful scientists, especially if they obtained the publicity and opportunities afforded the winner?

It is hoped that the sponsors of the Science Talent Search will not neglect the fine opportunity available to them to organize an investigation along experimental lines to determine the nature of science talent. The present Science Talent Search could well be called "Scholarships for Good Students with Present Interests in Science." It is, of course, entirely possible that all that is necessary to be a good scientist is to be a good student with an interest in science. Much would be accomplished if this could be proved scientifically.

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SCIENTIFIC BOOKS

BESSEL FUNCTIONS

A Treatise on the Theory of Bessel Functions. By G. N. WATSON. Second edition. vi + 804 pp. $7\frac{1}{2} \times 10$ inches. Cambridge University Press. New York: Macmillan. 1944. $15.

THIS excellent book was written at a time when the author was much interested in the propagation of electromagnetic waves over the surface of the earth, and consequently one of the important features of the book is that it contains material of interest to the radio engineer. Such a man is interested particularly in the asymptotic expansions of the Bessel functions, in definite integrals involving Bessel functions and in tables of Bessel functions. The subject of asymptotic expansions is treated with the thoroughness characteristic of a master in this field. It may be recalled that in 1912 Watson published in the Rendiconti di Palermo a memoir crowned by the Danish Royal Academy of Science in which among other things he gave expressions for the functions J_n (x), J_{-n} (x), Y_n (x) and K_n (x) as series of inverse factorials.

In Chapter III the Bessel functions of various types are defined for complex values of both the variable and index. The functions of an imaginary variable were required in physical investigations over a hundred years ago, the use of Bessel functions of a complex quantity is almost as old, as it began with work on the motion of a pendulum in a resisting medium. These functions were given a special notation by Lord Kelvin and were much used by electrical engineers

[1] H. A. Edgerton and S. H. Britt, *American Scientist*, 31: 255–262, 1943.
[2] Banesh Hoffman, *American Scientist*, 31: 255, 262, 1943.
[3] H. A. Edgerton and S. H. Britt, *American Scientist*, 31: 263–265, 1943.
[4] Paul F. Brandwein, *Science Education*, 28: 47–49, 1944.
[5] H. A. Edgerton, S. H. Britt and H. M. Davis, *Science Education*, 28: 229, 1944.

interested in the skin effect in the propagation of electric waves of high frequency. The properties of Kelvin's ber and bei functions and their generalizations are given on pages 81–82 and on p. 204, but many special formulae for these functions that are used by engineers are not given explicitly. For these it is necessary to go to the papers of Savidge, Airey, Russell and Whitehead and to the books and papers of Dwight and McLachlan. It may be mentioned in particular that for the numerical calculation of the functions for large values of the variable, Dwight recommends formulae somewhat different from Airey's formulae of p. 204. Tables for these functions are not included, and the author probably did not wish to enter into a lengthy discussion of matters that had been dealt with adequately by other writers.

In Chapter IV there is a useful discussion of the differential equations which can be solved with the aid of Bessel functions. This chapter and the following one contain many series that are often employed in physical investigations.

Chapters VI, XII, XIII and XIV on integral representations and definite integrals provide a mine of information. References to these chapters are given by countless authors of papers in pure and applied science. A valuable feature of these chapters is that the numerous integrals are established by rigorous methods.

The tables at the end of the book are particularly well chosen and form one of the most valuable parts of the book. It may be mentioned, for instance, that a recent formula for the radiative resistance of a cylinder obtained by H. Page, of Manchester University, involved the indefinite integral of the Bessel function J_0 (x) for which a table was available in Watson's treatise. In this connection it may be worth while to mention that ten place tables of the integrals of both J_0 (x) and Y_0 (x) have been published recently by A. N. Lowan and M. Abramowitz.

The expansions of planetary theory, which began with Lagrange's sine series for the difference between the mean and eccentric anomaly, involved Bessel functions of the form $J_{p\pm n}(pe)$ in which the order and argument were both large when p was large. For a discussion of the convergence of these expansions it was necessary to know the behavior of these Bessel functions for large values of p, and the early work of Carlini was followed by that of many other mathematicians. The history of this development is given in Chapter VIII and modern methods of dealing with the problem, such as the method of steepest descent, are clearly explained. The resulting asymptotic expansions are of great importance in physical mathematics, particularly in the theory of the propagation of waves, and Watson has made a notable advance in giving precise conditions under which certain formulae of approximation are applicable. In the most recent work the expressions in terms of the Airy functions are recommended and elaborate tables of these functions have been prepared by a committee of the British Association for the Advancement of Science.

The series of planetary theory are discussed in full in the Chapter XVII on Kapteyn series where a discussion is given of a general type of series which includes those of planetary theory and some series found by Schott and others in researches on the structure of the atom. The book contains also discussions of many other types of series.

The book closes with a very valuable bibliography which is nearly but not quite complete up to 1921. Among the omissions are some papers by Poisson, notably his memoir on the propagation of waves (1816) in which he gave an expression for the inverse distance of two points as an exponential integral involving J_0 (rt), and two papers by James Ivory (1832 and 1838) in which Bessel functions of an imaginary argument are used in the problem of astronomical refraction.

In the new edition the only notable change is in the valuable Chapter XV on the zeros of Bessel functions where a reference is made to the work of Siegel (1929) regarding the truth of Bourget's hypothesis that J_n (z), J_{m+n} (z) have no common zero except, perhaps, z = 0 when m and m are positive integers. Some related theorems have been given by D. Prasad Banerjee in the *Journal of the Indian Mathematical Society* for 1935.

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THE CONTROL OF BILHARZIA

The Control of Bilharzia in Southern Rhodesia. By ALAN MOZLEY. 1944. 307 pp. Southern Rhodesia: Salisbury.

WITH the people of more than one half of the globe subject to the debilitating disease, bilharzia, or schistosomiasis, any discovered method of controlling this serious disease becomes of general interest.

Alan Mozley is a malacologist with wide field experience in both the Old and New Worlds who went out to Southern Rhodesia in the company of Sir Malcolm Watson, director of the Ross Institute of Tropical Hygiene, in order to find out what should be done to control bilharzia as one of the worst diseases of that country.

The aid of a malacologist was invoked since the schistosoma worm that causes the disease passes from the blood vessels of man into water and then into certain snails and thence, after eight or nine weeks,