dition of the deaf." He states that "50 per cent. of the deaf over 20 years of age are reported in gainful occupations, the percentage for the general population being 50.2 per cent. In the five great occupations, agriculture, manufacture, service, trade and professions the proportions are about the same for the deaf and the general population. Their own achievements have thrown out of court the charge that they are a burden upon society."

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Natural Sines to Every Second of Arc, and Eight Places of Decimals. By Emma Gifford. Published by Mrs. Gifford, Oaklands, Chard, Somerset, 1914. Pp. vi + 543. Price £1.

It is evident to any one who takes the trouble to consider the matter that this is an era of efficiency in the computations of the laboratory and observatory as well as in the work of the great industrial plants of the world. The astronomer, the physicist, and he whom Sir George Greenhill often delights to refer to as the "mere mathematician" are all conscious that the time is past when the individual investigator should compute if he can get some instrument, human or mechanical, to do this work for him. And so we have in our day a remarkable surging forward of the flood of computing devices—slide rules of many types, listing machines, comptometers, cash registers which mechanically add, and all sorts of other devices which do for the computer what he one time was forced to do for himself at great expenditure of energy. And we also have, but in less marked degree, a number of new tables, ingenious little ones like those of Professor Huntington, and ponderous newly-computed ones like those on which M. Andoyer is still engaged. All these aids to computation are healthy signs that the scholar joins the "sharp-lined man of traffic" in seeking the greatest efficiency in his exhausting labors.

Of the recent tables for saving the time of the computer no one is more noteworthy than the one of natural sines which has been computed and recently published by Mrs. Gifford. Georg Joachim computed such a table to ten figures and to every ten seconds, and this was published in 1596, after his death. This table was again printed in 1897, but was carried to only seven figures. Mrs. Gifford, however, has prepared a table extending one figure further than this, namely, to eight places, and has carried it to every second instead of every ten seconds. It is therefore apparent that here is by far the most complete table of natural sines that has ever been attempted. And not only is it the most complete but it is a model of convenience, so that the computer who has occasion to use a table of this kind will have good reason to thank Mrs. Gifford for her great care and patience.

It is hardly possible that such a table can be free from errors, particularly in cases where the last figure is near 5. Aside from this, however, a rather extensive use of the work by one computer for some months has revealed only a single error, namely, in sin 56′ 40″. Mrs. Gifford is correcting the tables in this and other minor respects, however, before issuing them.

The tables should have place in every college library and in every physical laboratory, observatory and mathematical workshop.

David Eugene Smith

Principles of Physics. By Willis E. Tower, Charles H. Smith and Charles M. Turton. P. Blakiston's Son & Company. 1914.

The teaching of high-school physics presents difficult problems. For each teacher there is undoubtedly a "best" text, and it is highly desirable that every teacher have a number of good texts from which to make the selection that seems, in practise, to be the best suited to himself. For this reason the text of Tower, Smith and Turton should be welcome. It does not claim to possess striking peculiarities, but rather to incorporate the best ideas found through extended experience of the authors.

The authors have attempted to adopt what they consider to be the conclusions reached by the "new movement in the teaching of physics." An introductory chapter is followed by one which is given to the explanation of a selection of common things discussed under the title, "Molecular Forces and Motions." Here occur discussions of the diffusion of gases, the evaporation, diffusion and capillary action of liquids, crystallization, elasticity and general properties of matter. This introduction covers eight of the seventy-seven sections into which the book is divided, each section containing material enough for one recitation. The order of treatment of the subjects is as follows: Mechanics, Heat, Electricity, Sound, Light. By summarizing at the close of each section the important topics treated therein, and by setting problems which are related to the life of the pupil as well as to the principles of physics, the authors have made a special effort to produce a helpful book. Mathematical expressions are not avoided, but are used only where they are of apparent advantage to the student; indeed this advantage should be the only justification for mathematical expressions in either elementary or advanced physics. The illustrations, in both number and selection, are to be commended. The volume is distinctly a text-book, all of which is to be taught in the year's course in physics, save perhaps some of the numerous exercises which are found at the close of each lesson. The value of the work can only be ascertained by experience in the class room, but the spirit of the authors and their apparent success in applying it in the preparation of this book must commend the text to the consideration of every high-school teacher.

G. W. Stewart

SPECIAL ARTICLES

ANTAGONISM AND BALANCED SOLUTIONS [1]

The term *antagonism* came into general physiology from medicine, where it was used in the seventies by Rossbach, Luchsinger and others to designate the opposing types of physiological action produced by certain chemical substances. Luchsinger, Langley, Sydney Ringer and others applied the term to that type of physiological situation seen in the opposite effects produced by atropine and pilocarpine on the sweat glands. One alkaloid, atropine, stimulated the activity of the gland, the other depressed it, and one effect could be made to partly or wholly supersede the other by the proper adjustment of the concentration and quantity of alkaloidal solutions used. It was found possible to establish physiologically equivalent quantities of each alkaloid which would exactly nullify the action of the other when applied to the tissue, and a given physiological result could be calculated from given quantities of the antagonistic substances. As Luchsinger saw it, the action of these substances was like algebraic *plus* and *minus* and came back to mass action (Massenwirkung) and affinity, a view accepted in effect by Langley and Ringer. In these experiments physiological antagonism meant opposing action on a definite function as a criterion. Contraction of the frog's heart, action of the salivary gland and contraction of the pupil of the eye were examples of such criteria.

In work of this type the antagonists were used in simple solutions applied serially to the tissues in question, and the fact of antagonistic action was demonstrated by the disappearance of the action characteristic of the first substance upon the application of the second substance. The simultaneous application of the antagonistic substances seems not to have been made.

Work of this type developed a number of important differences in the behavior of supposed antagonists. Luchsinger found when the activity of the sweat gland of the cat was used as a criterion that pilocarpine and atropine produced opposite actions and that each was able to efface the other as wave-hollow effaces wave-crest or as algebraic plus effaces algebraic minus. This ability of each to efface the other and to produce the opposite physiological state in either order of application Langley proposed to call mutual antagonism.

This clean-cut, two-way, type of result, however, was not the rule, and for two chief reasons. (1) It was unusual that the action of two substances should cover precisely the same area of function and thus fully oppose each other throughout their effects. As a result,

[1] Published by permission of the Secretary of Agriculture.