Japanese scientist, Kitasato, who isolated the bacillus of tetanus. A Russian soldier saved by a blood transfusion is indebted to Landsteiner, an Austrian. A German soldier is shielded from typhoid fever with the help of a Russian, Metchnikoff. A Dutch marine in the East Indies is protected from malaria because of the experiments of an Italian, Grassi; while a British aviator in North Africa escapes death from surgical infection because a Frenchman, Pasteur, and a German, Koch, elaborated a new technique.

In peace as in war we are all of us the beneficiaries of contributions to knowledge made by every nation in the world. Our children are guarded from diphtheria by what a Japanese and a German did; they are protected from smallpox by an Englishman's work; they are saved from rabies because of a Frenchman; they are cured of pellagra through the researches of an Austrian. From birth to death they are surrounded by an invisible host—the spirits of men who never thought in terms of flags or boundary lines and who never served a lesser loyalty than the welfare of mankind. The best that every individual or group has produced anywhere in the world has always been available to serve the race of men, regardless of nation or color.

What is true of the medical sciences is true of the other sciences. Whether it is mathematics or chemistry, whether it is bridges or automobiles or a new device for making cotton cloth or a cyclotron for studying atomic structure, ideas can not be hedged in behind geographical barriers. Thought can not be nationalized. The fundamental unity of civilization is the unity of its intellectual life.

There is a real sense, therefore, in which the things that divide us are trivial as compared with the things that unite us. The foundations of a cooperative world have already been laid. It is not as if we were starting from the beginning. For at least three hundred years the process has been at work, until to-day the cornerstones of society are the common interests that relate to the welfare of all men everywhere.

In brief, the age of distinct human societies, indifferent to the fate of one another, has passed forever; and the great task that will confront us after the war is to develop for the community of nations new areas and techniques of cooperative action which will fit the facts of our twentieth century interdependence. We need rallying points of unity, centers around which men of differing cultures and faiths can combine, defined fields of need or goals of effort in which by pooling its brains and resources the human race can add to its own well-being. Only as we begin to build, brick by brick, in these areas of common interest where cooperation is possible and the results are of benefit to all, can we erect the ultimate structure of a united society.

A score of inviting areas for this kind of cooperation deserve exploration. Means must be found by which the potential abundance of the world can be translated into a more equitable standard of living. Minimum standards of food, clothing and shelter should be established. The new science of nutrition, slowly coming to maturity, should be expanded on a world-wide scale. The science of agriculture needs development, not only in our own climate but particularly in the tropic and subtropic zones. With all their brilliant achievements the medical sciences are in their infancy. Public health stands at the threshold of new possibilities. Physics and chemistry have scarcely started their contributions to the happiness and comfort of human living. Economics and political science are only now beginning to tell us in more confident tones how to make this world a home to live in instead of a place to fight and freeze and starve in.

All these matters await the future peace. Nevertheless they constitute the stern realities of the present, for as Vice-President Wallace has said: "From the practical standpoint of putting first things first, at a time when there are not enough hours in a day and every minute counts, planning for the future peace must of necessity be a part of our all-out war program."

SCIENTIFIC BOOKS

TRENDS IN PHYSICS TEACHING. SOME RECENT TEXTS

The art of teaching physics has developed almost in its entirety without benefit of the specialist in educational methods. For explanation, one need look no further than an outline of the subject itself. Hard work on the subject-matter is necessary on the part of almost any one before he can lay claim even to an elementary knowledge of physical principles. Many difficulties, not the first being those of mathematics, confront the student who desires a sufficiently good command of the subject to be able to understand its applications in engineering, chemistry, medicine or geology, to mention but a few fields in which special applications of physics abound. The result of this has been the development on the part of physics teachers of attitudes and methods which have made little concession to the tendency in some quarters to soften educational programs to the level of the average student.

This seeming aloofness of the physics teacher has served as a counter irritant, stimulating much of the best work which has been done in the text-book field in recent years, but it has brought with it a loss of influence with departments of education causing a deterioration or even, in many quarters, an abandonment of high-school physics programs and a consequent loss of students to more advanced courses in physics.[1] The war with its vast new instrumentation, whether for combat with the enemy or for civic protection and defense production, has brought into sharp relief the fantastic discrepancy between the need for and the supply of young people who have a laboratory sense of physics.

The situation might, indeed, be much worse had it not been for the formation in 1933 of the American Association of Physics Teachers and the establishment of their journal, the *American Physics Teacher,* now known as the *American Journal of Physics.* This journal has from the first been a forum for the expression of all shades of opinion and experience regarding the teaching of physics. In it have originated far-reaching programs for the improvement of the offering to students, for widening and strengthening its appeal and for the testing and evaluation of the results achieved. A nationwide program of testing of physics students under the joint auspices of the American Association of Physics Teachers and the American Council on Education has served also as a stimulus toward revitalizing the physics course at the college level.

Physics first made its way into the curricula of colleges and schools at a time when classical studies were supreme, and the study of physics had to be justified as mental discipline. The first text-books were as formal as grammars and as unvarying in their content. The infusion of qualities which might cause interest in the subject for its own sake by such writers as John Perry and Poynting and Thomson in England, and by our own well-loved W. S. Franklin, was of great service in the early years of this century, but new discoveries in physics and the constantly accelerating pace of new and important applications continually widened the gap between the developing science and the text-books. In the early twenties "modern physics" began to be incorporated into the books, sometimes as a cream puff for dessert, sometimes sprinkled about for seasoning. The most striking result of the many experiences of the compounders of text-books has been the increasing number of topics deemed of such importance as to demand the attention of the beginning student. Drastic experiments with this material have been carried out by some writers. Numerous new aids to teaching, such as the physics museum, have been developed. There has been a multiplication of objectives for which courses and texts have been designed, with a corresponding variation in choice of topics and character of presentation. Especially marked are the differing degrees of emphasis on practical applications and the more fundamental aspects of the science. The result has been a wealth of new books, new editions and new adaptations of older texts.

[1] See for example, M. H. Trytten, SCIENCE, 94: 387, 1941; also, G. P. Harnwell, *Review of Scientific Instruments,* 12: 571, 1941.

The commonest professed objective in writing a text-book in physics is the provision of one suitable for a first course, with relatively little mathematics, yet one satisfying requirements for a certain amount of professional training, and which with a little extra effort might also be used in preparation for engineering or for further science study. In this category are the following:

An Introductory Course in College Physics (revised edition). By N. HENRY BLACK. pp. 734 + viii. New York: The Macmillan Company. 1941. $3.75.

College Physics. By JOHN A. ELDRIDGE (second edition), pp. 702 + xii. New York: John Wiley and Sons, Inc. 1940. $3.75.

College Physics Abridged. By HENRY A. PERKINS. pp. 591 + ix, Figs. 450. New York: Prentice-Hall. 1941. $3.50.

Fundamentals of College Physics. By WILLIBALD WENIGER. pp. 694 + viii. Figs. 340. New York: American Book Company. 1940. $3.75.

Each of these books uses trigonometry and in varying degree provides the student with instructions for problem solving. Black's book is to a high degree pictorial; besides the many reproductions of line drawings and photographs there are many plates, two of them in color. The illustrations cover a great variety of applications and range in time from such subjects as the experiment with the Magdeburg hemispheres to the electron microscope. Each chapter is provided with a summary, a list of references and a set of problems; topics of special interest or of a more advanced nature are sometimes treated among the problems. The book by Eldridge is also profusely illustrated, but with relatively fewer photographs. There is likewise a résumé at the end of many of the chapters and a large number of questions and problems. The style of the book is personal and stimulating, the point of view is that of the physicist. Perkins' book is an abridgement of the author's "College Physics," which "was written with the purpose of offering such complete explanations of principles and theoretical deductions that the student would understand them without assistance from the instructor." The abridgement was accomplished by elimination of material rather than by condensation. No great concessions are made to popular interest. The topics chosen are thoroughly treated and the methods used are such that the book might serve very well as preparation for further courses in physics. Weniger's text is conservative and is no doubt intended primarily as a preparation for engineering. The author does not proceed far with modern physics, but a number of topics in applied physics are given unusual emphasis, as, for example, refrigeration, the elementary theory of the venturi meter and several others. The author takes care to present the theory needed for most of the usual laboratory experiments of the general physics course. Each chapter concludes with a list of suggested laboratory experiments and a goodly assortment of questions and problems.

Physics, the Pioneer Science. By L. W. TAYLOR, with the collaboration in the chapters on modern physics of FORREST GLEN TUCKER. pp. xii + 847 + Appendix xliv. Figs. 551. Boston: Houghton Mifflin Company. 1941. $4.00.

General Physics for Students of Science. By R. B. LINDSAY. pp. 534 + xiv. New York: John Wiley and Sons, Inc. 1940. $3.75.

Foundations of Modern Physics. By THOMAS B. BROWN. pp. 333 + xii. Figs. 155. New York: John Wiley and Sons, Inc. 1940. $3.25.

Laboratory Manual of Physics (second edition). By C. M. KILBY. pp. 146 + vi. New York: D. van Nostrand Company, Inc. 1940. $1.75.

The study of the historical development of physics, particularly the setting in contemporaneous thought of the various stages of evolution of the concepts of physics would seem to be a very special subject, one making the most rigorous demands upon the historian and the philosopher as well as the physicist, yet it is becoming increasingly attractive to many of those seeking to enlarge the resources of physics teaching. The most notable example of the use of historical material in the making of a physics text is without doubt "Physics, the Pioneer Science," by L. W. Taylor. Physical concepts are traced from their origin. Free use has been made of the writings of the original discoverers, and in many cases the argument is presented in its first form. This has resulted in a book which will be of great interest to teachers and many general readers. The text is richly illustrated with reproductions of original prints and diagrams forming a collection well devised to arouse the enthusiasm of any one interested in the history of science. As a text for students its success will depend upon the maintenance by the teacher of interest in the historical approach. It will not be sufficient to "adopt" this book as just another text, but the author has eased the task by providing excellent collections of problems where they are called for. Principal divisions of the subject are introduced by several chapters of preliminary historical material so that by the time the student is working with formulae he should be in command of the whole background of development of concept and law. A very large number of the chapters are sufficiently easy and of such general interest that this book will doubtless find use in general or scientific libraries. A list of references to sources includes 291 items. Excellent indices are provided.

"General Physics" by Lindsay is a "thorough and rigorous introduction to college physics for students who intend to pursue scientific careers." It is intended "to serve as a basic introductory text-book for science students who have had mathematics through elementary calculus, and also to provide an intermediate and more rigorous course for such students as have already taken an elementary, descriptive course in physics." As one would expect of this author, great care is taken in the exposition of fundamental concepts, and there are probably few graduate students of the subject who could not read this book with profit. The author has chosen topics with great skill and has managed to put an astonishing amount of good physics in the 520 pages of text. The student who is prepared to use it may well be congratulated on having such a text made available to him. In colleges where the first course is of the usual sort with little mathematics the present text will provide an ideal second-year course for students majoring in science or mathematics.

The term modern physics in connection with the general physics course has come to mean rather definitely the physics of the electron, and includes such matters as the electric and magnetic deflection of cathode rays and of positive rays, the mass spectrograph and isotopes, x-rays and crystal structure, photoelectric effects and more or less concerning radiation and line spectra. The inclusion of this material has seemed necessary to many writers because of the oft-repeated charge that the student completes his college course in physics without coming into contact with those matters which are the concern of present-day physicists. The inclusion has often been awkwardly made, and the choice of subjects included has seldom pleased any one but the author. Moreover, the limitations of time of most courses are such that the modern physics often receives very sketchy treatment with a holiday for the time being from problems and other systematic exercises. Professor Brown's book, "Foundations of Modern Physics," is intended to serve as the text for the fourth unit of a two-year college course in physics; the criterion for choice of material being that it be that which is "at present greenest with new growth." The book opens with an account of electrons and the determination of electronic charge, e/m, positive rays, the mass spectrograph, isotopes, and closes with a discussion of cosmic rays, cosmic ray shower theory and mesons. Between these two chapters the subject-matter ranges through enough physical optics, radiation theory, including electrical oscillations and waves, black body radiation, spectroscopy, x-rays, radioactivity, nuclear physics, to give the student a very good idea of the principal avenues of recent progress. The treatment is largely non-mathematical and can be followed easily by any one who has had a first course in college physics. An abundance of carefully drawn and well-reproduced figures, discussion of many applications of contemporaneous interest, collections of problems, lists of references, are all features which will appeal to the teacher who would supplement his physics course with a systematic treatment of modern physics or who might well give a three-hour year course in modern physics itself. The student who has the mathematics will doubtless prefer a treatment which will more effectively cross the threshold of this fascinating subject.

No part of the physics course has been under closer scrutiny for many years than the laboratory experiments. Many factors contribute to the present-day history of this subject. Laboratory equipment has become continually and ever more rapidly expensive, mass production has robbed much of it of the refinements and precision of an earlier day. Some of the arguments for physics for physics' sake have dwindled in importance. The mere acquisition of laboratory skill is no longer put forth as a principal objective in college physics courses. Nevertheless, there has never been a time when the importance of laboratory points of view and enough familiarity with instruments to remove the first awkwardness with them have been more clearly recognized. In Kilby's "Laboratory Manual of Physics" will be found a typical list of experiments, together with brief notes concerning their theory and directions for performance. The experiments for the most part require inexpensive apparatus and are suitable for a first course.

J. C. HUBBARD
THE JOHNS HOPKINS UNIVERSITY

SPECIAL ARTICLES

A QUANTITATIVE ANALYSIS OF SULFONAMIDE BACTERIOSTASIS

WOODS'S[1] observations on the relationship of para aminobenzoic acid to the bacteriostatic action of sulfanilamide and sulfapyridine have been amply confirmed and extended by other investigators.[2,3,4] However, his hypothesis that PAB is an essential metabolite of bacteria, and that the inhibition of bacterial growth by the sulfonamides "is due to competition for an enzyme between the essential metabolite and the inhibitor," has not been adequately supported as yet.

We have been engaged for some time in studies concerning the bacteriostatic potency of various sulfonamide derivatives in relation to (1) the minimal effective concentration of the drugs, (2) the type of media employed, (3) the size of inocula and (4) the amounts of PAB required to prevent bacteriostasis. Some of the results obtained are of interest and may shed new light on the mode of action of these compounds.

The bacteriostatic effects of sulfanilamide, sulfaguanidine, sulfapyridine, sulfathiazole and sulfadiazine were observed in two synthetic, inhibitor-free media, one of which affords sub-optimal growth of the test organism, *E. coli*, whereas the other gives growth comparable to that obtained in nutrient broth. The minimal effective concentration (MEC) of each drug was determined as the lowest molar concentration which prevented visible growth over a period of four days with inocula ranging from 25 to 25,000 cells per cc. These concentrations proved to be the same in both media. With all inocula the absolute amount of PAB required to abolish bacteriostasis was found to be the same for the MEC of each drug, as illustrated in Table I. It will be noted, however, that the $\frac{\text{PAB}}{\text{Drug}}$ ratio is inversely proportional to the MEC, which shows that the bacteriostatic potency of a sulfonamide is directly related to the quantity of the drug required to produce bacteriostasis in the presence of a given amount of PAB. Furthermore, the antagonistic effects of PAB and the sulfonamides are apparently related to their concentrations and are independent of the number of bacteria.

TABLE I

THE RELATIONSHIP BETWEEN THE MINIMAL EFFECTIVE CONCENTRATIONS OF SULFONAMIDES AND PARA AMINOBENZOIC ACID

	Minimal effective drug concentration $M \times 10^{-6}$	Minimal amount PAB required to prevent bacteriostasis $M \times 10^{-7}$	$\frac{\text{PAB}}{\text{Drug}}$ Ratio
Sulfanilamide ...	2500	5	1–5000
Sulfaguanidine ..	500	5	1–1000
Sulfapyridine ...	20	5	1–40
Sulfathiazole	4	5	1–8
Sulfadiazine	4	5	1–8

[1] D. D. Woods, *Brit. Jour. Exp. Path.*, 21: 74, 1940.
[2] E. Strauss, F. C. Lowell and M. Finland, *Jour. Clin. Invest.*, 20: 189, 1941.
[3] W. W. Spink and J. Jermsta, *Proc. Soc. Exp. Biol. and Med.*, 47: 395, 1941.
[4] E. Strauss, J. H. Dingle and M. Finland, *Jour. Immunol.*, 42: 313, 1941.