

SCIENTIFIC BOOKS

THERMODYNAMICS

The Nature of Thermodynamics. By P. W. BRIDGMAN. xii + 229 pp. Cambridge, Mass.: Harvard University Press. 1941. \$3.50.

ANY book dealing with the philosophic aspects of physics from the pen of Professor Bridgman is something which students of the subject may expect to read with profound interest. Thermodynamics is to many a confusing subject, a subject in which the student is apt to become familiar with the technique of manipulation of the formulae which lie in his own particular territory without any very clear concept of the fundamentals underlying the operations concerned. Mathematical physics frequently develops a kind of inertia of technique which enables really valuable discoveries to be made without the discoverer really knowing what he is doing. It is, therefore, refreshing occasionally to have the complacency of mathematical technique disturbed by an inquiry as to the significance of the assumptions involved and of the operations carried out. Professor Bridgman attempts such an inquiry in his book.

The book itself is divided into four chapters, the first entitled: "The First Law of Thermodynamics and the Concept of Energy"; the second, "The Second Law of Thermodynamics"; the third, "Miscellaneous Considerations," and the fourth, "Retrospect and Prospect." It is naturally impossible to review in detail the enormous number of points discussed. A general attempt is made to analyze the meaning of such concepts as the transportation of energy from place to place in terms of what the picture of the said energy might be supposed to be in terms of the matter which possesses it. The spirit of the inquiry is exemplified by such questions as Professor Bridgman asks in connection with heat regarded as a "thing." "The whole situation," writes Professor Bridgman, "with regard to flow is evidently embarrassed by strong verbal impulses: we find it difficult to say 'There is flux at this point' without wanting to say also 'Something is flowing at this point,' and if something, then there is velocity and a density. To what extent is the impulse verbal that demands a velocity if there is a 'thing'?"

In another place the unsophisticated will be disturbed to find flux of energy in the opposite direction to the motion of the matter which carries it. Again, in connection with the first law of thermodynamics a careful consideration is given of just what is meant by measurement of work and quantity of heat, and the conclusion well known to the more sophisticated, but coming as a surprise to the naive, is voiced in the insistence that the primary content of the first law is comprised in the statement that the sum of the differential elements of heat added to a system and work

performed upon it form an exact differential of suitably chosen coordinates.

Many questions are raised as to the significance of the allocation of energy in different places and entities in physics. Thus Professor Bridgman writes: "I can not help feeling that in some places there is a trace of mysticism left in the verbal impulse to say, 'Matter and energy are *really* the same thing.'" The implications of the second law of thermodynamics are discussed in the same detailed manner. We have Maxwell's demon subjected to a closer scrutiny as regards his mental processes than he has been accustomed to receive, and the general question of the assumption of specialized conditions in thermodynamical proofs is discussed in its relation to the extent to which such idealizations may themselves be inconsistent with the requirements of the second law.

Naturally, any one who has thought along lines paralleling those discussed by Professor Bridgman would find many points in which he would be inclined to raise minor arguments, but any differences of opinion of this kind would naturally be on a high plane of sophistication. Again there are many other matters of analogous nature to those covered in Professor Bridgman's book which invite attention, but any one who has been accustomed to take thermodynamics at its face value and use it merely as a tool will have his horizon of understanding greatly enhanced by a consideration of even a few of the points raised in this most interesting volume.

PHYSICAL AND CHEMICAL CONSTANTS

Tables of Physical and Chemical Constants and Some Mathematical Functions. Ninth Edition. By G. W. C. KAYE and T. H. LABY. 181 pp. London, New York, Toronto: Longmans, Green and Company. 1941. \$5.00.

THOSE who have been accustomed to use Kaye and Laby's "Tables of Physical and Chemical Constants" will welcome the appearance of this revised edition, which, while retaining the features which characterized the usefulness of the previous editions, is amplified so as to include data pertaining to modern researches—nuclear physics, etc.—as well as additional material pertaining to the older branches of physics.

The book is characterized by the ease with which it is possible to ascertain the exact meaning to be attached to the data given, and frequently a preliminary summary of the physical laws associated with the data is given in condensed form but with a completeness adequate to remind the reader of the exact significance of the data themselves. Indeed, there is quite a little physics contained in the Tables, but it is not allowed to dominate the situation in such fashion that one is unable to find the wood for the trees. So frequently

a Table of Physical Constants, in an attempt at completeness, requires a preliminary study of the book itself in order to ascertain how to use it. Kaye and Laby's book is free from this defect.

As before, useful mathematical tables are included at the end, and certain useful formulae, such as formulae for the moments of inertia, are to be found in the work.

All in all, this volume is one of the most useful books, for the purpose for which it is intended, with which this reviewer is acquainted.

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SENSATION AND PERCEPTION

Sensation and Perception in the History of Experimental Psychology. By EDWIN G. BORING. xv + 644 pp. New York: D. Appleton-Century Company, 1942.

THIS important book is really the second volume of the distinguished author's "History of Experimental Psychology." The first volume, published in 1929, traced the origin and development of scientific outlook and method in psychology, and dealt with the men and the schools without detailed attention to the results achieved. The present volume traces the growth of scientific knowledge, including the specific methods and theories, in one important part of the subject, as indicated in the title, and we may hope for at least one more volume on other topics similarly treated.

The scope of this volume is not limited to those who have been known as psychologists during the past eighty years. It goes behind them to the days when there was no distinct science of psychology. "The formal distinction between psychology, physiology and physics is but a product of the scientific specialization of the nineteenth century. . . . The first important knowledge of color and its stimulus was contributed by Newton, of visual space perception by Kepler, of the tonal stimulus by Galileo. These problems, which the psychologists now claim, had meaning and importance for the great natural philosophers of the seventeenth century. They were neither physics nor psychology then; they were philosophy" (p. 97). Until well along in the nineteenth century the most important contributions were made by physicists and sense physiologists, and names like Helmholtz, Hering and Wheatstone are bound to appear prominently in the history. Even after the establishment of psychological laboratories, the physiologists and physicists by no means lost their interest in the senses but continued to make important discoveries. A book like this one, in tracing the development of knowledge, could not

and does not attempt to separate the contributions of the several sciences. Any one desiring to reach a critical appraisal of the achievements of experimental psychologists as such would therefore have to sift the material rather carefully, as could be done by aid of the excellent annotated bibliographies supplied by the author. He would find, especially in the recent decades (though the author does not usually attempt to bring the story down to the very present), that the psychologists have been doing their share of the work.

The author begins with a brief account of general theories of sensation and perception, in their historical development, and follows with a condensed but informative history of the "physiology of sensation," including the distinction between sensory and motor nerves, the nature of nerve conduction, the all-or-none law and the doctrine of "specific nerve energies." He then takes up the senses in order, giving of necessity most space to vision with its numerous subtopics, including especially color vision and the perception of space and form. The part on hearing makes a neater and better integrated story and is perhaps the most excellent portion of the book. The story of taste and smell is quickly told, but there is much to say on the cutaneous and internal senses, with a chapter also on the perception of time and movement.

There are of course many special topics, such as color blindness, perception of the third dimension, localization of sounds, the upper and lower limits of audible vibrations, the muscle sense, the sensitivity of the viscera and each such topic has its special history. In general theory, psychology is said to have been concerned in the nineteenth century with an attempt to describe conscious experience by analysis into elementary sensations and discovery of their modes of composition, while in the twentieth century it has moved away from such elementarism either toward the behavioristic and positivistic concern with discriminatory reactions and the conditions that make discrimination possible or toward Gestalt psychology with its emphasis on the total field and the dynamics of field forces. Gestalt psychology is conceived rather broadly by the author and so made to include the work of some psychologists who are not exactly adherents of the "Gestalt school." In reading the detailed story of the various problems that have been subjected to experiment, one does not find it easy to see how the shift in theory has had much to do with the course of investigation. One rather gets the impression that those very general theories have been a recreation or hobby of the psychologists and that in their work as experimenters they have been guided by much more specific questions. It may well be true, as the author says, that the old theories have sometimes cramped the investigators and acted as inhibitors of free experi-