would appear therefore that it is the Lorentz theory which must be used in the ionosphere at oscillation-frequencies employed in ordinary broadcasting. But since it is the Sellmeyer theory which must be used at sufficiently small oscillation-frequencies we are faced with the following problem: At what frequency and in what manner does the transition from the Sellmeyer to the Lorentz theory take place?

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SCIENTIFIC BOOKS

THERMODYNAMICS

Text-book of Thermodynamics. By PAUL S. EPSTEIN, xii + 406 pages, 15 × 22.8 cm. John Wiley and Sons, New York, 1937. $5.00.

THIS book will fill a need which in the last few years has rapidly become acute, namely, for a treatment for the physicist which should adequately discuss the applications of thermodynamics to the many new experimental facts, particularly those involving quantum phenomena. Until the appearance of this book any one giving a course in advanced thermodynamics had to refer his students to the periodical literature for such important topics as: low temperature phenomena, in particular specific heats, degradation phenomena and the phenomena of supraconductivity; the calculation of specific heats from spectroscopic data; the thermodynamics of electron clouds; the thermodynamics of magnetic behavior, particularly in the neighborhood of the Curie point; and the thermodynamics of the transformations of matter into radiation. All these, as well as the conventional critical exposition of the fundamentals and applications to systems in which chemical reactions may take place, are treated with adequate fullness.

The treatment is mostly from the phenomenological point of view, and in this respect marks a return to an earlier practise, the tendency in recent years having been to treat classical thermodynamics and statistics simultaneously. But the development of subject-matter in the last few years has proceeded to such a point that the simultaneous exposition of the phenomenological and the statistical points of view has become so cumbersome as to demand, in the opinon of the author, a return to the earlier practise. It may be added that there is a great gain in the logical coherence of an exposition mainly from the one point of view. At the same time some statistical analysis can not well be avoided; in particular, the probability interpretation of the second law receives due attention.

It is, I suppose, unavoidable that in a subject where it appears to be necessary to devote as much attention as in thermodynamics to a critical examination of fundamental concepts differences of opinion should arise. In this respect physicists seem open to the same reproach that they have so often directed against the philosophers of not being able to come to agreement. Thus, personally, I have never liked using the idea of a perfect gas to give the approach to the second law and the absolute temperature scale, in spite of the fact that it is the method of Planck and the method adopted in this book. It is admitted that the perfect gas is an idealization; it has always disquieted me logically to think that perhaps the second law might possibly have been slipped in somewhere in the process of idealization. The logical tactics of the whole situation, I believe, are modified essentially since the day of Planck's treatment by the discovery that no substance can obey the perfect gas equation down to 0° Abs. without violating natural principles. When the student comes to the discussion of the degradation of all gases near 0° Abs. will he not be justified in saying, "What right did you have to assume that the existence of a particular kind of idealized substance was compatible with the first and second laws when you now know that it is inconsistent with the 'third law'"?

The book contains a number of minor slips which could be easily corrected in a later edition. On page 82 is the statement, "Processes (in an isolated system) attended by an augmentation of the entropy are not only permissible, as the second law states, but one of them will necessarily take place spontaneously." Any one who has waited for a piece of graphite shut up in a box to turn into a diamond will realize that there is something the matter with this. On page 115, the phase rule states, not that no more than three phases can be simultaneously in equilibrium, but that if more than three phases are in equilibrium there is some special relation between their properties. On page 120 the melting and regelation of ice under skates is usually thought to be connected with the one-sided pressure in the ice under the runners, not the hydrostatic pressure. The depression of the melting point by one-sided pressure is roughly ten times greater than by hydrostatic pressure. On page 130 I think it is recognized that the arguments of Keesom and von Laue against the existence of transitions of the second kind are invalidated by considerations which Epstein does not suggest, because a crossing of the potential curves may correspond to negative masses on one side of the point of intersection and so be physically meaningless. It is highly probable that various order-disorder transitions in alloys are actual examples of

transitions of the "second kind." On page 159 there is an unqualified statement that a neutral atmosphere does not influence the vapor pressure. It is true that the effect is very small, but it is definite and may be deduced by thermodynamic methods, as in Lewis and Randall, page 183, first edition, for example. The treatment of work function and potential differences in the chapter on the electron and ion clouds I think is very confusing and in need of radical clarification. On page 267 it is made to appear that the potential used in the analysis is the classical electrostatic potential; in a footnote on page 274 it is explained that it is not the classical potential, but is derived from the force on the electron *under the actual conditions* (that is, it includes the image force) and then on page 275 the Volta contact potential difference is found by subtracting two of these, whereas the Volta difference by definition is the difference of the classical potentials. Later, on page 367, the same confusion leads to a completely unjustified relation between Volta difference and Peltier heat.

One can excuse these various defects, some of them copied from the literature, in view of the fact that the author has put into the book a number of results of his own independent investigations. His little investigation of the historical background of the first law and why it was first formulated by men outside physics will be found illuminating. There is a chapter on the le Chatelier principle which is much more carefully done than usual, and recognizes that really two different principles are involved. There is a final chapter on the limitations of thermodynamics reproduced from the author's contribution to the "Commentary on the Writings of Gibbs" recently issued by the Yale University Press. All in all, a most useful career may be anticipated for this book.

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HIGHER ALGEBRA

Modern Higher Algebra. By ADRIAN ALBERT. Chicago University Press, xiv + 319 pages, $4.00.

THE title of Professor Albert's "Modern Higher Algebra" is very apt. The book is "modern" in its organization of algebraic theory around such central abstract concepts as those of a group, a ring, an integral domain and a field. This organization was perhaps inspired by van der Waerden's now classic "Moderne Algebra," but has never before been done in an English or American text.

The book is also a "higher algebra," in that it deals with such relatively advanced topics as the classification of fields and matrices, the abstract extension of fields by adjunction of roots of polynomial equations, Galois theory, Galois fields and valued fields ("bewertete Korper"). The study of matrices goes beyond anything in van der Waerden, but ideal theory is not studied.

The exposition of these subjects is extremely clear in detail throughout. On the other hand, the abstract point of view will not easily be assimilated by the average college undergraduate, who will also be hampered by the absence of any treatment of such "elementary" things as complex numbers and determinants. The dabbler, too, will find it hard to detach morsels of intellectual nourishment from a complex and highly coherent mass of ratiocination.

But the serious student of mathematics will find Professor Albert's book stimulating and packed with ideas. It is in a class quite apart from the mediocre and nearly identical "college algebras" which American commercial publishers seem to prefer. The University of Chicago is to be congratulated for publishing an indispensable book, which every specialist in algebra should own.

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SPECIAL ARTICLES

DEVELOPMENT UNDER STERILE CONDITIONS OF THE SHEEP STOMACH WORM HAEMONCHUS CONTORTUS (NEMATODA)

IN a paper now in press we report the cultivation of bacteria-free larvae of *H. contortus,* in a suitable medium, up to the infective stage, *i.e.,* through the two larval free-living stages. The larvae obtained from such cultures differed from those grown under natural conditions in that they were slightly smaller, although the size ranges overlapped. These *Haemonchus* larvae produced in a susceptible lamb normal adult forms.

We wish here to report progress in the cultivation of the parasitic stages. At first we used for the inoculum the bacteria-free larvae from the cultures of the free-living stages. It was, however, difficult to secure enough larvae from the initial medium and we therefore used larvae that had reached the end of their free-living stage in sheep feces. These larvae were isolated in a Baermann funnel.

Since bacterial sterility appears to be an absolute requirement for further progress, the infective larvae were washed by sedimentation many times in sterile water in long glass tubes. To expedite the sterilization and also to unsheath the infective filariform larvae, Labarraque's solution, diluted one to twenty parts with distilled water, was also used. Unsheathing takes only about fifteen minutes, but the entire procedure includ-