geographers and travellers have learnt there the practical astronomy necessary to those who explore far from the beaten tracks. One of its features is the absence of any regular classes; those who go there to learn can have a lesson at any time and the lesson is made to suit the special needs of the pupil. The last two articles are obituary notices of M. Loewy by H. Poincaré; and of C. Trépied by M. Loewy, written shortly before the sudden death of the latter.

ERNEST W. BROWN.

Die Zustandsgleichung der Gase und Flüssigkeiten und die Kontinuitätstheorie. Von J. P. KUENEN. Braunschweig, Vieweg und Sohn, 1907. x + 241 pp.

KUENEN'S volume on the equation of state of gases and fluids is one of the twenty monographs already printed by Vieweg and Son under the general title "Die Wissenschaft." It must be obvious to all that the subject of this particular volume is one which lends itself well to treatment in a separate monograph. The main outlines of the theory of corresponding states are given in many books, and no book which has to do with gases or fluids can get on without the equation of state; but the details of those theories and their agreement or disagreement with the results of the hundreds of experiments which have been performed since they were broached are not to be found collected in general texts and require for their satisfactory treatment a monograph like this.

The first five chapters, of about ten pages each, may be said to be of a heuristic and qualitative nature. The author traces the history of the rise of observations on the phenomena of condensation and on the existence of some principle of continuity between the different states of matter. He touches upon the kinetic theory sufficiently to show the justification of Boyle's law from that point of view and to indicate how van der Waals was led to his equation. After obtaining that equation, the author goes on to a careful explanation of phenomena of condensation and of the principle of continuity from the basis furnished by the equation. At about this point there begin to appear numerous evidences of the great care with which matters are to be set forth in their true light, and of the conscientious criticism with which the author is to expound the relation between experiment and theory. For instance, it is pointed out that although van der Waals's equation may be de-

duced from molecular considerations, yet in a broad way the theory of continuity does not depend on such considerations; it is noted that the vapor pressure is not strictly constant but has been found to depend on the relative amounts of liquid and vapor which are present; and, moreover, the effects of gravity and slight impurities are discussed and found to be surprisingly large for states of the mixture near the critical point.

The next four chapters fill about eighty pages and may be considered as the main part of the text. They deal with the correlation of the equation of state with experiment. Citations from experimental researches and deductions from thermodynamic theory as applied to van der Waals's equation are abundant and are freely intermingled until the reader cannot fail to see their interrelations, their points of concord, and their remaining outstanding differences. The critical constants are derived by two methods and put into relation with the theory of corresponding states. The wide divergence of the theoretical value of $RT/pv = 2.67$ at the critical point and actual values found by Young is amply illustrated by giving Young's results in detail. The influence of the temperature on the "constants" of van der Waals's equation is discussed, and some very neat methods (with figures) are given for readily comparing the theoretical and experimental isothermal curves. For handling the phenomena of saturation several distinct methods, including those of free energy and the thermodynamic potential, are offered and somewhat extensive tables afford a means of checking the results against actual observations. The chapter on thermal quantities (thermische Grössen) is equally detailed and instructive; there is really nothing more to be said about it.

The tenth chapter is a note of two pages on the dimensions of molecules. The following chapter deals with corresponding states. The distinction between substances which are normal and abnormal is brought out, and a number of somewhat unusual topics such as the determination of the degree of association, viscosity, capillarity, and molecular refraction are included in the discussion. The remaining three chapters are concerned with the improvements which have been suggested for van der Waals's equation, and the allied considerations. Among others, the equations of Lorentz, Reinganum, and Clausius are developed. The last of these chapters bears the title "Mathematical methods of deriving the equation of state"

and is naturally the most mathematical and difficult of the whole book. It should be stated, however, that the author nowhere shuns the use of that small amount of mathematics which is really essential to the proper development of his subject.

From this brief summary, it may be gathered that the range of topics which is treated is not large but that the treatment given is thorough, highly competent, open minded, and impartial. In short the book is just what it claims to be—a monograph in which the most important if not all of our knowledge, whether theoretical or experimental, on the equation of state is collected and carefully edited. For those who are interested in this subject the book appears to be well nigh indispensable, and for those who are not yet interested it would offer a pleasant day's reading in one of the most entertaining fields of modern physics. It would not do to close this review without mentioning the extensive bibliographical lists which follow many of the chapters. These will save the student from many unhappy hours spent in trying to find the important literature of the subject.

E. B. WILSON.

NOTES.

THE Fifteenth Summer Meeting of the AMERICAN MATHEMATICAL SOCIETY will be held at the University of Illinois, on Thursday and Friday, September 10–11, 1908.

THE following additional associate editors of the *Transactions* of the AMERICAN MATHEMATICAL SOCIETY have been appointed: Professor G. A. BLISS, of Princeton University; Professor F. R. MOULTON, of the University of Chicago; Professor E. J. WILCZYNSKI, of the University of Illinois.

AT the meeting of the London mathematical society held on February 13, the following papers were read: By H. A. DE S. PITTARD, "Proof that every algebraic equation has a root"; by W. H. YOUNG, "On the uniform approach of a continuous function to its limit"; by F. H. JACKSON, "Note on q-differences"; by A. E. WESTEN, "An extension of Eisenstein's law