in the study of hyperfine structure with examples drawn largely from work using ^{57}Fe. A reader who wishes to obtain an up-to-date view must have recourse to less readable sources, such as the Proceedings of the Third International Conference on the Mössbauer Effect, *Rev. Mod. Phys.* **36**, 333-503 (1964), which in addition provides a comprehensive list of references.

Physical Science. By John M. Cleveland. 618 pp. Charles E. Merrill, Columbus, Ohio, 1964. $8.95.
Reviewed by Robert L. Weber, The Pennsylvania State University.

Inviting in content, organization, style, and illustrations, this text avoids the deficiencies common to many survey books. Material from physics, chemistry, geology, and astronomy is presented. In each field the presentation is continued sufficiently far and coherently so as to give the reader a good sampling of the methods and achievements characteristic of that field. Yet the interdependence of these disciplines is made evident. The 578 pages of text are devoted (though not consecutively) somewhat as follows: to astronomy, 95; chemistry, 98; geology, 104; and physics, 281 (of which 49 pages discuss nuclear physics).

The level of the book is suitable for college freshmen. Using arithmetic and very simple algebra, appropriate topics are treated quantitatively. There is an adequate number of problems, placed in the relevant sections and not accumulated at the ends of chapters. Answers are given to some 175 starred problems. The Appendix contains a brief review of direct proportion, exponential notation, and inverse proportion, plus some extensions of the treatment of momentum, Thomson's e/m experiment, the kinetic theory of gases, Avogadro's law, and the Bohr hydrogen atom.

The informal pen drawings are clear and a pleasant change from the elaborate, mechanically contrived illustrations in some recent textbooks in which impressive display outweighs pedagogic value. In Cleveland's book, even somewhat standard illustrations are given a fresh treatment, however, as the addition of vectors over a network of roads (p. 83), the diffraction of x rays from a crystal (p. 284), or Archimedes' principle applied to a granite continent floating on basalt (p. 463).

I am pleased to see that Cleveland disregards the dicta of certain committees on symbols and nomenclature and uses gm for gram, nt for newton, and relegates the Celsius scale to a footnote (p. 108). However, there remains possible confusion in using W for both work and weight, and in using cm Hg as a unit of pressure. Also, I'd agree with committee recommendations that E_k is preferable to KE and E_p to PE. The typeface used for emphasis (e.g., Newton's laws on pp. 65, 66, 71) is so nearly like that used for the regular text as not to command attention nor give pleasing contrast. None of these trivia stands seriously in the way of the author's presentation in *Physical Science*, which is excellent.

Collision Efficiencies of Two Spheres Falling in a Viscous Medium for Reynolds Numbers up to 19.2. By Uri Shafrir and Morris Neiburger. 140 pp. University of California Press, Berkeley, 1964. Paper $3.00.
Reviewed by J. Gillis, Weizmann Institute of Science, Israel.

The motivation for this monograph arose from a study of the formation of raindrops by collision between droplets, the authors having very reasonably decided that understanding of this process might be advanced by analysis of the collision efficiency of two small spheres falling in a viscous medium. The numerical solution of the full equations of motion presents formidable technical difficulties at the present state of electronic computer development. (And the reviewer suspects that when these technical difficulties have been overcome, the even greater difficulties of the numerical analysis will make themselves felt and may prove much less tractable.)

Approximations were needed to render the problem manageable. These were essentially to study the fall of each sphere in a fluid whose motion has been instantaneously disturbed by the other sphere. It was thus possible to solve once and for all, by a relaxation process, for the disturbance field and then fit it on to each of the two spheres and move it about with them. The motion of each sphere in the disturbed fluid is computed by a standard Runge-Kutta procedure.

The results are presented in detailed tables and lucid diagrams, but the experimental evidence is not adequate for checking purposes. One check was to compare the results for very small Reynolds numbers with some previous results of Hocking, the only earlier theoretical work on the subject in which the authors show any real confidence. The fit seems to be very good.

The relaxation solution for the flow past a simple sphere indicates the separation of a wake behind the sphere for Reynolds numbers greater than 17.0. This agrees with an earlier result of Jenson, but one should not read too much into this agreement since the methods used are essentially the same. The critical value observed experimentally is 10.2.

It would be fair to say that the book makes a useful contribution to a very difficult problem.

Die chemische Bindung (2nd ed.). By H. Hartmann. 109 pp. Springer-Verlag, Berlin, 1964. Paper, DM 9,80.
Reviewed by M. E. Straumanis, The University of Missouri at Rolla.

The first edition of this small book appeared in 1955. Although at that time there existed a series of books on the elementary introduction to the theory of the chemical bond, the author decided to write another one, based on lectures given in Frankfurt. The reason for that was a different approach to the description of the chemical bond: while usually in the German literature the bond was treated from the viewpoint of the corpuscular theory, the author developed a qualitative treatment based on the wave theory of de Broglie, which had already been used for the same purpose by J. A. A. Ketelaar. No heavy mathematics was involved, only elementary derivations; all this had the purpose of making the book accessible to undergraduate students, who are not yet familiar with the mathematical apparatus of the quantum theory. The author succeeded so

well in this respect that a second edition was prepared in a slightly revised fashion in 1963.

The whole book consists of three lectures. In the first, electrons as particles and waves are discussed, the wave function of the ground state of the hydrogen atom is derived and then, using as an analogue the energy of an oscillating string, it is shown that the energy of the "cathodic substance" per mass unit (that is per electron, if particles are considered) is of the order of magnitude of the energy of a hydrogen atom calculated by Bohr. The Pauli principle is introduced and also the electron spin. Finally it is shown qualitatively how, on the basis of the Pauli principle, the periodic system is understood. In the second lecture the bond between H and H^+, the formation of H_2, and the impossibility of H_3 are discussed. The author continues by describing the bonds between Li and H, O and H, N and H, C and H, and closes the lecture with the three types of bonding (the van der Waals bond is not mentioned).

In the last lecture the ionic bond is discussed, starting with the calculation of the lattice energy and the Madelung factor. Then, upon introduction of steric factors, the formation of complex ions and complex compounds is described. The book ends with the discussion of the covalent and the atomic bond, bonding in organic compounds, and finally bonding in metals.

The book may be useful for chemistry students, and even for students of physics if they wish to become acquainted with the problem of bonding. However, no literature is cited, and only at the end are the books of Heisenberg, Hund, and Hartmann himself recommended for further study.

Activation Processes in Solid Metals and Alloys. By K. A. Osipov. Transl. by Scripta Technica. 131 pp. American Elsevier, New York, 1964. $7.75.
Reviewed by Norman H. Nachtrieb, University of Chicago.

This small monograph adds little to the literature of metal physics, and its translation from Russian was a waste of time in this reviewer's opinion. To give it its due, it *does* summarize in useful tabular form a large number of experimental results on the energy of formation and migration of lattice vacancies in various metals. However, its approach to activated processes (diffusion, plastic deformation, recovery, creep, and recrystallization) is heavily biased with the author's views on heterophase fluctuations.

Many eminent physicists, including Maxwell, Planck, and Kammerlingh-Onnes, have entertained the idea that a continuous series of states connects the solid and liquid states. It was the Russian theoretical physicist, John Frenkel, however, who developed the theory of heterophase fluctuations most fully, arguing that thermal energy fluctuations lead to transient nuclei of the liquid phase in the thermodynamically stable crystalline state at all temperatures below the melting point. No direct experimental evidence has yet established the existence of such *proto* liquid nuclei, although a certain amount of indirect evidence has been adduced.

This review is critical, not of the concept of heterophase fluctuations, but rather of the author's oversimplified approach to the estimation of their energy. He endeavors to calculate the change in the thermodynamic potential from functions of the heat capacity, when a metal is heated from 0°K to its melting point. The resulting quantity, called q, is variously compared with experimental values of the formation energy and migration energy of lattice vacancies. The author seems to be uncertain as to just which of these two quantities his calculation relates. The reader might well suppose that q could be the sum of the formation and migration energies, but alas! it falls short of reliable values for the activation energy for self-diffusion in metals by factors that range from one to four.

A reader has a right to expect several things of an author. One of these is critical judgement of the validity of data in his field of knowledge. Yet Osipov reports without surprise the unbelievable work of Pryanishnikov, who found that the activation energy for self-diffusion in λ-iron falls from 75 kcal. g. $atom^{-1}$ to 26 kcal. g.