lightning discharges are produced in this frequency range. These two topics, united by the theory of radio-wave propagation between the earth and the ionosphere, brought together two distinct groups of experimental scientists to discuss their problems. The book is the collection of the papers presented at the seventh meeting of the AGARD ionospheric research committee in Munich in 1962.

It was a difficult task for the editor to arrange the papers, and to some extent the sequence and group classification must remain arbitrary. In the first chapter the properties of the lower ionosphere, and in the second the D-layer irregularities, are considered. The third chapter, on lower ionospheric layers and on low-frequency propagation, presents data obtained from the LOFTI satellite experiment. Oblique incidence measurements and radio noise below 300 kc/s are considered in the next two chapters. In Section 6 very-low-frequency propagation and recordings of radio transmission during the nuclear test on Johnson Island in 1962 are dealt with. The seventh chapter considers extremely low-frequency transmission (10-20 kc/s), and in the last section investigations on resonances of the earth-ionosphere cavity are presented.

In this book there is a good balance between theory and experiment, and for the first time experimental data are compared and explained by mode theory. These proceedings are an excellent reference for workers in the field or those engaged in related research. It is a reference book of the state of the art, and many valuable data are presented.

**Advances in Catalysis and Related Subjects, Volume 14.** D. D. Eley, Herman Pines, and Paul B. Weisz, eds. 522 pp. Academic, New York, 1963. $16.00.
*Reviewed by H. Wise, Stanford Research Institute.*

To the physicist the most recent developments in research on heterogeneous catalysis should prove of interest because of the emphasis placed on the physical properties of the solid surface. No longer is the field of catalysis the happy hunting ground of the chemist who, in the past, centered his entire attention on the chemical distribution of product molecules. Four of the six contributions to this volume of *Advances in Catalysis* reflect to a major extent this shift from catalytic chemistry to catalytic physics. The chapter by G. Ehrlich on Modern Methods in Surface Kinetics represents a comprehensive review of the experimental techniques developed for the study of elementary processes occurring on solid surfaces. The availability of ultrahigh vacuum techniques, field-electron and field-ion microscopy, and flash-desorption experiments, has led to new insights on gas-solid interactions during the initial stages of surface coverage.

The chapter "Catalytic Oxidation of Hydrocarbons" by L. Ya. Margolis reviews the catalytic activity of various metals, metal-oxide semiconductors, and spinels for hydrocarbon oxidation, a most important process in the chemical industry. It is of interest that the interpretation of the catalytic properties is attempted in terms of the electronic properties of the catalyst and its modification by the presence of adsorbates. An apparent correlation is noted between chemical parameters, including rate and selectivity, and the electron work function.

Another interesting physical tool in the study of solid catalysts is to be found in optical absorption spectroscopy. In a chapter by H. P. Leftin and M. C. Hobson on Application of Spectrophotometry to the Study of Catalytic Systems some recent observations are described on the identification of chemisorbed reaction intermediates. During the last ten years these optical measurements have shed new light on some of the chemical species present on the surface of the solid and their role during catalytic reaction. It has been questioned whether the species observed in the absence of catalytic surface reaction bear any relationship to those present during catalysis. The authors of this chapter give some good evidence to demonstrate the existence of such relationships. The brief, but stimulating, chapter on Quantum Conversion in Chloroplasts by M. Calvin deals with an interpretation of photophysical effects of biological systems in terms of a model reminiscent of solid-state semiconductor theory. With new experimental tools for the study of solid surfaces at various stages of development, the next decade promises to be an exciting one to the scientists engaged in research on gas-solid reactions.

**L'Effet Mössbauer et ses Applications à l'Etude des Champs internes.** By A. Abragam. 70 pp. Gordon and Breach, New York, 1964. Cloth $3.95; paper $1.95.
*Reviewed by G. K. Wertheim, Bell Telephone Laboratories.*

The following quoted from the editors' preface to the new series *Documents on Modern Physics* is largely applicable to the present state of Mössbauer effect research.

> Today the dramatic phase of a new branch of physics spans less than a decade and subsides before the definitive treatise is published. Moreover, modern physics is an extremely interconnected discipline and the busy practitioner of one of its branches must be kept aware of breakthroughs in other areas. An expository literature which is clear and timely is needed to relieve him of the burden of wading through tentative and hastily written papers scattered in many journals.

In the spirit, we are given *L'Effet Mössbauer et ses Applications à l'Etude des Champs internes.* The manuscript has been well known to scientists active in Mössbauer research since 1961 when it was first circulated by its author. Many students have found it useful and the editors and publishers are doing a service by making it generally available.

The volume under review reproduces the original version with only minor corrections. No attempt has been made to update the volume or to include references to work published since the early part of 1961. As a result, the chief value of this book is to be found in the clear and concise treatment of fundamentals. The references cited do not give an adequate picture of the scope of Mössbauer research as it bears on the study of internal fields today.

About one-third of the book is devoted to the theory of the Mössbauer effect and the rest to its application

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