compound's structure to its chemistry, to correlate structural features with those of other related compounds, and to rationalize the molecular parameters in terms of modern bonding theories from which useful and predictive information can be obtained.

The author modifies the empirical valence theory of G. N. Lewis by defining a chemical bond as the sharing of an electron pair *among two or more atoms* and extends it to embrace molecules that seemingly violate the classical Lewis rules. Rundle discusses in detail how electron-deficient compounds, certain transition metal complexes including metal carbonyls, and so-called outer *d*-orbital compounds such as PCl_5, SF_6, polyhalide ions, and noble gas fluorides follow the principles of bond delocalization and make use of all the low energy valence orbitals. He uses molecular orbital symmetry arguments to show that, for the latter compounds, the outer *d*-orbitals are not utilized appreciably for σ-bonding but do play an important role in providing π-bond character. He also concludes that the rare gas rule is seldom violated, except in transition metal compounds where valence orbitals may be sterically shielded.

Examples are given to show the importance of steric and multiple bonding factors in determining molecular configuration. In the case of molecular systems for which no Lewis-type structures can be written, the advantages of molecular orbital formulation over ligand field and valence bond treatments in utilizing molecular symmetry arguments to describe the ground state electronic configuration of compounds are demonstrated.

Rundle's article spans much of the part of inorganic chemistry that has been directly influenced by his own research productivity, and it provides a penetrating insight into his own scientific philosophy.

The fourth article, by W. F. Little, is a comprehensive and lucid account of the chemistry of "metallocenes" as it has evolved since the discovery in 1951 of the sandwich compound ferrocene. The reader cannot help but be impressed by the tremendously rapid development of this exciting new field of organometallics, which has created intense interest and research activity among inorganic, organic, and theoretical chemists. Little gives a detailed discussion of the different types of known metallocene complexes, their preparations, and their characterizations by physical and chemical techniques. This review is extremely well documented and offers the reader an excellent opportunity to see modern chemistry in action.

The fifth article, by K. W. Wiberg, is "Oxidation-reduction mechanisms in organic chemistry." In it Wiberg demonstrates extremely well how important it is to critically evaluate different types of evidence in reaching conclusions concerning possible mechanisms of reaction. He illustrates the power of the use of isotopes in elucidating organic reactions and at the same time makes the reader aware of the dangers involved in interpreting results. He discusses in detail the implications of the kinetic hydrogen isotope effect for different chemical reactions and shows that reactions involving cleavage of bonds to hydrogen need not give a large isotope effect. A presentation of different type mechanisms (ester, hydride transfer, hydrogen atom abstraction, electron abstraction, displacement, and addition-elimination) follows, with detailed examples. Wiberg points out that a knowledge of reaction mechanisms not only leads to a better ability to control the products and improve the reaction yields but also enables one to devise new synthetic methods. The article is well documented.

The purpose of the sixth article, "The chemistry of biological energy transfer," which is by W. P. Jencks, is to give the nonbiological chemist an up-to-date understanding of the remarkable chemical processes that occur in living organisms. In particular, the reader is introduced to biochemical terminology and to the mechanisms by which metabolic energy is generated, transferred, and utilized. Although not written in layman's language and not as easily digestible as a novel, this article presents a wealth of fascinating concepts and information.

In the last article, "The structure of the Grignard reagent and the mechanisms of its reactions," R. M. Salinger gives a thorough and well-documented review of the present knowledge of this ubiquitous reagent. It is significant that there are still a considerable number of conflicts and ambiguities concerning its structure(s) and reaction mechanisms that need to be resolved.

Arthur Scott, the editor of this volume, is to be congratulated for getting together a first-rate collection of manuscripts. I found all of them definitely interesting and gained from them a better appreciation of the tremendous diversity of research aims and interests.

The illustrations used in this book are very good and there are very few typographical errors. That the explosive nature of present-day research quickly outdates information is illustrated in several instances—the structure E for $C_3H_4(CH_3)Co(CO)_3$ (p. 100) now has been conclusively shown to be an (allylic) $Co(CO)_3$ interaction, while the presumed $Ru_2(CO)_9$ and $Os_2(CO)_9$ compounds (Table II, p. 99) have been recharacterized as $Ru_3(CO)_{12}$ and $Os_3(CO)_{12}$. The Jahn-Teller Theorem is not applicable to the MO correlation diagram for the assumed ethane-like $[(CH_3)_2Al]_2$ structure of D_{3d} symmetry (p. 94) since the E_u level would be half-filled resulting in a totally symmetric ground state. Structure (CLII), on page 203, which should have the dimethyl carboxylate groups attached to the olefin coordinated to the nickel, has been verified by an x-ray examination.

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Crystallography

Crystallographic Data on Metal and Alloy Structures. Compiled by A. Taylor and Brenda J. Kagle. Dover, New York, 1963. vi + 263 pp. Paper, $2.25.

The text of this book consists of a half-page introduction. The data are given in three tables covering (i) alloys and intermetallic compounds (2300 substances); (ii) borides, carbides, hydrides, oxides, and nitrides (700 substances); and (iii) crystal structures of the elements (77). The data tabulated are system, structure type and powder file data, space group, lattice constants, and cell content. For the elements the "x-ray density" is also given. In each table the arrangement is alphabetical by the first letter of the chemical formula, but in Table 2 the compounds in each chemical category are grouped together.

The definition of intermetallic compound on which Table 1 is based must be very broad. Not only are numerous sulfides and sulfosalts included but even halides are found in Table 1. The basis for selection is not readily apparent. For instance, one finds KCl and NaI

but not KI and NaCl. In Table 2 a few carbonates and about 35 silicates are included among the oxides. Several formulas and names are listed without data. No explanation is offered for this seemingly capricious coverage.

This compilation may prove useful to those who work within the undefined limits of its particular range and do not require such comprehensive and authoritative treatment as that given by the new edition of *Crystal Data*, recently reviewed in *Science* [**140**, 1230 (1963)].

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Mathematics

Mathematical Discourses. The heart of mathematical science. Carroll V. Newsom. Prentice-Hall, Englewood Cliffs, N.J., 1964. x + 125 pp. Illus. $5.

Topics in Modern Mathematics. Ralph G. Stanton and Kenneth D. Fryer, Eds. Prentice-Hall, Englewood Cliffs, N.J., 1964. xii + 187 pp. Illus. $5.95.

Although a few of the same topics are discussed in both of these books, the books were written with very different purposes in mind. Carroll Newsom's *Mathematical Discourses* is an attempt to explain to the layman what a deductive, or axiomatic, system is. (Why the author prefers the name "mathematical discourse" is not clear.) *Topics in Modern Mathematics*, edited by Ralph Stanton and Kenneth D. Fryer, is intended chiefly for high school teachers.

In the first three chapters of *Mathematical Discourses*, Newsom discusses the historical development of the concept, in the fourth he gives several examples, listing the axioms and proving a few theorems, and in the fifth he discusses the use of axiomatic systems in dealing with practical and scientific problems.

I do not think the book successfully achieves its aim. The historical parts are superficial, with far too many names and dates, some of them unimportant. The style is heavy—for example, "utilize" is preferred over "use," and there is the strange expression (page 93) "by actually indulging in the process of division," which is apparently not intended to be humorous.

What is more serious is that there are a good many mathematical statements which will confuse or be meaningless to the average reader. One example is on page 93: "Interestingly enough, one may write, 1 = 0.99999 . . . and 23 = 22.99999. . . ." There is no explanation. In the discussion of the postulates for a complete ordered field (pp. 96–102), it is not pointed out that the subset P is the set of positive real numbers. Finally, some of the proofs are probably too difficult for the readers for whom the book was intended.

Topics in Modern Mathematics contains ten independent chapters with the following titles: "Groups and fields," "Set theory," "Boolean algebra," "Logic and computing," "Vector spaces and matrices," "Numerical analysis," "Functions of a single variable," "Fundamental concepts of calculus," "Probability theory and statistics," and "Some types of geometry." There is an epilogue, in which the editors express their misgivings about many aspects of the current curriculum reform in American high schools.

Most high school teachers could profit from reading this book. Many topics are discussed which they will soon be teaching, if they are not already doing so. However, there is, unfortunately, not a single chapter about which I do not have serious reservations. The treatment simply does not have the accuracy and clarity required in a book of this sort. It is impossible, in a brief review, to argue the point in detail, but perhaps the following examples will show what I mean.

The discussion of the null set (p. 20) does not make it clear that what is involved is merely a convention. The proof that 3 has no rational square root is not complete. In a discussion of the vector space of ordered pairs of real numbers (p. 68), it is stated that addition and scalar multiplication will be defined and then a zero vector will be selected; we have no choice, of course. The relation between 2 × 2 real matrices and the transformations of a plane into itself is discussed (pp. 72–75), but the fact that the transformations are linear is not mentioned. In a discussion of scalar multiplication (p. 78), it is claimed that (a, b) and $\lambda\ (a, b)$ have the same direction; on the next page there is a simple error in algebra, which is the result of the same disregard of signs. We are told (p. 78) that in a later section it will be proved that 0/0 can have no meaning, but that at the moment it is enough to notice that it certainly differs from the quantity 14/9. The list of Hilbert's undefined relations for geometry (p. 167) includes three that do not belong there.

My list of examples is far from exhaustive, but perhaps it is enough to show why I do not think the book should be used in training high school teachers.

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Satellite Geodesy

The Use of Artificial Satellites for Geodesy. A symposium held at Washington, D.C., in April 1962. G. Veis, Ed. North-Holland, Amsterdam; Interscience (Wiley), New York, 1963. xii + 424 pp. Illus. $14.

This collection of papers that were presented at the first international symposium on the use of artificial satellites for geodesy gives evidence of the wide range of talents that are necessary to exploit the new area of satellite geodesy. The invited papers were augmented by a considerable number of contributed papers, in order to provide more complete coverage of the subject matter. George Veis, the editor, has succeeded in arranging the material with as much continuity as can be expected in a collection of individual papers, written by more than 50 of the most knowledgeable but, nevertheless, highly specialized authors.

The well-rounded coverage is a reflection of the excellent planning of the symposium; W. M. Kaula, as chairman of the program committee, saw to it that the necessary geographical and technical diversity was reflected in the presentations on the new approaches to the classic problem of geodesy—the determination of the size and shape of the earth. In addition to geodesists and photogrammetrists, the list of authors contains the names of specialists in the fields of mathematics, astronomy, physics, geophysics, electronic engineering, and other fields, thus providing evidence of the numer-