1964, and the thoroughness of coverage is demonstrated by the approximately 950 references cited. The two major subjects treated in this book are trigonal boron compounds containing at least one boron-nitrogen bond, and borazines. Compounds with boron-boron bonds have been excluded from the series. Other classes of compounds covered are heterocyclic boron-nitrogen compounds other than the borazines, tetrahedral boron-nitrogen compounds, boron-nitrogen polymers, and boron-phosphorus compounds. Though ignored in the title, boron-arsenic and boron-antimony compounds are also included. Nomenclature is discussed in each of the chapters, whereas in volume 1 this was done in a separate chapter near the beginning of the book.

Since boron-nitrogen compounds do not occur in nature, a book on these compounds must necessarily be an account of their preparation and reactions. The authors have provided excellent coverage of both. In addition, they have included an impressive quantity of data on physical constants. In the literature there are a number of reviews that deal with some classes of compounds, such as borazines, covered in this book, and there are also general reviews with a less restricted coverage of boron-nitrogen chemistry. But this book is nevertheless highly recommended as an excellent detailed reference work for those interested in this fascinating and rapidly growing field of synthetic chemistry.

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Letters of Priestley

A Scientific Autobiography of Joseph Priestley (1733–1804). Selected scientific correspondence, edited, with a commentary, by ROBERT E. SCHOFIELD. M.I.T. Press, Cambridge, Mass., 1967. 431 pp., illus. $13.50.

Joseph Priestley was one of the most prolific writers in an age noted for its prolific writers. One thinks immediately of the massive volumes of Edward Gibbon's *Decline and Fall* and of Dr. Samuel Johnson's dictionary, but these pale into insignificance (quantitatively) beside the theological, polemical, political, historical, and scientific writings of Priestley. It was Priestley's proud boast that he never revised but published everything at the white heat with which it left his pen. The result is a forbidding pile of material upon which the historian of science must look with some degree of apprehension, for the scientific nuggets are often buried in a veritable mountain of other matters. From this mountain, Robert E. Schofield has extracted the essence (he feels) of Priestley's scientific thought. His edition is a model for future editors of scientific correspondence. From it there emerges what the title describes as a scientific autobiography, for Priestley was a frank man and his ideas and his opinions are clearly expressed in his letters.

Here are to be found many of the more important controversies of the 18th century. There is Priestley's caustic letter to Father R. J. Boscovich on the application of Boscovich's theory of point atoms to what Boscovich thought to be the cause of materialism. One can also read Priestley's reaction to the new chemistry which dispensed with phlogiston in favor of the new French essence of combustion, oxygen. And there is much more. Interspersed throughout are commentaries by Schofield which add materially to the value of the letters.

I have only two criticisms to direct at this work. The first is the failure of the editor to identify people mentioned in the body of the letters. There is an excellent biographical appendix which gives short sketches of the recipients of Priestley's pen, but the reader is left to fend for himself with those people mentioned by Priestley. Thus, on pages 205, 208, 215, and 261, for example, a Mr. William Russell is mentioned but, in spite of the terms of familiarity with which Priestley speaks of him, we are given no clue as to his identity. The second criticism is one the justice of which only Schofield can decide, for only he knows the Priestley material thoroughly. He has restricted this volume to the "scientific" correspondence of Priestley but he has also noted that Priestley's "science" was, in many cases, subordinate to his larger vision of reality. The question is, where has Schofield drawn the line? Do we lack some essential documents here because they were not "scientific" as Schofield understands the term? Fortunately, the answer will soon be forthcoming, for Schofield's biography of Priestley will, undoubtedly, be the definitive life. In the meantime, I can only recommend this volume strongly as a work which sheds great light upon the career of Joseph Priestley in particular and upon the life of science in the 18th century in general.

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Mathematics of Systems

Modern Foundations of Systems Engineering. WILLIAM A. PORTER. Macmillan, New York, 1966. 501 pp., illus. $14.95.

Techniques for the analysis and design of engineering systems are undergoing major revision, largely because of the availability of the digital computer for the simulation and realization of complex systems. Whereas classical approaches are directed toward closed-form analytical descriptions of system behavior and performance, the more recent techniques lead to algorithmic descriptions. The tools and notation for this kind of description have been found in matrix algebra and in the more abstract framework of functional analysis. These techniques have not yet been fully established or refined to the point where intuition and insight are easily conveyed.

Porter's book is another step in the direction of these goals. It is oriented toward providing a mathematical basis of modern system theory rather than a detailed account of the applications. While the book is written in a mathematical style, the author has made an effort to motivate the development. He has been particularly successful in the first two chapters, which deal with the definitions and properties of function spaces and with transformations between spaces. The material in these chapters is presented with enough informality to make the reader comfortable while maintaining the precision and elegance of the ideas. The remaining two chapters investigate the structure of linear systems and the application to a class of problems in optimal control. The nine appendices provide supplementary material both on functional analysis and on the optimal control problem considered in chapter 4.

This book is somewhat of a departure from other recent texts in its use of the more general and abstract function space notation, and it is characterized primarily by the generality of the approach. As the author says: ". . . the basic problem is com-

pletely solved in the abstract and examples are not concerned with the question 'what is the solution?' but rather with the simple matter of what the known solution looks like in the various concrete settings." Although several of the examples are concerned with the solution of simple problems within this more general framework, the book does not successfully relate these new techniques to classical methods, or demonstrate that the approach leads to the solution of new problems and a deeper understanding of old ones. Thus, its value lies primarily in its clear introductory exposition of functional analysis. An extensive list of references is included, and the text contains an abundance of exercises making it suitable as a reference for classroom use.

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One of Our Necessities

Mineral Resources. Geology, Engineering, Economics, Politics, Law. PETER T. FLAWN. Rand McNally, Chicago, 1966. 418 pp., illus. $9.

The circumstance that distinguishes modern industrial civilization from all its predecessors is its dependence upon mineral resources—metallics, nonmetallics, and fossil fuels. These resources are irregularly distributed about the earth; they occur in finite amounts, and most are exhaustible at present rates of consumption in a matter of decades or centuries. In view of the importance of this subject, and the dearth of recent, comprehensive books concerning it, the present book, written by an economic geologist, is particularly welcome.

As is the case with any other subject of comparable complexity, the published data on the world's mineral resources comprise an extensive library. The problem of reducing these data to a meaningful form within the scope of a single volume is therefore formidable. Of necessity, the data must be presented in a statistical form, but what data to present, and in what manner, is dependent upon what theoretical framework one chooses to use. One may use that of physical science, or that of business enterprise and its handmaiden, economics. One's treatment may be based on the physical and chemical properties of matter and energy, the geological occurrence and processes of origination of minerals, and the technological processes of their extraction and utilization, or on concepts of property and ownership, monetary value, and profitability of exploitation. The author of *Mineral Resources* has attempted to combine these two approaches, but in fact the treatment vacillates between them, with the heavier weighting apparently given to the second.

The business-economic framework is dominant in chapters 1, 4, 7, and 8, dealing with Minerals, Mineral Deposits, Reserves, and Resources; Lessons and Laws of Ancient History; Ownership of Mineral Deposits; and Minerals and Government. In these sections one of the more useful discussions pertains to the evolution of mining law in the United States, culminating in the "Law of the Apex," which originated as common law in California in the 1850's but which has by now become one of the most inhibitory influences to exploration in the U.S. mining industry.

The history of mineral exploitation from ancient to modern times is treated in chapters 4, 5, and 6, but so superficially as to be of little use to the otherwise uninformed reader. Obscure geographic place names and the names of mining districts are used extensively, yet only five maps are given in the entire book. Of these, four pertain to anicent Egpyt and the Middle East, and one is a boundary map of the North Sea.

The physical-science framework is used as the principal basis for chapters 2 and 3, on the geology of mineral deposits, and chapters 9, 10, and 11, dealing with modern mining practices, world distribution and reserves of minerals, and future supplies.

To me, the most informative section of the book is chapter 10, which includes tables giving the percentages of world production by geographical region for various minerals and the recent rates of production and "indicated reserves," by producing country or area, for selected key minerals. Of particular significance is the "reserves-production index," defined as the ratio of reserves to annual production. For most key minerals this is measurable in decades. For some, however, notably iron, aluminum, and coal, it is measurable in centuries.

As to the future, the author recognizes the necessity for stabilization of world population, but he has not faced with equal realism the impossibility of a continued exponential growth in the consumption rate of nonreplaceable minerals.

A great asset of the book is the extensive bibliographies given at the end of each chapter. On the negative side, the book suffers from a number of serious defects of editing and publishing. Some of the important tables are so poorly laid out that they are almost unintelligible.

Most of the contents of the book are factual, and the interpretations are characterized by good judgment. A significant exception is the discussion of extraterrestrial sources on pages 381 and 382. Despite the fact that the author had previously dismissed as visionary and impractical recent proposals for obtaining metals from such low-grade terrestrial sources as granites, he has been credulous enough to allot more than a page to a vastly more visionary project, now being financed by the National Aeronautics and Space Administration, pertaining to mining operations on the moon.

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A View of Terrestrial Space

L'Organisation de l'espace. Eléments de géographie volontaire. JEAN LABASSE. Hermann, Paris, 1966. 605 pp., illus. 75 F.

One of the remarkable success stories of the last 20 years has been the rise of France from the physical and psychological ruin of World War II. No small part of the French success has been due to carefully organized public leadership in economic planning. General Charles de Gaulle for the last ten years has so effectively upstaged everyone else on the French scene that we are apt to forget that the foundation for recent French prosperity was effectively laid by others who conceived and implemented the succession of four-year plans that commenced in 1947. Jean Labasse, a geographer, planner, and banker, is an influential member of a group of relatively young men who have provided much of the intellectual motivation for French planning.

Labasse has been interested particularly in regional organization and land-use planning. In *L'Organisation de l'espace* he presents a comprehensive