clusion of such topics in a textbook for advanced undergraduate students is to be welcomed. Although they are generally considered the field of specialists, they are important enough to justify giving undergraduate students a basic idea of the question. The authors have proved it possible.

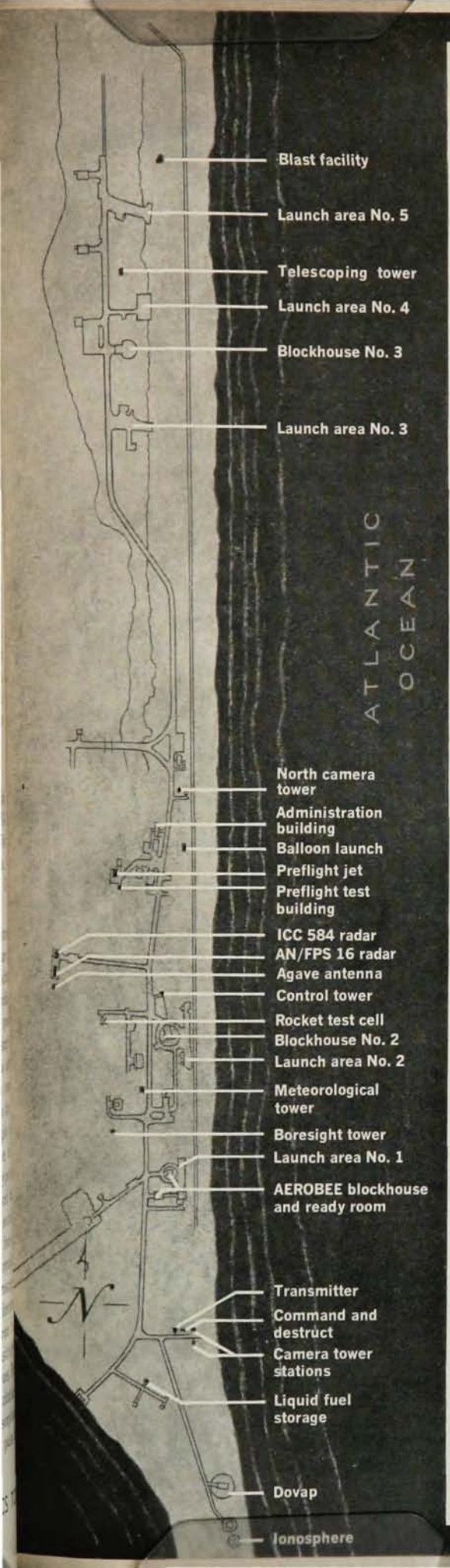
As a general procedure, the authors start from a summary of known experimental facts, proceed by straightforward reasoning to a rigorous theory, and solve several important examples to link theory and problems. Every chapter ends with a collection of interesting problems, mainly of a practical kind (the answers to odd-numbered ones are given). Giorgi's rationalized system of units is used throughout the text. The exposition and general aspect are clear and pleasant; there are useful figures and tables. But the book lacks a general list of references; literature is referred to only in a few chapters. Although the book is a very good one indeed, every student can benefit by looking through more than one textbook.

The contents include a summary of vector analysis, a practical treatment of boundary problems, a short introduction to the mechanism of metallic conduction and to transient behavior of a circuit under a slowly varying emf, plane and spherical electromagnetic waves, reflection and refraction, and waveguides. Anisotropic materials are alluded to on several occasions, but are not handled in this book.

X-Ray Absorption and Emission in Analytical Chemistry. Spectrochemical Analysis with X-Rays. By H. A. Liebhafsky, H. G. Pfeiffer, E. H. Winslow, P. D. Zemany. 357 pp. John Wiley & Sons, Inc., New York, 1960. $13.50. *Reviewed by Harry C. Baden, Eastman Kodak Company.*

THE publication of this book will be welcomed by the practicing analyst, for the authors have produced a usable handbook on x-ray spectrochemical analysis. With instrument manufacturers providing increased automation, greater precision and speed of analysis, x-ray spectroscopy is being increasingly applied in the modern analytical laboratory. The authors, fully experienced in this technique, present a complete résumé of the field as it is known today. To the analytical chemist who is just beginning to employ x-ray spectroscopy and to one who must consider the advisability of doing so, this book is particularly pertinent.

The origin and properties of x rays are traced historically in the introductory chapters, many sections of which are headed interestingly by quotations from original publications. A logical sequence of absorptiometry, thickness measurement, and emission spectroscopy follows. Many specific examples from the literature as well as hitherto unpublished experiences from the authors' laboratories well illustrate the sensitivity and precision obtainable by these x-ray techniques. For the analyst, discussion of the problems of excitation efficiencies, and matrix or interelemental absorption and enhancement effects, and the treatments of pulse height



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analysis, and statistics, and error measurement are competently presented and are most valuable. Being designed primarily for the analytical chemist, a brief section of notes on currently available, representative equipment is included, as well as a modest but adequate presentation of the necessary physics and electronics.

References cited date only through 1957; thus it is fortunate that three of the authors compile and publish a biennial review of recent advances in x-ray spectrochemical analysis (see *Analytical Chemistry*), which will aid in updating the book.

Hochbelastbare Wasserstoff-Diffusions-Elektroden für Betrieb bei Umgebungstemperatur und Niederdruck. (High-drain hydrogen-diffusion-electrodes operating at ambient temperature and low pressure.) By Eduard Justi, Manfred Pilkuhn, Wolfgang Scheibe, and August Winsel. 235 pp. Akademie der Wissenschaften und der Literatur, Mainz, Germany, 1959. Paperbound, DM 22.40. *Reviewed by H. A. Liebhafsky, General Electric Research Laboratory.*

PART of the large new research effort on old methods of energy conversion is directed toward the fuel cell, which differs from the other devices involved in that it converts chemical energy directly into electrical. (See an earlier book review in *Physics Today*, Dec. 1960, p. 58.) The present book is a welcome account of intensive fuel-cell research carried out under industrial sponsorship during the last decade by Professor Justi and his colleagues in West Germany. As its title shows, the book is concerned mainly with the hydrogen electrode. The completeness of the information released on this electrode betokens unusually enlightened sponsorship, and encourages one to anticipate early similar treatment for the oxygen electrode.

The most difficult of fuel-cell problems is to attain satisfactory electrode reactivity (hence, current density) under advantageous conditions. Justi and his collaborators have solved this problem for the hydrogen electrode by using two kinds of nickel (carbonyl and Raney) to give a microporous structure, in which the pores facing the electrolyte are smaller than those facing the gas. Others have used this structure, but no one in this reviewer's opinion has produced a better and more convenient hydrogen electrode for high current densities.

After a short and adequate introduction, the book proceeds to a theoretical treatment of the processes at a simple hydrogen gas-diffusion electrode, as the electrodes under discussion are called. The treatment is particularly noteworthy in that it strongly emphasizes the kinetic point of view over the thermodynamic; it is founded on the realization that the *rates* of physical, chemical, and electrochemical processes at the electrodes of a fuel cell determine whether or not electrons originally resident in the fuel can be made to flow *usefully* through an external circuit to be captured by oxygen. Such treatment cannot in the present state of our