without the tremendous assistance of this volume. For all chemists (experimental and theoretical) this volume summarizes neatly the tremendous progress that has been made in our understanding of "electron deficient" compounds. At the same time even the casual reader will note that significant problems remain. The book is a major contribution to a rapidly expanding field.

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History of an Industry

The Petroleum Industry. George Sell. Oxford University Press, New York, 1963. x + 276 pp. Illus. $5.60.

The author attempts in this short book to give the reader a panoramic picture of this vast industry, its history, its techniques, and its size. The story ranges from the building of the ark to the production of biologically soft detergents. In general, the story is well told. It is a book intended for the general reader, of course, not for the specialist; although specialists are becoming so specialized that perhaps they, too, will pick up new information. In any book of this type, the question that the author must answer is, "how much information should I include?" If he includes too much, the book is costly and overspecialized; if he includes too little it is superficial. Sell has managed to steer skillfully between this literary Scylla and Charybdis.

The book is logically arranged; Sell begins with the origin and nature of petroleum and considers exploration, drilling, and production. He then moves to manufacturing—various refinery processes (distillation, cracking, platforming, treating, and the like) as well as the physical and chemical properties of petroleum products are discussed. The use and distribution of petroleum products are considered and the vast research activities of the petroleum industry are noted. A following chapter recounts how these research activities have led to the production of chemicals.

That the author emphasizes exploration and production more than manufacturing and research is probably a reflection of his background. There are a few specific points that might be raised: the double bond in an olefin is not a weak linkage, it is a reactive linkage; diolefins are not really less stable, just more reactive. Sell's statement (p. 145) that during refining the total sulfur content is reduced to negligible proportions is at odds with the immediately following statement in which he (correctly) says that this sulfur has an adverse effect on the antiknock properties of tetraethyl lead. In the discussion of jet fuels the five-line paragraph (p. 151) on thermal stability seems somewhat inadequate in view of the importance of this property with respect to present and future aircraft and the immense amount of work devoted to its study. Further, in the discussion of detergents produced from alkylated benzene, a few words explaining that branched dodecenes are replaced with straight-chain dodecenes because this provides a more palatable food for microorganisms and thus promotes the purification of water supplies, might have been worthwhile in view of the great current interest in water conservation.

However, these are relatively minor points. My only major criticism is that almost no references are cited. Apart from the IP and ASTM test numbers and some indication of sources for the statistical data on production and reserves, there is no indication that the author consulted anyone in writing this book. References to some of the more extensive and intensive works that are available would have made this book more valuable, for the general reader could then have satisfied his urge for more detailed information.

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Mathematical Psychology

Handbook of Mathematical Psychology. vol. 1. R. Duncan Luce, Robert R. Bush, and Eugene Galanter, Eds. Wiley, New York, 1963. xiii + 491 pp. Illus. $10.50.

Although mathematical psychology has been with us for many years and its central role in the area of psychometrics has long been well established, the approach has only recently begun to assume an important place within the framework of general experimental psychology. The past 15 years have seen a remarkable growth in the development and use of mathematical models in various areas of experimental psychology. The editors of the *Handbook* have undertaken the task of bringing together the new material into a single source, as a kind of advanced introduction to the present state of mathematical psychology in each of the areas in which the techniques are now being extensively used. To accomplish their purpose, they have persuaded major contributors in each area to prepare chapters in their special fields. This first installment of what will be a three-volume work fully lives up to expectations. It will certainly become a necessary item in the libraries of all who profess interest or competence in quantitative experimental psychology.

In the first chapter, Suppes and Zinnes present by far the most elaborate and sophisticated formal analysis of the nature of measurement that has appeared in the psychological literature. Because it is written largely in "axiomatics," a language not unlike English but with a somewhat different vocabulary and a greatly expanded character set, this chapter is likely to be avoided by all but the most highly motivated readers. This will be unfortunate: the chapter states with great (and agonizing) precision a good many things that badly need saying.

Roughly half of the book is devoted to the "new psychophysics." Included here is an organizing chapter by Bush, Luce, and Galanter, a chapter on detection and recognition by Luce, and chapters on discrimination and psychophysical scaling by Luce and Galanter. The new psychophysics is a rather surprising discipline. The experimental methods and the simple sensory continua to which the methods are applied are essentially those of traditional psychophysics: only the problems have been changed. Concern here is not so much with what is detectable or identifiable or discriminable as it is with the response processes themselves. Three main classes of models have been developed which attempt to account in detail for the behavior of subjects in these simple judgmental tasks. Chapters 3 and 4 are largely devoted to presenting adaptations and modifications of these models to fit various psychophysical situations. The same scheme is followed as far as possible in the chapter on psychophysical scaling. Here, however, the carefree empiricism underlying the quantitative judgment methods presents a truly formidable task for the axiomatic approach of the theoretician. The exposition throughout the section

is lucid and the adaptations and modifications of models ingenious. It is by far the best introduction available today to the objectives and approach behind the new look in psychophysics.

In the chapter on stochastic latency mechanisms, interest is in using the stochastic properties of the time interval between stimulus and response, or between one response and another, to deduce properties of the processes that intervene. McGill covers a variety of latency mechanisms ranging from the most simple to those composed of rather complex chains. The chapter is most impressive. Much the same can be said for the next chapter (by Newell and Simon) on the use of computers in psychology. This is an excellent introduction to a new approach that many feel represents the only real hope for objective, precise theory for the more complex—and hence more interesting —cognitive processes.

The final chapter, by Bush, is concerned with parameter estimation and evaluation of goodness of fit. Although the chapter is aimed at people with a rather strong background in mathematical statistics, most experimenters in the behavior sciences can benefit from the wisdom it contains.

This first volume of the *Handbook* has succeeded admirably in its purpose. It is hoped that the fields covered in the other volumes will fare as well.

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Linear Algebra

A Geometric Introduction to Linear Algebra. Daniel Pedoe. Wiley, New York, 1963. xii + 224 pp. Illus. $5.95.

This textbook for use in an undergraduate course in linear algebra is excellent with respect to the mathematics it sets forth and the manner in which the material is developed. That linear algebra is an essential subject in undergraduate mathematics education has become increasingly evident, and a great many textbooks for courses in this area have been published in the past few years. But few of these texts have all the virtues of Pedoe's book. The student who uses this book should obtain a just idea of what linear algebra is about, of what a vector space is, and of the important problems of geometry and algebra which find a natural formulation and solution in this setting.

He should also obtain a just idea of how the concepts and calculations of this subject are interrelated, know in matrix algebra how to distinguish the tail from the rest of the dog, and have an adequate knowledge of determinants. He should also profit from having seen mathematics presented as something more structured than the collection of problem-solving procedures that he probably met in his calculus course.

The coordinate geometry of two and three dimensions is covered in the first 90 pages. It is assumed that the student is familiar with the classical analytic geometry of these spaces, and the linear aspects of this subject are reexamined from the point of view of vector spaces. This somewhat lengthy motivation for the later study of abstract vector spaces (with real scalars) derives from Pedoe's statement—"I do not believe that the most general definition is the one which should be hurled at the student on the very first page." In fact, before the student meets the axioms for a vector space, he encounters their counterparts as theorems in two contexts—in geometry and in the algebra of n-tuples—and it is only in chapter 4, which begins more than halfway through the book, that the definition in question is finally hurled at the student. From this point, the chapter titles are "Vector spaces," "Matrices," "The concept of rank," and "Linear mappings and matrices." Quadratic forms are not discussed since "a further course can deal with them adequately."

The choice of topics, the clear exposition, the carefully designed and worked out examples, and the excellent exercises all contribute to the high quality of this fine book. The only reservation that I have is concerned with the place of such a course in the undergraduate curriculum. The author uses geometry as a familiar vantage point from which to survey and eventually study linear algebra. This is certainly the correct order of events from the point of view of history, but it is not necessarily the most effective order. An alternative is to use linear algebra to develop geometry—to replace the obsolete classical course in analytic geometry with a course in vector spaces and geometric algebra. Such a course would not presuppose the training in geometry needed in this book. Since this is almost what Pedoe does, this book can be regarded as a demonstration of the feasibility of this program as well as a distinguished realization of his own.

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Note

Meyrick's Microlepidoptera

Catalogue of the Type Specimens of Microlepidoptera in the British Museum (Natural History) Described by Edward Meyrick. vol. 4, *Phaloniidae, Carposinidae, Chlidanotidae, Oecophoridae, Blastobasidae, Momphidae, Epermeniidae, Strepsimanidae, and Physoptilidae* (British Museum, London, 1963. 521 pp. Plates. £12 10s.), by J. F. Gates Clarke, is the latest volume on the enormous Meyrick Collection. Edward Meyrick was probably the last of the great namers who flourished in the 19th century, and he described thousands of species, chiefly of microlepidoptera, from all parts of the world. His original descriptions, although good by the standards of his times, are completely inadequate for modern work on the systematics of this very complex group. Fortunately, his collection is preserved in the British Museum. There Clarke studied it in detail, identifying and, when necessary, choosing type specimens and dissecting and mounting the genitalia, the chief modern criteria for identification. For each name there are photographs (from the type when possible) of the pattern, wings, and genitalia, sometimes of the head and palpi, and sometimes drawings of the venation. In many instances the species are placed in other genera than the original ones, as modern work has shown such changes to be advisable. More than 760 species are treated. Relatively few are North American, the majority being Neotropical, Ethiopian, or Indo-Australian. It is safe to say that Clarke's great work will always be an essential in the systematics of this large group, and that without it chaos would reign.

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