

meet the second of the above situations, for it presupposes a fairly sound working knowledge of at least simple mechanistic organic chemistry; it could be used with advantage by second or third year undergraduates in Britain, and it would also be of considerable value as a starting point for graduate students as well.

The arrangement of the material is relatively orthodox, though logical—three-membered rings with one, and then two, hetero atoms; four-membered rings; furan, pyrrole and thiophene; condensed five-membered rings; azoles; pyridines; quinoline and isoquinoline; diazines and s-triazine; and some heterocycles of biological interest. Within these subject divisions the emphasis is not then on systems with differing hetero atoms seriatim. Instead, an attempt is made to establish general features and behaviour first, and only then to consider differences that change of hetero atom may produce. Within each section there is first a discussion of synthetic methods—this discussion is not exhaustive, but it sensibly discriminates in terms of those that are preparatively successful and of general utility. Then ring-opening, substitution and, where relevant, addition and side chain reactions are discussed in terms of their mechanistic type. A relatively novel feature is to return, late in the book after the student has become familiar with a very wide range of material, to a consideration of further principles of heterocyclic synthesis in terms of cycloaddition reactions, valence-bond isomerizations and enamine condensations.

There is an enormous amount of material here, sensibly selected and very well set out, and the coverage of, and reference to, the literature is quite unusually useful and comprehensive. Indeed, one's only reservation is that perhaps so many reactions have been included that not quite enough space has always been left for explanation and rationalization. Problem exercises have been provided at the end of each chapter, but one wonders a little whether at this level of sophistication they really warrant the space that they take up. But it would be a pity to end on a slightly carping note about what is an extremely well done and most useful text: it can be warmly recommended as a first rate work.

PETER SYKES

## EMISSIONS OF LIGHT

### Luminescence in Chemistry

Edited by E. J. Bowen. (The Van Nostrand Series in Physical Chemistry.) Pp. xiv + 254. (Van Nostrand: London and Princeton, October 1968.) 75s.

THE fields of research in which a knowledge of luminescence phenomena is required are continually increasing in number. The principles involved are identical in all of the diverse areas to which they may be applied, so that a unified treatment is both timely and desirable. Unfortunately, this relatively short work has contributions from ten authors with a resulting unevenness of treatment. A useful, if elementary, introduction defines the chief mechanisms of emission of light and touches on the concepts of quantum yield, quenching and light absorption. A more detailed treatment of the last subject would have been a better preparation for some of the material too briefly discussed in later chapters. Instrumentation is given a well and concisely written following chapter with an effective bibliography. The description of discharge lamps in a short and interesting section provides a useful summary somewhat reduced in utility by a lack of reference to particular commercial examples. Brief reports on luminescence in the gas phase and in inorganic substances provide useful introductions to two fruitful fields. Larger sections dealing with phosphorescence and delayed fluorescence and intramolecular energy transfer are excellent. Some readers may be confused, however,

by the abrupt introduction of conceptually difficult mathematical treatments insufficiently developed for obvious reasons of space. Examples are the considerations of spin-orbit coupling and resonance transfer. Also, the diagram on page 146 will not be particularly informative to those new to the field.

On the whole, the physical aspects of the subject are satisfactory, but, with one exception, the applications of luminescence are doubtful. The information to be obtained from the study of fluorescence in biological systems is very well brought out in the chapter on luminescence in biochemistry. Bioluminescence is not well served, particularly because the information has not been brought up to date. In the chapter on the fluorescence of organic compounds less precision than in earlier sections is to be expected because the complexity of most organic molecules does not allow, for example, the specific prediction of the occurrence of fluorescence. The requirements for fluorescence are adequately covered, but lapses elsewhere may prevent confident use of the material presented. Thus there are a large number of typographical errors, and also several structures the inaccuracy of which is more fundamental; for example, those on pages 82 (formula VI), 105 (both formulae) and 108 (formulae XXXIX and XLII). Structure XXXV is wrongly called a resonance structure and the greater acidity of aniline in the excited state is not clearly appreciated. Some of the analogies and concepts used are so imprecise as to be misleading. For example, the comparison of anthracene with phenanthrene (page 81), the idea of the "mobility of electrons" as used on several occasions, and the suggestions for enhanced fluorescence found in rigid molecules and for the reduced fluorescence of nitrogen heterocycles, all have more informative explanations than those given.

Chemiluminescence of solutions is given a brief and superficial discussion which by being out of date does not convey a proper impression of the field. It should be possible to produce a more balanced account of this subject with a better indication of the direction of advance. A more detailed treatment of mechanism both physical and chemical is necessary and feasible. A final chapter introduces what will be to many users of the book a novel field. "Fluorescence Microscopy and Histochemistry" concerns mainly the latter, the other applications not being considered. As the author points out, advances in this area depend greatly on the accuracy with which the observations under the microscope are correlated with known and reliable chemistry. Again, formulae errors result in some almost meaningless reaction sequences (for example, page 243), and interpretation is seriously wrong in the formulae on page 244. One's guesses about the reactions involved reinforce the author's plea for contributions from chemists to this difficult but potentially rewarding field.

The format of the book is pleasing and it is well produced, with the exception of the errors noted. Approaches to what is the best size of bibliography for each chapter differ markedly, reflecting to some extent a certain confusion as to the intended readership. The index is quite inadequate. In summary, the book presents a useful breadth of subject, marred by some carelessly written chapters and redeemed by some very useful contributions.

FRANK MCCAPRA

## GAME IDEAS

### Game Theory

By Guillermo Owen. Pp. xii + 228. (Saunders: Philadelphia and London, 1968.) 76s 6d.

A READER prepared for a really "mathematical" presentation of the subject will find this book pleasant reading. The theorems are proved with a fair degree of rigour (not as in Bourbaki, but certainly not as in an engineering