lude to the second volume which will deal with a whole range of polymers, including crystalline, fibrous and biological materials.

The two final chapters really whet one's appetite for volume 2: they indicate the remarkable way in which the behaviour of high polymers can depend critically on minute details of structure and, conversely, on the way in which minimal changes in structure can produce drastic modification of properties.

While it seems unlikely that the earlier established works by Chapiro and Charlesby will become redundant, it is obvious that this book and its successor will be essential for any comprehensive library in a polymer science environment.

A. D. JENKINS

Essential Photosynthesis

Photosynthesis. By D. O. Hall and K. K. Rao. Pp. 68. (Edward Arnold: London, November 1972.) £1.50 cloth; 75p paper.

IN this text (*Studies in Biology*, No. 37) intended for sixth-formers, their teachers and first-year undergraduates, Hall and Rao have set out a description of photosynthesis that is admirably clear and terse. After an introduction and history, they concentrate on sub-cellular aspects and explain light absorption (chapter 4) and electron transport (chapter 5) in chloroplast membranes (chapter 3) and the metabolic assimilation of CO_2 in their immediate environment (chapter 6). A comparative outline of bacterial photosynthesis follows (chapter 7).

This account, necessarily complex, is illustrated by a well-chosen series of electron micrographs and by clear diagrams explaining some crucial historical experiments, and others by which the student could corroborate the text. Recipes are given for chloroplast isolation and in chapter 9 some 15 practical experiments are listed (by reference).

The set length has restricted the discussion to the area which the authors can claim to be reasonably agreed. In chapter 8, however, there is a list of some of the regions where current research is most active. The suppression in the interests of brevity of details of, for example, the nature of redox carriers, or metabolic intermediates, also has some compensation in that each pathway can more readily be perceived as a whole by the student.

This approach must be successful provided that the text is used in situations where basic teaching can be relied on to establish the concepts of metabolic maps, electron transport, ATP and so on. In turn, the details that are provided will serve as an index for the student to enter the major literature and to tackle the many controversies yet to be resolved.

R. P. F. GREGORY

Frege on Geometry

On the Foundations of Geometry and Formal Theories of Arithmetic. By Gottlob Frege. Translated and with an introduction by Eike-Henner W. Kluge. Pp xlii+163. (Yale University: New Haven and London, November 1971.) $10; £4.75 cloth.

FREGE'S articles on the foundations of geometry which are translated in this volume had their origin in a correspondence with David Hilbert about Hilbert's famous Festschrift. In the Festschrift, Hilbert constructed an axiomatic system for geometry and sought to prove the independence of the parallel axiom. Frege does not concern himself with the technical details of the system but with the fundamental questions whether the concepts of geometry can be defined intrinsically by means of axioms. In his reply to Frege's first letter Hilbert states his position in the following words: "If the arbitrarily posited axioms together with all their consequences do not contradict one another, then they are true and the things defined by these axioms exist." Frege contests this view in its entirety, arguing that there are no means of proving consistency other than by exhibiting an object with the properties demanded by the axioms, and if one has such an object what need is there to prove its existence by the roundabout method of consistency? Hilbert does not continue the correspondence, but the attack on Frege is taken up by Korselt who reiterates the standpoint of "modern mathematics". Frege's reply to Korselt is highly abusive: "I have been at pains," Frege says, "to draw sharp boundaries: Mr Korselt, it seems, diligently blurs them once again. How is this to be explained? Perhaps by a drive for self preservation on the part of Hilbert's doctrine for which an obscurity of the issue may well be a condition of survival." Again later in the same article he criticizes Korselt's changing conceptions of axioms, finding at least four different uses of the term. Frege rejects the axiomatic method for its failure to give references (denotations) to the words "point", "line", "plane" and so on, demanding of a definition (of a point for instance) that we will be able to judge by it of any object whether or not it be that which is defined. The kernel of Frege's opposition to formalism is that the propositions of mathematics are not mere sequences of words or groups of signs, but are thoughts, something which can be true or false.

In addition to the articles on the foundations of geometry the translator has included Frege's controversy with his Jena colleague J. Thomas about formal theories of arithmetic and contributes a thirty page introduction which sets the scene and fills in the background to the controversies.

The subtlety of Frege's mind and his tremendous gifts for logical analysis and disputation are boldly displayed in the essays in this collection, but the judgment of history has gone against Frege and the axiomatic method in mathematics has prevailed against all the fury of his attack.

R. L. GOODSTEIN

Quantum Theory

The Quantum Theory of Atoms, Molecules and Photons. By John Avery. Pp. xv+378. (McGraw-Hill: Maidenhead, September 1972.) £8 cloth; £5.50 paper.

THE quantum theory of atoms, molecules and photons forms a central part of undergraduate and graduate courses in physics and chemistry. There are a number of very good textbooks covering this field, so it is reasonable to ask if a new one is needed. No doubt we could do without this book, but it will surely find some friends, particularly among physical and theoretical chemists.

The author is a graduate of the Massachusetts Institute of Technology and of the Universities of Chicago and London, and is a lecturer in the Chemistry Department at Imperial College, London. The book has been written for chemistry students who like mathematics. It uses advanced mathematical techniques when these are needed but it does not assume too much prior knowledge. The style is lucid and pleasing, although the first chapter, on the development of mechanics, is rather long.

There are nine chapters covering topics such as Hilbert space, angular momentum, the chemical bond, translational symmetry, vibration and rotation, and "ions and ligands". There are seven appendices of which the largest is a 23-page account of group theory. A few examples are given and some have hints for their solution. The book provides a modern approach to many topics of interest to chemists and physicists—phonon and photon creation and annihilation, the scattering of radiation, optical activity, and semi-empirical computations of molecular structure and properties. Some of these and other topics are only lightly touched upon, but the overall coverage will appeal to theoretically inclined research students in chemistry and to a very few undergraduates. The charm of the book is enhanced by amusing historical and biographical anecdotes. Very few mistakes were noticed, although Russell, who is often linked to Saunders, is misspelled throughout.

A. D. BUCKINGHAM