# BOOK REVIEWS

## DALTONIAN REVOLUTION

### Atoms and Elements

A Study of Theories of Matter in England in the Nineteenth Century. By David M. Knight. (The History of Scientific Ideas.) Pp. 167. (London: Hutchinson and Co. (Publishers), Ltd., 1967.) 30*s*. net.

IT is customary to regard nineteenth century chemistry as proceeding smoothly in the wake of a chemical revolution initiated by Lavoisier; but, as this book shows, there was another revolution stemming from Dalton's atomic theory. It is not the case, of course, that Dalton's theory was universally accepted; it was not, even by English chemists. But the importance of Dalton's theory and its inclusion of the very useful and helpful theory of definite proportions made chemists necessarily more sensitive to the problem of the nature of matter, and caused physicists to realize that theories of matter must meet chemical as well as physical tests. That physicists like Kelvin were forced to take chemical problems into consideration when attempting to devise a new theory of matter is an indication both of the power of Dalton's work and of the growing maturity of chemistry.

The conventional view of the history of atomic theories in the nineteenth century has been that the Daltonian atom was unacceptable to physicists because of its "billiard ball" characteristics. As Dr Knight here shows, the real snag about the Daltonian atom was metaphysical, not physical: chemists and physicists alike generally preferred the view that matter is homogeneous to Dalton's view that the atom of each element is physically and therefore chemically distinct. They were also truer Newtonians than Dalton, and conscious of the existence of forces. For all these reasons, as recent work on the history of science has shown, English physicists and chemists of the nineteenth century found the atomic theory of Boscovich peculiarly satisfying. The attempts of Boscovich himself to apply his theory of point forces (endowed with inertia) to chemistry had not been very successful, but his *Theoria naturalis philosophiae* was too early (it was published at Venice in 1763) for his chemical knowledge to have anything to contribute to the nineteenth century; indeed his applications of his theory to physics were not noticeably more helpful. But the theory itself was wonderfully versatile and appealed particularly to English natural philosophers. (On the whole, continental scientists were more pragmatic.) Expounded in the supplement to the third edition of the *Encyclopaedia Britannica* (1803), discussed in early lectures at the Royal Institution by Thomas Garnett (1801), Boscovich's theory was adopted successively by Davy and Faraday and remained a dominant feature of English scientific thought in the nineteenth century, being used at the end of the century by J. J. Thomson.

In spite of its title, this book is mainly about the atom in chemistry; the author has not discussed the relation of theories of matter to the development of such physical problems as the kinetic theory of gases. It is also mainly concerned with the earlier half of the century. The sixth chapter does deal with the curious "debates" between officers of the Chemical Society in the late 1860s, and there is an epilogue on the next two decades, but these are specialized and not so easy to follow as the earlier chapters. Unlike the earlier chapters, these later ones presuppose considerable knowledge of the history of chemistry in the period—of the development of the periodic table, of the long, tangled and slow growth of an understanding of organic compounds, and of the acceptance of the theory of valency. Two of the leading English protagonists in the development of the concepts of valency and organic structure, Alexander Williamson and William Odling, were active in these debates; the problems there raised have been more fully and therefore more lucidly developed in the accounts already published by the author in collaboration with W. H. Brock.

It is a fascinating subject for chemistry and physics alike, and one little studied so far. This book makes an admirable introduction to a subject worthy of much further study.

MARIE BOAS HALL

## MATHEMATICAL LOGIC

### Mathematical Logic

By Stephen Cole Kleene. Pp. xiii + 398. (New York and London: John Wiley and Sons, Inc., 1967.) 85*s*.

THIS book for undergraduate study is written by the author of a famous postgraduate text *Introduction to Metamathematics* written nearly twenty years ago. Like the more advanced work the present volume is characterized by its comprehensiveness and thorough treatment. Sentence and predicate logic are both presented in a variety of ways, from model theory to several versions of proof theory including axiomatic proof theory, natural inference and (in the last chapter) Gentzen's sequent calculus. The account of the difficult subject of substitution in predicate logic is particularly successful, but I do not consider the treatment of sentence formation which allows collision of variables and vacuous quantification suitable for a first course in logic. The simplicity gained in the definition must be paid for at too high a price in the interpretation of sentences like $\forall x \exists x Px$ in the model theory; I think a clearer distinction and separation between free and bound variables (and not just free and bound occurrences) is desirable for beginners in predicate logic even if this requires a definition of sentence by level of complexity.

As one would expect from one of the pioneers in general recursive function theory, the chapter on computability and decidability is extremely good and contains many references to recent work; for instance, on degrees of unsolvability and the arithmetical hierarchies (which the author initiated).

Completeness of predicate logic is established by means of Gentzen's sequent calculus and a proof of the equivalence of the axiomatic and the sequent formulations; the idea behind the completeness proof is to set up a systematic method of search which for any predicate sentence $F$ leads either to a counter example to $F$ if there is one or to a closing of all avenues to a counter example when $F$ is valid. The equivalence of the axiomatic and sequent formulations is also exploited to give a simple proof of Craig's interpolation theorem for predicate calculus with equality which says that if $E \supset F$ is provable then there is a sentence $I$ the parameters of which are common to $E$ and $F$ such that $E \supset I$ and $I \supset F$ are both provable.

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## ELECTRON DIFFRACTION METHOD

### Electron-Diffraction Analysis of Clay Mineral Structures

By B. B. Zvyagin. Revised edition. Translated from the Russian by Simon Lyse. (Monographs in Geoscience.) Pp. xvi + 364. (New York: Plenum Press, 1967.) $19.50.

FOR crystal structural studies, the method of single-crystal X-ray diffraction is generally the most successful, but because of the fine grained nature of clays, only powder