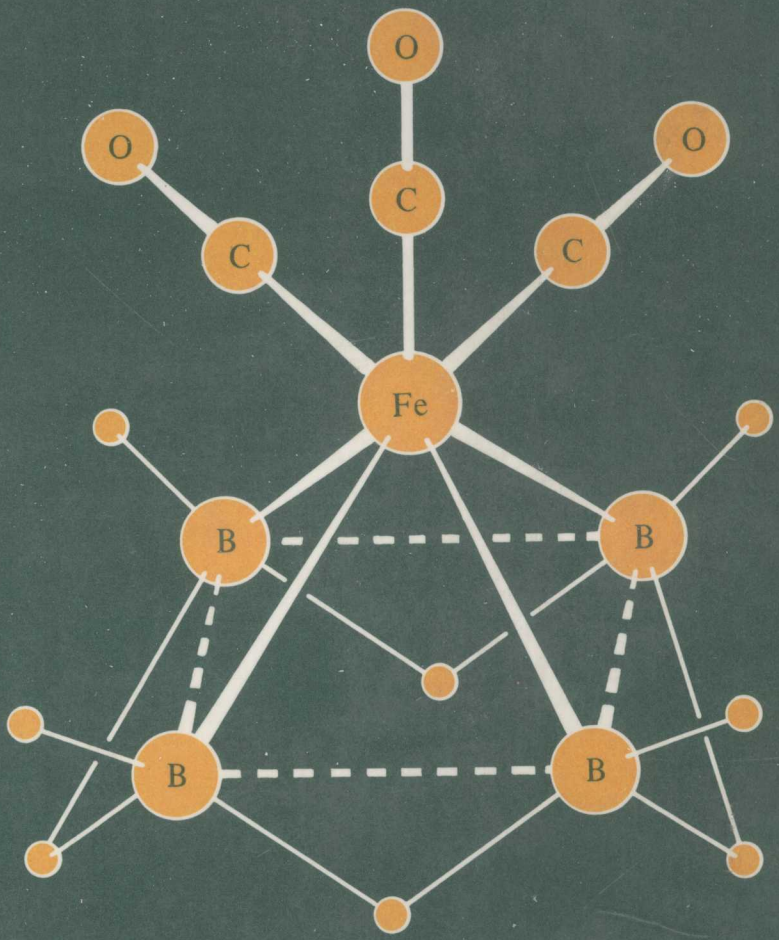
CHEMISTRY OF THE ELEMENTS

N. N. Greenwood and A. Earnshaw



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Chemistry of the Elements

N. N. GREENWOOD and A. EARNSHAW

Department of Inorganic and Structural Chemistry
University of Leeds, U.K.

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Foreword

THE publication of a new comprehensive treatment of the chemistry of the elements is an event of major importance for both teachers and students. The majority of the more recent textbooks of inorganic chemistry place considerable emphasis on the theories of inorganic chemistry and do not give a systematic comprehensive treatment of the properties and reactions of the elements and their compounds. The *Chemistry of the Elements* therefore fills a real need for an up-to-date, critical, comprehensive account of the chemistry of the elements. The facts concerning the properties and reactions of substances are the very essence of chemistry. Facts undergo little if any change in contrast to constantly changing theories. Moreover, it is important that students appreciate that a chemist needs a solid background of facts in order to appreciate the need for theories and to be able to judge their usefulness and the limits of their applicability. Anyone who just dips into the book at random will quickly realize that there are numerous facts that remain intriguing and unexplained and which provide a stimulus for the development of new or modified theories. The writing of this book was clearly a prodigious task and the authors are to be congratulated on having presented such a comprehensive in-depth account of the elements in such a readable fashion. It deserves to become the standard reference in inorganic chemistry for both teachers and students for many years to come and I wish it every success.

R. J. GILLESPIE
McMaster University
Hamilton, Ontario, Canada

Preface

IN this book we have tried to give a balanced, coherent, and comprehensive account of the chemistry of the elements for both undergraduate and postgraduate students. This crucial central area of chemistry is full of ingenious experiments, intriguing compounds, and exciting new discoveries. We have specifically avoided the term *inorganic chemistry* since this emphasizes an outmoded view of chemistry which is no longer appropriate in the closing decades of the 20th century. Accordingly, we deal not only with inorganic chemistry but also with those aspects which might be called analytical, theoretical, industrial, organometallic, bio-inorganic, or any other of the numerous branches of the subject currently in vogue.

We make no apology for giving pride of place to the phenomena of chemistry and to the factual basis of the subject. Of course the chemistry of the elements is discussed within the context of an underlying theoretical framework that gives cohesion and structure to the text, but at all times it is the chemical chemistry that is emphasized. There are several reasons for this. Firstly, theories change whereas facts do so less often—a greater permanency and value therefore attaches to a treatment based on a knowledge and understanding of the factual basis of the subject. We recognize, of course, that though the facts may not change dramatically, their significance frequently does. It is therefore important to learn how to assess observations and to analyse information reliably. Numerous examples are provided throughout the text. Moreover, it is scientifically unsound to present a theory and then describe experiments which purport to prove it. It is essential to distinguish between facts and theories and to recognize that, by their nature, theories are ephemeral and continually changing. Science advances by removing error, not by establishing truth, and no amount of experimentation can "prove" a theory, only that the theory is consistent with the facts as known *so far*. (At a more subtle level we also recognize that all facts are theory-laden.)

It is also important to realize that chemistry is not a static body of knowledge as defined by the contents of a textbook. Chemistry came from somewhere and is at present heading in various specific directions. It is a living self-stimulating discipline, and we have tried to transmit this sense of growth and excitement by reference to the historical development of the subject when appropriate. The chemistry of the elements is presented in a logical and academically consistent way but is interspersed with additional material which illuminates, exemplifies, extends, or otherwise enhances the chemistry being discussed.

Chemistry is a human activity and its results have a substantial impact on our daily lives. However, we have not allowed ourselves to become obsessed by "relevance". Today's relevance is tomorrow's obsolescence. On the other hand, it would be obtuse in the modern world not to recognize that chemistry, in addition to being academically stimulating and aesthetically satisfying, is frequently also useful. This gives added point to

much of the chemistry of the elements and indeed a great deal of that chemistry has been specifically developed because of society's needs. To many this is one of the most attractive aspects of the subject—its potential usefulness. We therefore wrote to over 500 chemically based firms throughout the world asking for information about the chemicals they manufactured or used, in what quantities, and for what purposes. This produced an immense wealth of technical information which has proved to be an invaluable resource in discussing the chemistry of the elements. Our own experience as teachers had already alerted us to the difficulty of acquiring such topical information and we have incorporated much of this material where appropriate throughout the text. We believe it is important to know whether a given compound was made perhaps once in milligram amounts, or is produced annually in tonne quantities, and for what purpose.

In a textbook devoted to the chemistry of the elements it seemed logical to begin with such questions as: where do the elements come from, how were they made, why do they have their observed terrestrial abundances, what determines their atomic weights, and so on. Such questions, though usually ignored in textbooks and certainly difficult to answer, are ones which are currently being actively pursued, and some tentative answers and suggestions are given in the opening chapter. This is followed by a brief description of chemical periodicity and the periodic table before the chemistry of the individual elements and their group relationships are discussed on a systematic basis.

We have been much encouraged by the careful assessment and comments on individual chapters by numerous colleagues not only throughout the U.K. but also in Australia, Canada, Denmark, the Federal Republic of Germany, Japan, the U.S.A and several other countries. We believe that this new approach will be widely welcomed as a basis for discussing the very diverse behaviour of the chemical elements and their compounds.

It is a pleasure to record our gratitude to the staff of the Edward Boyle Library in the University of Leeds for their unfailing help over many years during the writing of this book. We should also like to express our deep appreciation to Mrs Jean Thomas for her perseverance and outstanding skill in preparing the manuscript for the publishers. Without her generous help and the understanding of our families this work could not have been completed.

N. N. GREENWOOD
A. EARNSHAW

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