Preface to the Second Edition

When this book first appeared in 1984 it rapidly established itself as one of the foremost textbooks and references on the subject. It was enthusiastically adopted by both students and teachers and has already been translated into several European and Asian languages. The novel features which it adopted (see Preface to the First Edition) were clearly much appreciated and we have been pressed for some time now to bring out a second edition. Accordingly we have completely revised and updated the text and have incorporated over 2000 new literature references to work which has appeared since the first edition was published. In addition, innumerable modifications and extensions incorporating recent advances have been made throughout the text and, indeed, no single page has been left unaltered. However, by judicious editing we have ensured that all the features which made the first edition so attractive to its readers have been retained.

The main plan of the book has been left unchanged except that the general section on organometallic chemistry has been removed from Chapter 8 (Carbon) and has been incorporated, together with a summary of other aspects of coordination chemistry, in a restyled Chapter 19. However, the chemistry of even the simplest elements has been considerably enriched during the past few years, sometimes by quite dramatic advances. Thus the chemistry of the alkali metals has a complexity that was undreamt of one or two decades ago and lithium, for example, is now known in at least 20 coordination geometries having coordination numbers from 1 to 12. Compounds of alkali metal *anions* and even electrides are known. Likewise, there is expanding interest in the organometallic chemistry of the heavier congeners of magnesium, particularly those with bulky ligands. Boron continues to amaze and confound, and its cluster chemistry continues to expand, as does sulfur–nitrogen chemistry, heteropolyacid chemistry, bioinorganic aspects of the chemistry of many of the elements, lower-valent lanthanide element chemistry, and so on through each of the chapters, up to the synthesis and characterization of the heaviest trans-actinide element, $Z = 112$. It is salutory to reflect that there are now 49 more elements known than the 63 known to Mendeleev when he devised the periodic table of the elements.

A further indication of the rapid advances that have occurred in the chemistry of the elements during the past 15 years can be gauged from the several completely new sections which have been added to review work in what were previously both nonexistent and unsuspected areas. These include (a) coordination compounds of dihapto-dihydrogen, (b) the fullerenes and their many derivatives, (c) the metcars, and (d) high-temperature oxide superconductors.

We hope that this new edition of *Chemistry of the Elements* will continue to stimulate and inform its readers, and that they will experience something of the excitement and fascination which we ourselves feel for this burgeoning subject. We should also like to thank our many correspondents who have kept us informed of their work and the School of Chemistry in the University of Leeds for providing us with facilities.

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A. Earnshaw
August, 1997

Preface to the First Edition

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. First, 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, through 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 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.

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