11th Edition

A TEXTBOOK

OF

INORGANIC CHEMISTRY

BY

G.S. NEWTH, F.I.C., F.C.S

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PREFACE

In drawing up a systematic course of elementary chemical instruction based upon the periodic classification of the elements, whether it be as a course of lectures, or as a text-book, a number of serious difficulties are at once encountered. These possibly are sufficient to account for the fact, that although twenty-five years have elapsed since Mendelejeff published this natural system of classification, the method has not been generally adopted as the basis of English elementary text-books.

I have endeavoured to obviate many of these difficulties, while still making the periodic system the foundation upon which this little book is based, by dividing the book into three parts. Part I. contains a brief sketch of the fundamental principles and theories upon which the science of modern chemistry is built. Into this portion of the book I have introduced, necessarily in briefest outlines, some of the more recent developments of the science in a physico-chemical direction, of which it is desirable that the student should gain some knowledge, even early in his career.

Part II. consists of the study of the four typical elements, hydrogen, oxygen, nitrogen, and carbon, and of their more important compounds. By dissociating these four elements from their position in the periodic system, and treating them separately, the student is early brought into contact with many of the simpler and more familiar portions of the science. Such

subjects as *water*, the *atmosphere*, and *combustion*, to which it is desirable that he should be introduced at an early stage in his studies, are thus brought much more forward than would otherwise be the case.

In Part III. the elements are treated systematically, according to the periodic classification. In this manner, while avoiding a sharp separation of the elements into the two arbitrary classes of metals and non-metals, it has been possible to so far conform to the prevailing methods of instruction, that all those elements which are usually regarded as non-metals (with the two exceptions of boron and silicon) are treated in the earlier portion of the book.

The science of chemistry has of recent years developed and become extended to such a degree, that the difficulty of giving a fairly balanced treatment of the subject, within the limits of a small text-book, is an ever-increasing one, and it necessarily resolves itself into a question of the judicious selection of matter. In making such a selection, I have endeavoured, as far as possible, to keep in view the requirements of students at the present time, without, however, following any examination syllabus.

Acting upon this principle, I have omitted all detailed description of the rare elements and their compounds, confining myself merely to a short mention of them in a few general remarks at the commencement of the various chapters.

Although from a purely scientific standpoint many of these rare substances are of the greatest interest and importance, it must be admitted that they stand quite outside the range of all the customary courses of chemical instruction; and so far as the wants of the ordinary student are concerned, the space which would be occupied by an account of these elements is more advantageously devoted to such matters

as are discussed in the Introductory Outlines. Moreover, it is a matter of common observation that text-books, even upon the shelves of reference libraries, and which bear unmistakable evidence of much use, are frequently *uncut* in those portions which treat of these elements.

Details of metallurgical processes, also, are out of place in a text-book of chemistry, and must be sought in metallurgical text-books. Only such condensed outlines, therefore, have been given as are sufficient to explain the chemical changes that are involved in these operations.

The great importance to the student, of himself performing experiments illustrating the preparation and properties of many of the substances treated of in his text-book, cannot well be over-estimated. If he be in attendance upon a course of chemical lectures, opportunity should be given to him for repeating the simpler experiments he may see performed upon the lecture table: if he be not attending lectures, the necessity for this practical work on his part is greater still. Instead of burdening this text-book with specific directions for carrying out such elementary experiments, frequent references have been made to my "Chemical Lecture Experiments," where minute directions are given for carrying out a large number of experiments, many of which may be easily performed, and with the very simplest of apparatus.

Several of the woodcuts have been borrowed from existing modern works, such as Thorpe's "Dictionary of Applied Chemistry," Mendelejeff's "Principles of Chemistry," Ostwald's "Solutions," and others. Care has been taken, however, to exclude all antiquated cuts, and a large number of the illustrations are from original drawings and photographs.

G. S. N.

SOUTH KENSINGTON.

PREFACE

TO THE NINTH EDITION

In preparing this edition I have availed myself of the opportunity, which the necessity to reset the book in type has afforded me, of making some more extensive changes and additions than the exigencies of stereotype plates would have allowed, with a view to bringing the matter well into line with the most recent advances of the science. The general plan of the book remains the same, the alterations consisting almost entirely of extensions and additions, amounting in all to about fifty pages. Some of the subjects dealt with in Part I will be found considerably amplified, without, however, any departure from the original intention of making these chapters *introductory outlines* only. A new section in the text of the book has been devoted to a description of the five new elements of the argon group, and these elements have been included in the periodic scheme of classification. For many of the most recent facts relating to these elements I am indebted to Travers' "Experimental Study of Gases."

Descriptions have also been included of a number of recent manufacturing processes (several being illustrated by new cuts), which are now being carried on by the modern applications of electricity—such as the manufacture of phosphorus, graphite, caustic soda, sodium carbonate, potassium chlorate, aluminium, and others.

The atomic weights which in previous editions were given in a separate column of the table of weights, under the head of *more exact values*, have now been replaced by the so-called *international atomic weights*, which are published annually in the *Berichte*. Not that it is of any moment to the student whether the atomic weight of, say nickel, is 58.6 or 58.7 : but it is obviously desirable that as far as possible there shall be some uniformity, so that he shall not find a different value given in every different book he may refer to.

G. S. N.

July 1902.

HINTS TO STUDENTS

FOR the help of students who may use this book at the commencement of their chemical studies, and especially for those who may not be working under the immediate guidance of a teacher, the following hints are given :—

Begin by carefully reading the first four chapters (pages 1–24). Then pass on to Part II. (page 171), and begin the study of the four typical elements, hydrogen, oxygen, nitrogen, and carbon, and their compounds, in the order in which they are treated. Accompany your reading by performing as many of the experiments referred to as possible, in order that you may become practically familiar with the substances you are studying.

During the time occupied in the study of these four elements and their compounds, again read Chapters I. to IV., and slowly and carefully continue reading Part I., so that by the time Part III. is reached, you may have fairly mastered at least the first thirteen chapters of the Introductory Outlines.

The order in which the elements are treated in Part III. is based upon the periodic classification, therefore read the short introductory remarks at the commencement of the various chapters, in the light of the table on page 118.

Throughout the book temperatures are given in degrees of the Centigrade thermometer. 1° Centigrade equals 1.8°

Fahrenheit, and as the zero of the latter scale is 32° below that of the Centigrade, temperatures given in degrees of one scale are readily translated into degrees of the other, by the simple formula—

$$(n°\text{C.} \times 1.8) + 32 = °\text{F.}$$

The abbreviation mm. stands for millimetre; the $\frac{1}{1000}$ part of a metre (1 metre = 39.37079 inches; or roughly, 25 mm. = 1 inch). The abbrevation c.c. signifies cubic centimetre; the $\frac{1}{1000}$ part of a cubic decimetre, or litre (1 litre = 1.76077 pints).

1 gramme (the weight of 1 c.c. of distilled water, taken at its point of maximum density) = 15.43235 English grains.