THE EXPERIMENTAL BASIS OF CHEMISTRY

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SUGGESTIONS FOR A SERIES OF EXPERIMENTS ILLUSTRATIVE OF THE FUNDAMENTAL PRINCIPLES OF CHEMISTRY

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PREFACE

IDA FREUND had been for many years before her death a naturalised British subject, but was Austrian by birth. Left an orphan while still quite young, she was brought up by her grandparents in Vienna, and received her early education at a Bürgerschule in that city. Afterwards she took the diploma of a State Training College for teachers, and the experience there gained in the study of continental methods broadened her outlook and was possibly the origin of the interest in the profession of teaching and sympathy with teachers which were to become marked characteristics of her later career. She then came to England to make her home with her uncle, the violinist Ludwig Straus, well known to music lovers as a member of the Joachim quartet. Her uncle sent her to Cambridge, where as a student of Girton College she took the complete honours course in Natural Sciences, and in 1886 was placed in the first class of the second part of the Natural Sciences Tripos for her knowledge of chemistry.

In the following year she began her life's work as a teacher at Newnham College where she laboured till her retirement in 1912. At that time women students were not admitted to the University Chemical Laboratory until they had passed Part I of the Tripos, and thus Miss Freund was entirely responsible for the laboratory training of the majority of her students, many of whom came up to College with little or no knowledge of chemistry.

Triumphing over disabilities due to physical infirmities and indifferent health such as would have daunted a less intrepid spirit, she devised and elaborated for her first year students a course of practical work supplemented by short lectures, demonstration experiments and discussions, and

these form the basis on which this book rests. In 1904 she published a considerable work entitled *The Study of Chemical Composition*, which carried her influence as a teacher far beyond the limits of her own laboratory. The orderly arrangement of the book, the fulness of its historical references, and the quotations often of considerable length from the original papers in which the fundamental laws of chemistry were enunciated and established by their discoverers give it permanent value as a students' "source book" of chemical theory, and secured for it a favourable reception. This encouraged Miss Freund to attempt to bring to the notice of other teachers her views as to the manner in which students might be helped to realise that chemistry is a science based on experiment and that the logical interpretation of experiment leads directly to the generalisations known as the laws of chemistry. Miss Freund had a dread of thoughtless experimenting and slipshod thinking. She felt strongly that much that passes for training in science has little relation to scientific method and is of small educational value. The scheme of practical work which she arranged for her students was designed to include not only the performance of many of the experiments usually found in an elementary course, but also the repetition in a simple form of experiments historically interesting and of fundamental importance to the theory of chemistry, and such that the manipulative difficulties involved were not too great to allow of the attainment of a reasonable degree of accuracy in the hands of beginners. By directing special attention to the sources of error inherent in the methods employed, by distinguishing carefully between what was taken for granted and what was really proved, and by getting her students to compare the accuracy attained in their illustrative experiments with that of the most trustworthy work on the subject, she was able to arouse the critical faculty and to give some insight into the methods and aims of the science. To quote her own words, "I aimed at giving by means of class teaching not only a common ground of knowledge, but also a common standard concerning the nature of scientific proof and the meaning of real accuracy

to a number of students differing greatly in knowledge of chemical facts and manipulative experience. As was to be expected, I find that in order to make a connected and fairly proportioned book, gaps have to be filled in between the experiments, and a connecting story has to be supplied so as to make it clear where and how the experiments fit in to the fabric of the science and to establish a sequence; as a matter of fact I have to write what I used to give in every demonstration as a half hour's introductory lecture. This connecting story has turned out very long in the chapters already written ...but I have got to feel convinced that this is a necessity, and even to think it possible that it may prove an advantage, raising the book above the scope of a mere laboratory manual."

After her retirement from active teaching she began to arrange the material collected in her laboratory note books and students' records with a view to describing a series of illustrative experiments such as she had found specially suited to her needs. The Syndics of the Cambridge University Press, the publishers of her first book, having expressed their willingness to bring out a second work from her pen, an agreement was signed in November 1913, and almost up to the time of her death, which followed an operation in May 1914, Miss Freund was busily engaged in preparing the manuscript for the Press. The book was planned to consist of twenty chapters; the first ten are those which appear here, the rest were to have dealt with the detailed study of water, oxygen and hydrogen, and with the consideration of acids, bases and the classification of oxides, and were to have included a discussion of the law of mass action, of oxidation and reduction and of the conditions which modify chemical change.

The first ten chapters were left by Miss Freund almost ready for the Press. They would have formed the larger part of the book and the part in which she was most interested, and are not only complete in themselves but also give a clear idea of her views and aims. Further they exhibit many and characteristic differences from the ordinary text book of experimental chemistry. For these reasons it was decided to

proceed with the printing of this section, and to us as personal friends of Miss Freund of long standing, and well acquainted with her ideas, was entrusted the duty of seeing the book through the Press. As editors our task has been a light one; we have corrected a few obvious slips, made a few verbal changes, and here and there slightly altered the construction of a sentence, where we deemed that by so doing Miss Freund's meaning would be more clearly expressed. We have scrupulously refrained from making any omission, addition or alteration which should in any way conflict with or obscure her intentions. To Mr Peace, the University Printer, and to his staff, we desire to express our best thanks for the patient kindness with which they have endeavoured to carry out our views as to the way in which justice should be done to the somewhat complicated system of headings and sub-headings indicated in the manuscript, and for the care which they have devoted to the reproduction and arrangement of the diagrams.

All teachers worthy of the name strike out lines of their own and devise their own schemes, and it is unlikely that many will feel inclined to conduct their students through the whole of the work here detailed. But feeling as we do that Miss Freund's criticisms of methods still current are just and that many valuable suggestions are to be found in the following pages, we commend them to students and teachers alike, in the belief that much may be learnt by examining methods which have stood the test of practical experience in the laboratory of a teacher richly endowed with the critical faculty, keenly sensitive to fallacious reasoning, and quick to detect an unwarrantable assumption.

A. HUTCHINSON.
M. B. THOMAS.

August 1920.

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