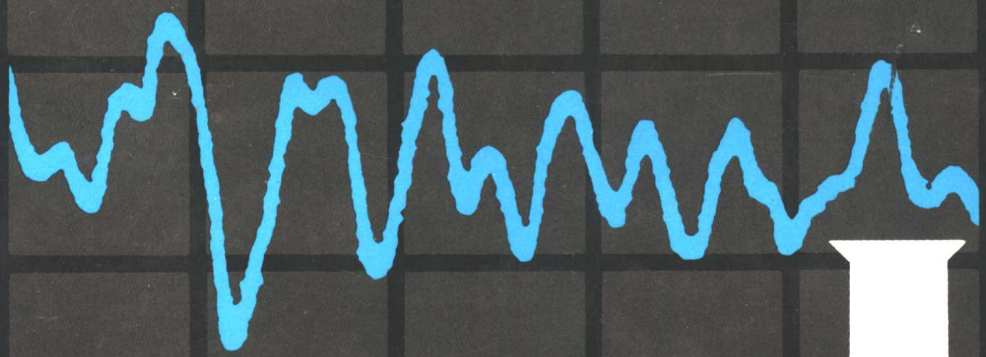
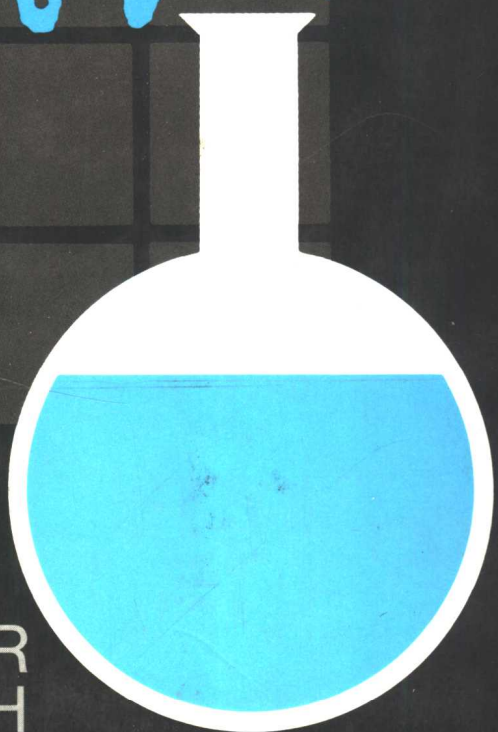
quantitative analysis





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Quantitative Analysis

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Dedicated to Bess Harrison Kenner

Preface

Modern analytical chemistry is the science of chemical measurements. Chemical measurements play an important role in many diverse disciplines, such as agriculture, geology, metallurgy, medicine, psychology, engineering, and environmental science, by providing information essential in solving practical problems. In its widest sense, analytical chemistry embraces the theory and practice of all the diverse means by which information of all forms may be obtained on the composition of matter. The content and scope of analytical chemistry is continually expanding as new techniques are developed to solve ever more challenging problems. To meet the need for increasingly more sophisticated knowledge regarding the composition of matter, analytical scientists are studying all facets of the chemical measurement process. Indeed, research on the development of new means of obtaining chemical information on the composition of matter may more appropriately be termed analytical science rather than analytical chemistry, because its progress depends on a combination of disciplines, including chemistry, physics, engineering, and applied mathematics.

The present work is an attempt on the part of the authors to meet the needs of students and teachers for an introductory textbook covering some of the more important aspects of modern analytical chemistry. Every effort has been made to produce a balanced, readable text flexible enough to be adaptable to the wide range of analytical programs currently being offered at colleges and universities throughout the country. In this respect, the text should be appropriate for programs where only a single course in analytical chemistry is offered and where the instructor wishes to discuss some basic instrumental methods as well as gravimetric and volumetric principles. Furthermore, we anticipate that this text will also prove useful at institutions that offer a separate course for the large number of students in related disciplines, such as biology, geology, medicine, clinical chemistry, and science education. Such students need some basic knowledge of instrumentation but not at the level or depth needed by chemistry majors who plan to become practicing chemists. Our philosophy in writing the instrumental portion of the book has been to emphasize the principles and capabilities of instruments to solve analytical problems rather than to stress their design and construction.

Because of the wide scope of modern analytical chemistry, it is difficult to select the subjects and instruments to discuss as well as to decide on the amount and level of material that should be included in an introductory text. Comprehensive coverage of basic quantitative analysis, separation science, and instrumental methods in one book is neither desirable nor practical; thus, this text is necessarily a compromise. Although there is no formal separation into parts, the first fifteen chapters in the text deal with material ordinarily covered in beginning analytical courses, stressing volumetric and gravimetric analysis. Chapters 16 through 27 cover instrumental methods and introductory separation science. Chapter 28 discusses and illustrates the most widely used manual laboratory techniques. The detailed table of contents gives a complete outline of the text, which will be helpful both to students and to instructors. Each chapter is written so that the material may be covered in any sequence desired by the instructor.

We believe that we have included sufficient material for the student to understand each technique and instrument without having a detailed knowledge of all of its operational aspects. We have selected subjects and instruments that are in widest use in commercial, educational, and research laboratories. As examples, we have given preference to volumetric analysis over gravimetric, and have included radiochemical techniques and electrophoresis instead of thermal and high-frequency methods. A short introduction to organic chelates and a short review of inorganic complexes are included for those students who have not completed a course in organic chemistry. This material is needed to understand extraction, which, in turn, is needed to understand liquid–liquid and gas–liquid chromatography. We have stressed all types of chromatography and all types of absorption photometry, together with flame atomic spectroscopy, potentiometric measurement of hydrogen and other ions, and automated analyses by giving more details of these techniques than is given for subjects such as x-ray, nuclear magnetic resonance, mass spectrometry, and emission spectroscopy.

No laboratory directions are given in the text, although the theoretical basis of typical determinations is discussed. The authors believe that most instructors prefer to design their own experiments, and that they normally modify the experiments in any text by issuing complete mimeographed instructions suited to their own needs. The students prefer to use the inexpensive or free instructions so that they will not have to bring their textbooks into the laboratory.

We wish to express our appreciation to the many students who have aided in the preparation of the book through their comments and class notes during the preparative stages. Thanks are expressed to Dr. George Howard Luttrell, Jr., who prepared Chapter 25 on automated analysis, and Rev. Walter Ross Purkey, who is responsible for Chapter 27 on microelectronics. We are deeply grateful to Mrs. Shirley McLean, who typed the manuscript with a minimum of errors. Our thanks also go to our wives, Bess and Marianna, for their forbearance during the preparatory stages and for sharing in the task of proofreading the manuscript.

C. T. K.

K. W. B.

Contents

3 Methods of Expressing Concentrations of Solutions 24

4 Reliability of Measurements 48

13 Potentiometric Measurements 244

14 Complexiметry 267