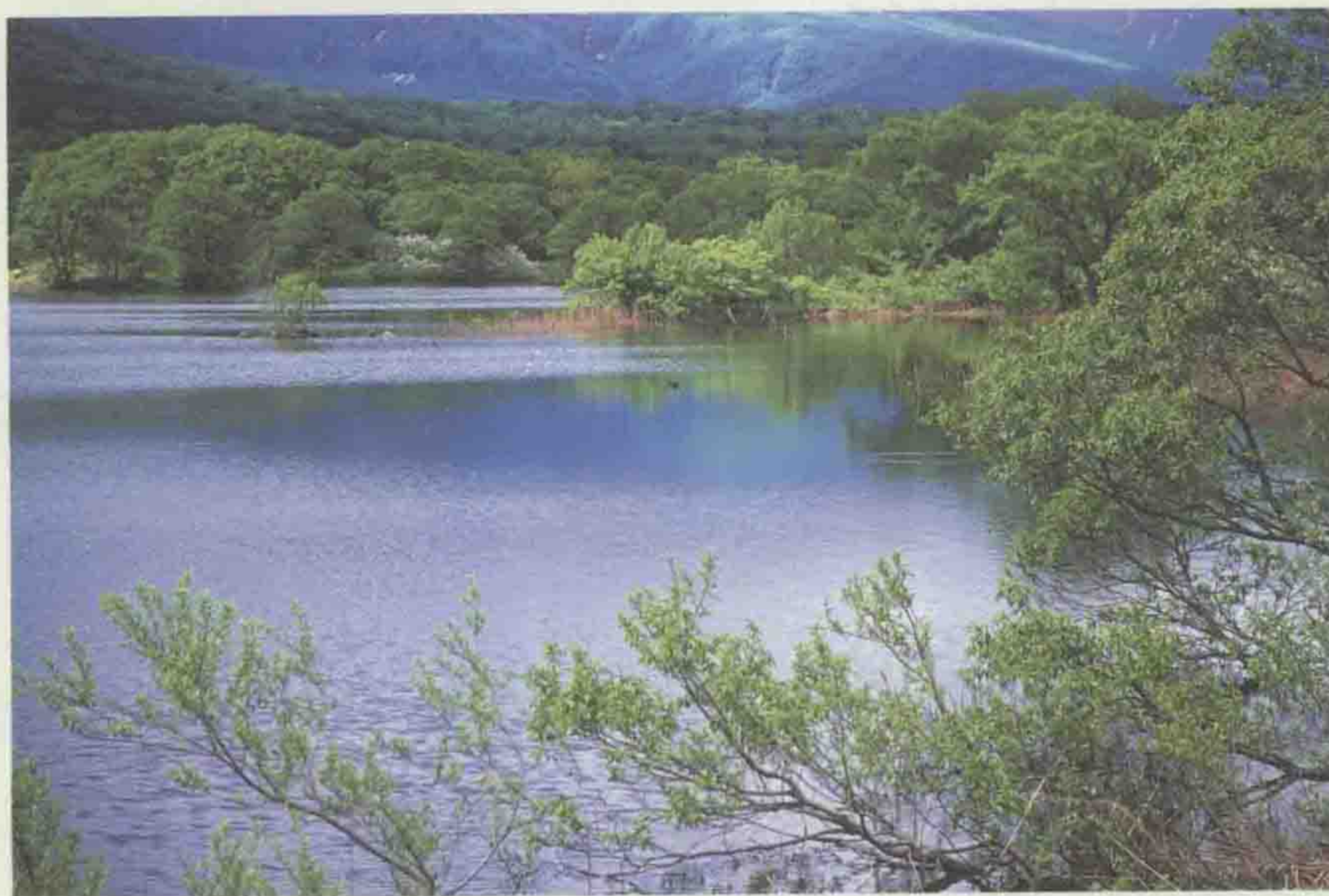


Clair N. Sawyer Perry L. McCarty Gene F. Parkin

Chemistry for Environmental Engineering and Science

(Fifth Edition)

环境科学与工程化学 (第5版)



清华大学出版社





书 (影印版)

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北京

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Chemistry for Environmental Engineering and Science (Fifth Edition)
EISBN: 0-07-248066-1

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本书封面贴有 McGraw-Hill 公司防伪标签, 无标签者不得销售。

图书在版编目(CIP)数据

环境科学与工程化学=Chemistry for Environmental Engineering and Science: 第5版/索耶(Sawyer, C. N.), 麦卡蒂(McCarty, P. L.), 帕金(Parkin, G. F.)著. —影印本. —北京: 清华大学出版社, 2003
(大学环境教育丛书)

ISBN 7-302-07817-3

I. 环… II. ①索… ②麦… ③帕… III. 环境化学—高等学校—教材—英文 IV. X13

中国版本图书馆 CIP 数据核字(2003)第 117307 号

出版者: 清华大学出版社

<http://www.tup.com.cn>

社总机: (010) 6277 0175

责任编辑: 柳 萍

印刷者: 清华大学印刷厂

发行者: 新华书店总店北京发行所

开 本: 185×230 印 张: 48.5

版 次: 2004 年 1 月第 1 版 2004 年 1 月第 1 次印刷

书 号: ISBN 7-302-07817-3/X·56

印 数: 1~3000

定 价: 59.00 元

地 址: 北京清华大学学研大厦

邮 编: 100084

客户服务: (010) 6277 6969

装 订 者: 三河市新茂装订有限公司

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出版前言

在 21 世纪初,面临各种环境问题,人类清醒地认识到要走可持续发展之路。而发展环境教育是解决环境问题和实施可持续发展战略的根本。高等学校的环境教育,是提高新世纪建设者的环境意识,并向社会输送环境保护专门人才的重要途径。为了反映国外环境类教材的最新内容和编写风格,同时也为了提高学生阅读专业文献和获取信息的能力,我们精选了一些国外优秀的环境类教材,组成大学环境教育丛书影印版和翻译版,本书即为其中的一册。所选教材均在国外被广泛采用,多数已再版,书中不仅介绍了有关概念、原理及技术方法,给出了丰富的数据,还反映了作者不同的学术观点。

我们希望这套丛书能对高等院校师生和广大科技人员有所帮助,同时为我国环境教育的发展作出贡献。

清华大学出版社

PREFACE

Education in environmental engineering and science has historically been conducted at the graduate level, and up to the present time has drawn mainly on students with a civil engineering background. In general, education in civil engineering does not prepare a student well in chemistry and biology. Since a knowledge of these sciences is vital to the environmental engineer, the graduate program must be designed to correct this deficiency. In recent years, students from other engineering disciplines and from the natural sciences have been attracted to this field. Some have a deficiency in chemistry and biology similar to that of the civil engineer and need exposure to general concepts of importance.

A current trend in the United States is the introduction of an undergraduate environmental engineering option or degree program within civil engineering departments. These students also require an introduction to important concepts in chemistry and biology.

This book is written to serve as a textbook for a first course in chemistry for environmental engineering and science students with one year of college-level chemistry. Environmental professionals need a wide background in chemistry, and in recognition of this need, *Chemistry for Environmental Engineering and Science* summarizes important aspects from various areas of chemistry. This treatment should help orient the students, aid them in choosing areas for advanced study, and help them develop a better “feel” for what they should expect to gain from further study.

The purpose of this book is twofold: It (1) brings into focus those aspects of chemistry that are particularly valuable for solving environmental problems, and (2) it lays a groundwork of understanding in the area of specialized quantitative analysis, commonly referred to as water and wastewater analysis, that will serve the student as a basis in all the common phases of environmental engineering practice and research.

Substantial changes continue to occur in the emphasis of courses for environmental engineers and scientists. The trend is toward a more fundamental understanding of the chemical phenomena causing changes in the quality of surface and groundwaters, of waters and wastewaters undergoing treatment, and of air. This fundamental understanding of chemistry is absolutely critical as environmental professionals attempt to solve complex problems such as hazardous waste pollution, air pollution from emission of toxic compounds, radioactive waste disposal, ozone depletion, and global climate change.

Chemistry for Environmental Engineering and Science is organized into two parts. Part One is concerned solely with fundamentals of chemistry needed by environmental engineers and scientists. It includes chapters on general chemistry,

physical chemistry, equilibrium chemistry, organic chemistry, biochemistry, colloid chemistry, and nuclear chemistry. Each emphasizes environmental applications. In this new edition, the chapters on general and physical chemistry have been updated, and new homework problems have been added. The chapter on equilibrium chemistry has been revised, with many new example and homework problems. The chapter on organic chemistry includes an added emphasis on organic compounds of environmental significance (e.g., chlorinated solvents). Sections are included on the behavior (fate) of organic compounds in the environment and in engineered systems and on the use of structure-activity relationships. The chapter on biochemistry has been updated. We feel that these revisions make the text even more suitable for lecture courses on environmental chemistry principles.

Part Two is concerned with analytical measurements. A new chapter has been added on statistical analysis of analytical data. All analytical procedures are subject to errors. There is a critical need for students to learn how to evaluate the uncertainties such errors present. This chapter discusses basic methods for evaluating and reporting uncertainties in measurements that are essential for analytical chemists, regulatory agencies, and environmental professionals who use analytical data to make important decisions.

The next several chapters contain general information on quantitative, qualitative, and instrumental methods of analysis, useful as background material for the subsequent chapters concerned with water and wastewater analyses of particular interest to environmental engineers and scientists. These chapters are written to stress the basic chemistry of each analysis and show their environmental significance. They should be particularly useful when used with "Standard Methods for the Examination of Water and Wastewater," published jointly by the American Public Health Association, American Water Works Association, and Water Environment Federation, and giving the details for carrying out each analytical determination. The final chapter stresses trace contaminants, many of which are determined analytically with instrumental procedures discussed in earlier chapters. A listing of U.S. Environmental Protection Agency drinking water standards and World Health Organization drinking water quality guidelines for various trace contaminants are also contained in this chapter. Part Two is considered to be most useful as lecture material to accompany a laboratory course in environmental chemistry. Revisions have been made in other chapters to reflect the many changes in "Standard Methods" that have occurred since the last edition of this text.

Problems are included at the end of most chapters to stress fundamentals and increase the usefulness of this book as a classroom text. Example problems throughout the text help increase the students' understanding of the principles outlined. In Part One of the book, where the emphasis is on chemical fundamentals, answers are included after many homework problems, allowing students to evaluate independently their understanding of the principles emphasized.

To meet textbook requirements, brevity has been an important consideration throughout. For those who believe that we have been too brief, we can only beg their indulgence and recommend that they seek further information in standard references on the subject. Important references are listed at the end of each chapter.

It is inevitable that we have made errors in producing this textbook. For this we apologize. Hopefully they are not so numerous that they impede the student's ability to learn the material. Fortunately, for this new edition, McGraw-Hill is providing a website where we can list errata that can be readily downloaded with no charge to students and faculty. A solution manual for text problems can also be obtained at this website, but by faculty members only. We hope also to use this website to post more example problems and their solutions. There was a request for such by reviewers, and this is one way that we can provide additional material without expanding the number of pages and costs for the text. The website for this textbook can be found at <http://www.mhhe.com/sawyer>. We would appreciate hearing from students and faculty when errors are found so that we can enter them in a timely manner on the website. Our e-mail addresses are included in the errata section of the website.

Special thanks are due colleagues at the University of Iowa—Michelle Scherer for specific suggestions to improve the text and generous help with new homework problems, and Pedro Alvarez, Keri Hornbuckle, Craig Just, Jerry Schnoor, and Richard Valentine for helpful discussions. Thanks also to Mark Benjamin of the University of Washington for e-mail discussions of activity corrections and other weighty matters. Finally, we wish to express our gratitude to William Burgos, Pennsylvania State University; Cindy Lee, Clemson University; Howard Liljestrand, University of Texas, Austin; John Pardue, Louisiana State University; and Andrew Randall, University of Central Florida, as well as the anonymous reviewers, all of whom were selected by the publisher to provide comments about the textbook and to provide recommendations for change. We appreciate the many thoughtful and detailed comments that were offered and used them extensively in preparing this revision. We hope that the reviewers and other faculty find the changes to be beneficial to them and to their students.

Perry L. McCarty

Gene F. Parkin

ABOUT THE AUTHORS

The late **Clair N. Sawyer** was active in the field of sanitary chemistry for over 30 years. He received a Ph.D. from the University of Wisconsin. As Professor of Sanitary Chemistry at the Massachusetts Institute of Technology, he taught and directed research until 1958. He then was appointed Vice President and Director of Research at Metcalf and Eddy, Inc., and served as consultant on numerous water and wastewater treatment projects in the United States and many foreign countries. After retiring, he served as an environmental consultant for several years. He passed away in 1992. He was the originator and sole author of the first edition, which was published in 1960.

Perry L. McCarty is the Silas H. Palmer Professor Emeritus of civil and environmental engineering at Stanford University. He received a B.S. degree in civil engineering from Wayne State University and S.M. and Sc.D. degrees in sanitary engineering from the Massachusetts Institute of Technology, where he taught for four years. In 1962 he joined the faculty at Stanford University. His research has been directed towards the application of biological processes for the solution of environmental problems. He is an honorary member of the American Water Works Association and the Water Environment Federation, and Fellow in the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the American Academy of Microbiology. He was elected to the National Academy of Engineering in 1977. He received the Tyler Prize for environmental achievement in 1992 and the Clarke Prize for outstanding achievement in water science and technology in 1997.

Gene F. Parkin is a Professor of Civil and Environmental Engineering at the University of Iowa, and Director of the Center for Health Effects of Environmental Contamination. He received a B.S. degree in civil engineering and an M.S. degree in sanitary engineering from the University of Iowa and a Ph.D. degree in environmental engineering from Stanford University. He taught at Drexel University for eight years before joining the faculty at the University of Iowa in 1986. His teaching interests have been in biological treatment processes and environmental chemistry. His research has been directed toward anaerobic biological processes and bioremediation of waters contaminated with organic chemicals. He has received the J. James R. Croes Medal from the American Society of Civil Engineers and the Harrison Prescott Eddy Medal from the Water Environment Federation. In 1989 he received the Hancher-Finkbine Medallion from the University of Iowa for outstanding teaching and leadership and in 1999 he received a state of Iowa Board of Regents Award for Faculty Excellence.

CONTENTS

Preface xiii

PART 1 **Fundamentals of Chemistry for Environmental Engineering and Science 1**

CHAPTER 1 **Introduction 3**

- 1.1 Water 4
- 1.2 Wastewater and Water Pollution Control 5
- 1.3 Industrial and Hazardous Wastes 6
- 1.4 Air Pollution and Global Environmental Change 7
- 1.5 Summary 9

CHAPTER 2 **Basic Concepts from General Chemistry 10**

- 2.1 Elements, Symbols, Atomic Weights, Gram Atomic Weights 10
- 2.2 Compounds, Formulas, Formula Weights, Gram Molecular Weights, Mole, Equivalent Weights, Equivalent 11
- 2.3 Avogadro's Number 13
- 2.4 Valency, Oxidation State, and Bonding 13
- 2.5 Nomenclature 16
- 2.6 Chemical Equations: Weight Relationships and Conservation of Mass and Charge 17

- 2.7 Oxidation-Reduction Equations 18
- 2.8 Metals and Nonmetals 24
- 2.9 The Gas Laws 24
- 2.10 Solutions 27
- 2.11 Equilibrium and Le Chatelier's Principle 29
- 2.12 Activity and Activity Coefficients 30
- 2.13 Variations of the Equilibrium Relationship 32
- 2.14 Ways of Shifting Chemical Equilibria 42
- 2.15 Amphoteric Hydroxides 45
- Problems 46
- References 51

CHAPTER 3 **Basic Concepts from Physical Chemistry 52**

- 3.1 Introduction 52
- 3.2 Thermodynamics 52
- 3.3 Vapor Pressure of Liquids 63
- 3.4 Surface Tension 64
- 3.5 Binary Mixtures 66
- 3.6 Solutions of Solids in Liquids 69
- 3.7 Membrane Processes: Osmosis and Dialysis 71
- 3.8 Principles of Solvent Extraction 74
- 3.9 Electrochemistry 76
- 3.10 Chemical Kinetics 86
- 3.11 Catalysis 96
- 3.12 Adsorption 97
- Problems 106
- References 112

CHAPTER 4**Basic Concepts from Equilibrium Chemistry 114**

- 4.1 Introduction 114
- 4.2 Limitations of Equilibrium Calculations 114
- 4.3 Ion Activity Coefficients 116
- 4.4 Solution to Equilibrium Problems 118
- 4.5 Acids and Bases 121
- 4.6 Buffers 160
- 4.7 Buffer Index 162
- 4.8 Complex Formation 164
- 4.9 Solubility of Salts 174
- 4.10 Oxidation-Reduction Reactions 190
- 4.11 Computer Methods for Solving Equilibrium Problems 198
Problems 199
References 211

CHAPTER 5**Basic Concepts from Organic Chemistry 212**

- 5.1 Introduction 212
Aliphatic Compounds
- 5.2 Hydrocarbons 216
- 5.3 Alcohols 222
- 5.4 Aldehydes and Ketones 227
- 5.5 Acids 231
- 5.6 Esters 235
- 5.7 Ethers 236
- 5.8 Alkyl Halides and Other Halogenated Aliphatic Compounds 237
- 5.9 Simple Compounds Containing Nitrogen 242
- 5.10 Cyclic Aliphatic Compounds 245
- 5.11 Mercaptans or Thioalcohols 245
Aromatic Compounds
- 5.12 Introduction 246
- 5.13 Hydrocarbons 247

- 5.14 Phenols 251
- 5.15 Alcohols, Aldehydes, Ketones, and Acids 254
- 5.16 Simple Compounds Containing Nitrogen 256
Heterocyclic Compounds
- 5.17 Heterocyclic Compounds 258
- 5.18 Dyes 260
The Common Foods and Related Compounds
- 5.19 General 260
- 5.20 Carbohydrates 260
- 5.21 Fats, Oils, and Waxes 266
- 5.22 Proteins and Amino Acids 269
Detergents
- 5.23 Detergents 275
- 5.24 Soaps 275
- 5.25 Synthetic Detergents 276
Pesticides
- 5.26 Pesticides 279
- 5.27 Chlorinated Pesticides 279
- 5.28 Organic Phosphorus Pesticides 281
- 5.29 Carbamate Pesticides 282
- 5.30 s-Triazines 283
- 5.31 Biological Properties of Pesticides 283
- 5.32 Pharmaceutically Active and Endocrine-Disrupting Chemicals 284
Behavior of Organics in the Environment and in Engineered Systems
- 5.33 Introduction 288
- 5.34 Fate of Organics 289
- 5.35 Structure- and Property-Activity Relationships 303
Problems 307
References 313

CHAPTER 6**Basic Concepts from Biochemistry 315**

- 6.1 Introduction 315
- 6.2 Enzymes 316

- 6.3 Cofactors 318
- 6.4 Temperature Relationships 318
- 6.5 pH 321
- 6.6 Major and Trace Elements 322
- 6.7 Biodegradation 322
- 6.8 Biochemistry of Carbohydrates 324
- 6.9 Biochemistry of Proteins 325
- 6.10 Biochemistry of Fats and Oils 326
- 6.11 General Biochemical Pathways 328
- 6.12 Energetics and Bacterial Growth 336
- 6.13 Novel Biotransformations 339
- 6.14 Molecular Biology and Genetic Engineering 345
- 6.15 Biochemistry of Humans 352
 - Problems 355
 - References 359

CHAPTER 7

Basic Concepts from Colloid Chemistry 360

- 7.1 Introduction 360
- 7.2 Colloidal Dispersions in Liquids 364
- 7.3 Colloidal Dispersions in Air 373
 - Problems 375
 - References 375

CHAPTER 8

Basic Concepts from Nuclear Chemistry 376

- 8.1 Introduction 376
- 8.2 Atomic Structure 377
- 8.3 Stable and Radioactive Nuclides 379
- 8.4 Atomic Transmutations and Artificial Radioactivity 385
- 8.5 Nuclear Reactions 387
- 8.6 Nuclear Fission 388
- 8.7 Nuclear Fusion 390
- 8.8 Use of Isotopes as Tracers 390

- 8.9 Effect of Radiation on Humans 394
 - Problems 396
 - References 397

PART 2

Water and Wastewater Analysis 399

CHAPTER 9

Introduction 401

- 9.1 Importance of Quantitative Measurements 401
- 9.2 Character of Environmental Engineering and Science Problems 402
- 9.3 Standard Methods of Analysis 402
- 9.4 Scope of a Course in Analysis of Environmental Samples 402
- 9.5 Expression of Results 403
- 9.6 Other Items 408
 - Problems 408

CHAPTER 10

Statistical Analysis of Analytical Data 410

- 10.1 Introduction 410
- 10.2 Rounding Numerical Data 411
- 10.3 Definitions 412
- 10.4 Distribution of Experimental Data 416
- 10.5 Errors 419
- 10.6 Hypothesis Testing 426
- 10.7 Detection Limits 430
- 10.8 Lognormal Distribution 433
- 10.9 Regression Analysis 437
- 10.10 Quality Assurance and Quality Control 446
 - Problems 446
 - References 451

CHAPTER 11**Basic Concepts from
Quantitative Chemistry 452**

- 11.1 General Operations 452
- 11.2 The Analytical Balance 455
- 11.3 Gravimetric Analysis 457
- 11.4 Volumetric Analysis 458
- 11.5 Colorimetry 466
- 11.6 Physical Methods of
Analysis 472
- 11.7 Precision, Accuracy,
and Statistical Treatment
of Data 474
Problems 474
References 475

CHAPTER 12**Instrumental Methods of
Analysis 477**

- 12.1 Introduction 477
- 12.2 Optical Methods of Analysis 478
- 12.3 Electrical Methods of
Analysis 490
- 12.4 Chromatographic Methods
of Analysis 503
- 12.5 Other Instrumental Methods 512
Problems 516
References 517

CHAPTER 13**Turbidity 518**

- 13.1 General Considerations 518
- 13.2 Environmental Significance 519
- 13.3 Standard Unit of Turbidity 520
- 13.4 Method of Determination 520
- 13.5 Application of Turbidity
Data 521
Problems 522
Reference 522

CHAPTER 14**Color 523**

- 14.1 General Considerations 523
- 14.2 Public Health Significance 524
- 14.3 Methods of Determination 524
- 14.4 Interpretation and Application of
Color Data 526
Problems 527
Reference 527

CHAPTER 15**Standard Solutions 528**

- 15.1 General Considerations 528
- 15.2 Preparation of 1.00 N
and 0.020 N H_2SO_4
Solutions 530
- 15.3 Preparation of 1.00 N
and 0.020 N NaOH
Solutions 532
Problems 534
Reference 535

CHAPTER 16**pH 536**

- 16.1 General Considerations 536
- 16.2 Theoretical Considerations 536
- 16.3 Measurement of pH 538
- 16.4 Interpretation of pH Data 540
Problems 540
References 541

CHAPTER 17**Acidity 542**

- 17.1 General Considerations 542
- 17.2 Sources and Nature
of Acidity 542
- 17.3 Significance of Carbon Dioxide
and Mineral Acidity 544

- 17.4 Methods of Measurement 544
- 17.5 Application of Acidity Data 547
 - Problems 547
 - Reference 548

CHAPTER 18

Alkalinity 549

- 18.1 General Considerations 549
- 18.2 Public Health Significance 550
- 18.3 Method of Determining Alkalinity 550
- 18.4 Methods of Expressing Alkalinity 551
- 18.5 Carbon Dioxide, Alkalinity, and pH Relationships in Natural Waters 557
- 18.6 Application of Alkalinity Data 558
- 18.7 Other Considerations 559
 - Problems 560
 - Reference 562

CHAPTER 19

Hardness 563

- 19.1 General Considerations 563
- 19.2 Cause and Source of Hardness 564
- 19.3 Public Health Significance 566
- 19.4 Methods of Determination 566
- 19.5 Types of Hardness 568
- 19.6 Application of Hardness Data 569
 - Problems 569
 - Reference 570

CHAPTER 20

Residual Chlorine and Chlorine Demand 571

- 20.1 General Considerations 571
- 20.2 Chemistry of Chlorination 574
- 20.3 Public Health Significance of Disinfection Residuals 578
- 20.4 Methods of Chlorine Residual Determination 580
- 20.5 Measurement of Chlorine Demand 583

- 20.6 Disinfection with Chlorine Dioxide 583

- 20.7 Disinfection with Ozone 584

- 20.8 Application of Disinfectant Demand and Disinfectant Residual Data 585

Problems 585

Reference 586

CHAPTER 21

Chloride 587

- 21.1 General Considerations 587
- 21.2 Significance of Chloride 588
- 21.3 Methods of Determination 588
- 21.4 Application of Chloride Data 590
 - Problems 591
 - References 592

CHAPTER 22

Dissolved Oxygen 593

- 22.1 General Considerations 593
- 22.2 Environmental Significance of Dissolved Oxygen 595
- 22.3 Collection of Samples for Determination of Dissolved Oxygen 596
- 22.4 Standard Reagent for Measuring Dissolved Oxygen 597
- 22.5 Methods of Determining Dissolved Oxygen 599
- 22.6 Dissolved-Oxygen Membrane Probes 601
- 22.7 Application of Dissolved-Oxygen Data 602
 - Problems 602
 - References 603

CHAPTER 23

Biochemical Oxygen Demand 604

- 23.1 General Considerations 604
- 23.2 The Nature of the BOD Reaction 605
- 23.3 Method of Measuring BOD 610
- 23.4 Rate of Biochemical Oxidations 616

- 23.5 Discrepancy between L_0 Values and Theoretical Oxygen Demand Values 620
- 23.6 Discrepancy between Observed Rates and First-Order Rates 621
- 23.7 Application of BOD Data 621
 - Problems 622
 - Reference 624
- 26.5 Determinations Applicable to Industrial Wastewaters 655
- 26.6 Determination of Solids in Sludges 656
- 26.7 Applications of Solids Data in Environmental Engineering Practice 657
 - Problems 657
 - Reference 658

CHAPTER 24

Chemical Oxygen Demand 625

- 24.1 General Considerations 625
- 24.2 History of the COD Test 626
- 24.3 Chemical Oxygen Demand by Dichromate 626
- 24.4 Inorganic Interferences 629
- 24.5 Application of COD Data 629
 - Problems 630
 - References 630

CHAPTER 25

Nitrogen 631

- 25.1 General Considerations 631
- 25.2 Environmental Significance of Nitrogen Species 635
- 25.3 Methods of Analysis 640
- 25.4 Application of Nitrogen Data 646
 - Problems 647
 - References 648

CHAPTER 26

Solids 649

- 26.1 General Considerations 649
- 26.2 Environmental Significance of Solids Determinations 651
- 26.3 Determination of Solids in Water Supplies 652
- 26.4 Determinations Applicable to Polluted Waters and Domestic Wastewaters 653

CHAPTER 27

Iron and Manganese 659

- 27.1 General Considerations 659
- 27.2 Environmental Significance of Iron and Manganese 661
- 27.3 Methods of Determining Iron 661
- 27.4 Methods of Determining Manganese 662
- 27.5 Applications of Iron and Manganese Data 663
 - Problems 664

CHAPTER 28

Fluoride 665

- 28.1 General Considerations 665
- 28.2 Chemistry of Fluorine and Its Compounds 667
- 28.3 Methods of Determining Fluoride 668
- 28.4 Application of Fluoride Data 669
 - Problems 669

CHAPTER 29

Sulfate 670

- 29.1 General Considerations 670
- 29.2 Methods of Analysis 674
- 29.3 Applications of Sulfate Data 675
 - Problems 676
 - Reference 676

CHAPTER 30**Phosphorus and Phosphate 677**

- 30.1** General Considerations 677
- 30.2** Phosphorus Compounds of Importance 679
- 30.3** Methods of Determining Phosphorus or Phosphate 679
- 30.4** Applications of Phosphorus Data 681
 - Problems 681
 - Reference 682

CHAPTER 31**Oil and Grease 683**

- 31.1** General Considerations 683
- 31.2** Oil and Grease and Their Measurement 684
- 31.3** Methods of Analysis 685
- 31.4** Applications of Oil and Grease Data 687
 - Problems 688
 - Reference 688

CHAPTER 32**Volatile Acids 689**

- 32.1** General Considerations 689
- 32.2** Theoretical Considerations 691
- 32.3** Methods of Determining Volatile Acids 694
- 32.4** Applications of Volatile-Acids Data 697
 - Problems 698
 - Reference 698

CHAPTER 33**Gas Analysis 699**

- 33.1** General Considerations 699
- 33.2** Methods of Analysis 700
- 33.3** Volumetric Analysis 701
- 33.4** Gas Chromatographic Analysis 705
- 33.5** Hydrogen Sulfide 706
- 33.6** Applications of Gas-Analysis Data 707
 - Problems 708
 - Reference 708

CHAPTER 34**Trace Contaminants 709**

- 34.1** General Considerations 709
- 34.2** The Safe Drinking Water Act 713
- 34.3** Drinking Water Standards 714
- 34.4** Trace Organic Contaminants 716
- 34.5** Trace Inorganic Contaminants 718
- 34.6** Secondary Standards and Guidelines 723
- 34.7** Trace Chemical Analyses 724
 - Problems 727
 - References 728

APPENDIX A**Thermodynamic Properties at 25 °C 729****APPENDIX B****Acronyms, Roman Symbols, and Greek Symbols 736****Index 742**

PART 1

Fundamentals of Chemistry for Environmental Engineering and Science