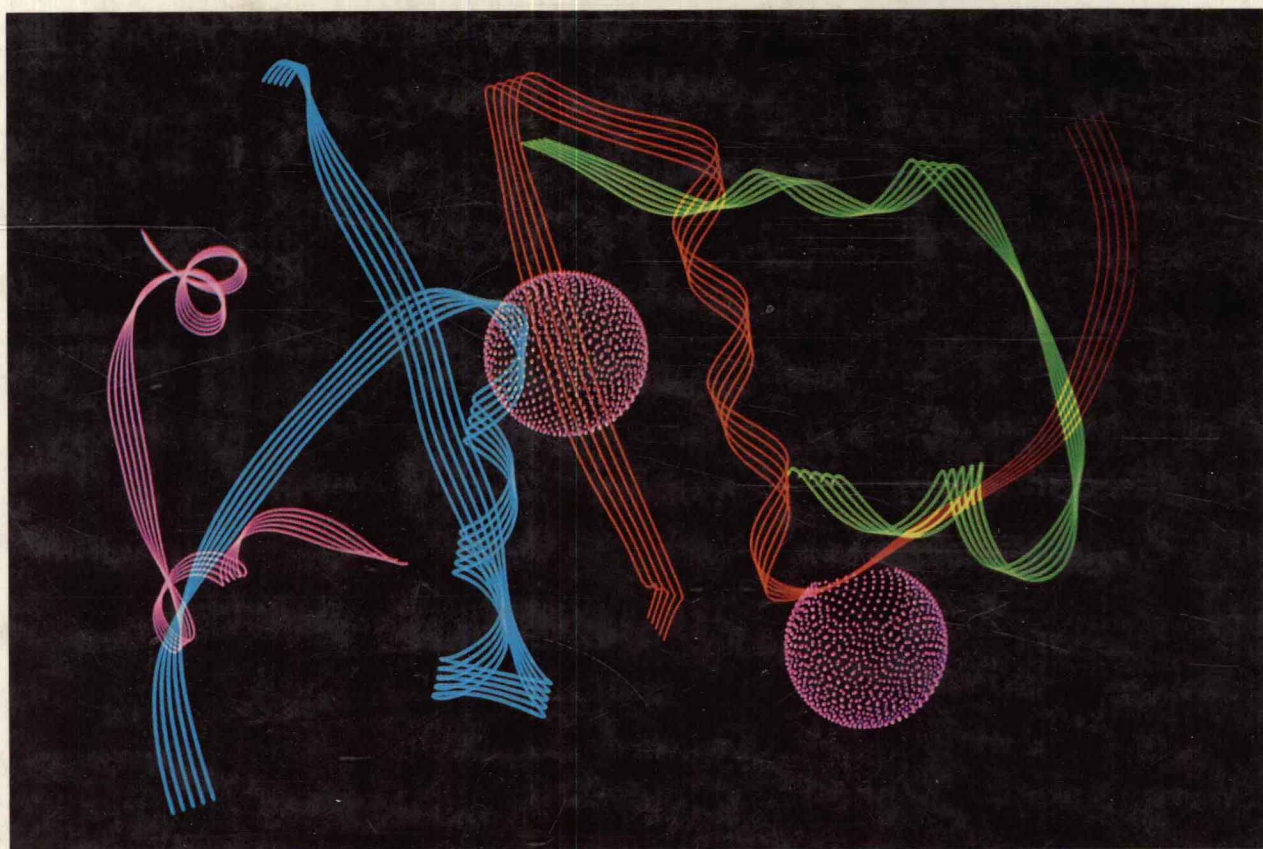


# Essentials of General, Organic, and Biological Chemistry



John McMurry

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John McMurry  
Cornell University



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# Preface

In writing this book, my goal was to create the finest available introductory text on general, organic, and biological chemistry. The book is designed for use in a one-term college course for students with no prior preparation in chemistry. It is also well suited for a two-quarter or two-semester course.

In addition to the careful pedagogy that should be expected of any introductory text, this book includes many special features that set it apart.

## CONTENT AND EXPOSITION

**Writing** Great care has gone into the writing of this book, and every attempt has been made to make it as lucid and readable as possible. Paragraphs begin with summary sentences, transitions between topics are smooth, and new concepts are introduced only as needed. Explanations are concise and to the point; the focus is on the essentials.

**Applications** Each chapter includes a brief discussion of some special topic that shows how the material presented in the chapter is relevant to a specific biological or medical application.

Chapter 1	Measuring Percent Body Fat
Chapter 2	Chernobyl and Cesium
Chapter 3	Biologically Important Ions
Chapter 4	Mercury—Reactivity and Toxicity
Chapter 5	Inhaled Anesthetics
Chapter 6	Gout and Kidney Stones—Problems in Solubility
Chapter 7	Ulcers and Antacids
Chapter 8	Displaying Molecular Shapes
Chapter 9	The Chemistry of Vision
Chapter 10	Morphine Alkaloids
Chapter 11	Chemical Warfare among the Insects
Chapter 12	Thiol Esters—Biological Carboxylic Acid Derivatives
Chapter 13	Cell-Surface Carbohydrates
Chapter 14	Cholesterol and Heart Disease
Chapter 15	Protein and Nutrition
Chapter 16	Medical Use of Enzymes—Isoenzymes
Chapter 17	Viruses
Chapter 18	Barbiturates
Chapter 19	Diabetes, A Metabolic Disorder
Chapter 20	Medical Uses of Radioactivity

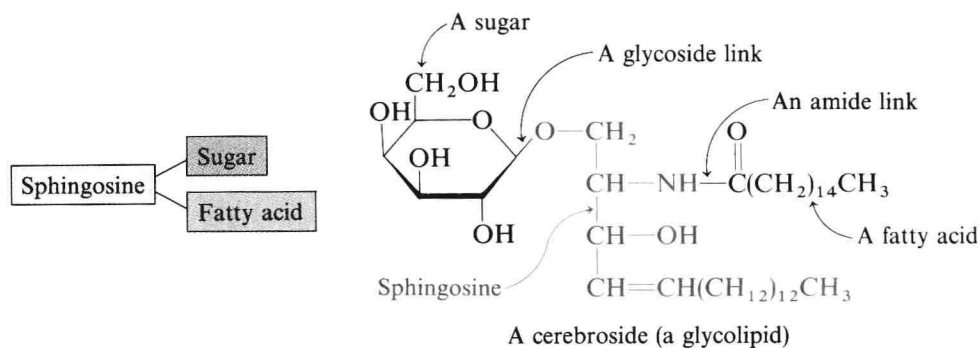
**Interludes** Each chapter ends with a brief Interlude extending the material of the chapter into a broader context: ecological, clinical, social, or technological.

Chapter 1	Powers of Ten
Chapter 2	Are Atoms Real?
Chapter 3	Diamond and Graphite
Chapter 4	Regulation of Body Temperature
Chapter 5	Blood Pressure
Chapter 6	Dialysis
Chapter 7	Acid Rain
Chapter 8	Petroleum
Chapter 9	Alkene Polymers
Chapter 10	Chlorofluorocarbons and the Ozone Layer
Chapter 11	A Biological Aldol Reaction
Chapter 12	Nylons and Polyamides
Chapter 13	Sweetness
Chapter 14	Chemical Communication
Chapter 15	Determining Protein Structure
Chapter 16	Penicillin, the First Antibiotic
Chapter 17	Recombinant DNA
Chapter 18	Diets, Babies, and Hibernating Bears
Chapter 19	Exercise and Weight
Chapter 20	Archaeological Radiocarbon Dating

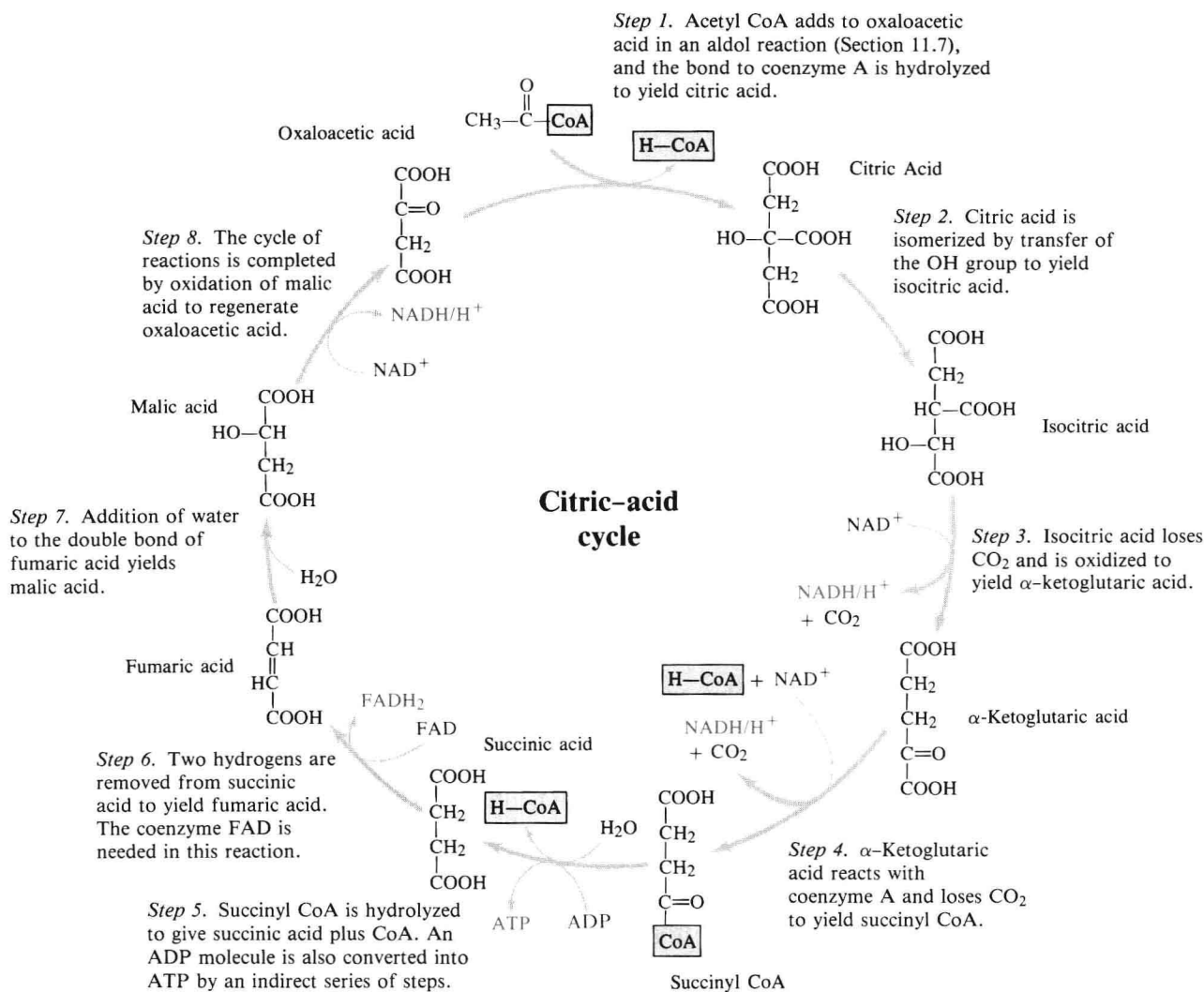
**Currency** Coverage is up to date throughout the book—particularly in the biological chapters, where new breakthroughs seem to occur almost daily. DNA sequencing (Section 17.10), recombinant DNA technology (Interlude, Chapter 17), prostaglandins (Section 14.10), cell-surface carbohydrates (Application, Chapter 13), chlorofluorocarbons and the ozone layer (Interlude, Chapter 10), and diagnostic imaging techniques (Interlude, Chapter 20) are among the currently exciting topics treated in this book.

## GRAPHICS

**Color** Full color has been used throughout this book, not only to make it attractive but to serve important pedagogical purposes. Many topics, especially in organic and biological chemistry, become much clearer when the reacting portions of complex molecules are color coded.



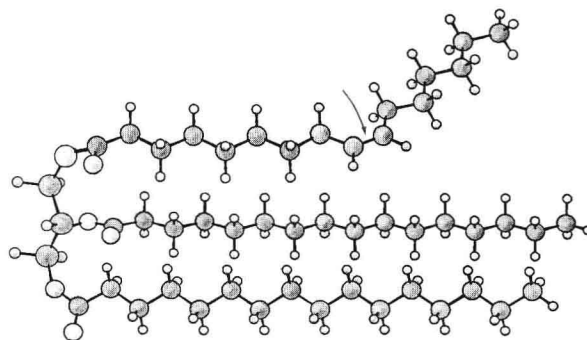
Important groups, such as phosphate, are colored consistently throughout the text so that students can recognize them more quickly and relate material presented in different chapters. Moreover, in the chapters on bioenergetics (Chapters 18 and 19), energy rich forms of compounds, such as ATP and reduced coenzymes, are depicted in red, whereas their lower energy counterparts, such as ADP and oxidized coenzymes, are represented in blue.



**Figure 18.6**

The citric-acid cycle, an eight-step series of reactions whose net effect is the metabolic breakdown of acetyl groups (from acetyl CoA) into two molecules of carbon dioxide plus energy.

**Computer-Generated Structures** Computer-generated molecular models are used extensively in the organic and biological chapters, both for their accuracy in portraying the three-dimensional structures of molecules and for their visual appeal.

**Figure 14.3**

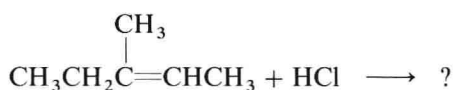
Molecular model of an unsaturated triglyceride. The double bond (arrow) prevents the molecule from adopting a regular shape and crystallizing easily.

## PROBLEM SOLVING

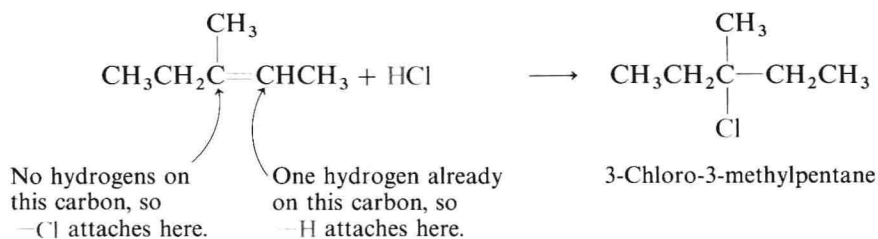
**Solved Problems** Eighty-two fully worked-out sample problems are used in the text to demonstrate methods of solving commonly encountered types of problems.

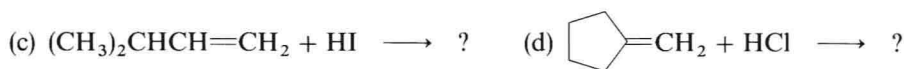
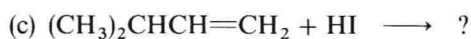
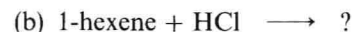
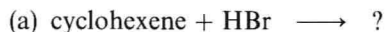
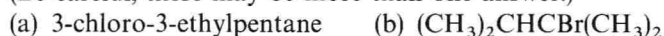
**Practice Problems** Solved problems are always followed by related practice problems for students to solve. Most text sections conclude with additional practice problems to provide an immediate test of understanding. The book includes a total of 245 practice problems, answers to all of which are provided in a section at the end of the text.

**Solved Problem 9.4** What product would you expect from the following reaction?



**Solution** We know that reaction of an alkene with HCl leads to formation of an alkyl chloride addition product. The question here is which of two possible products will form. To make a prediction, look at the starting alkene, and count the number of hydrogens already attached to each double-bond carbon. Then write the product by attaching H to the carbon that already has more hydrogens and attaching Cl to the carbon that has fewer hydrogens.



**Practice Problems****9.7** What products would you expect from these following reactions?**9.8** What alkenes are the following alkyl halides likely to have been made from? (Be careful, there may be more than one answer.)

**Ballpark Answers to Problems** In addition to the standard factor-label method used throughout for solving numerical calculations, the idea of first getting an approximate or “ballpark” answer is taught. This method serves not only as a test of understanding specific concepts but also as a useful device for developing general intellectual skills.

**Solved Problem 7.6** When a 5.00 mL sample of household vinegar (dilute aqueous acetic acid) was titrated, 44.5 mL of 0.100 M NaOH solution were required to reach the end point. What is the acid concentration of vinegar?

**Ballpark Solution** Since the volume of base required to neutralize the acid sample is about nine times the volume of the sample (44.5 mL versus 5 mL), the concentration of the acid is about nine times that of the base, or 0.9 M.

**Solution** First, write the balanced equation for the neutralization to find the number of moles of base required to neutralize each mole of acid. In this example, the mole ratio of base to acid is 1:1.



Next, calculate how many moles of NaOH are consumed in the titration:

$$44.5 \cancel{\text{mL}} \times \frac{0.100 \text{ moles NaOH}}{\cancel{\text{L}}} \times \frac{1 \cancel{\text{L}}}{1000 \cancel{\text{mL}}} = 0.00445 \text{ moles NaOH}$$

Since the balanced equation says that each mole of NaOH reacts with one mole of acetic acid, the 5.00 mL sample of vinegar must contain 0.00445 moles of acetic acid:

$$\begin{aligned} \text{Acetic acid concentration} &= \frac{0.00445 \text{ moles CH}_3\text{COOH}}{5.00 \cancel{\text{mL}}} \times \frac{1000 \cancel{\text{mL}}}{1 \text{ L}} \\ &= 0.890 \text{ M} \end{aligned}$$

Thus, the acetic acid concentration in vinegar is 0.890 M, very close to the ballpark answer.



---

**Practice Problems**

- 7.9** In order to determine the concentration of an old bottle of aqueous HCl whose label had become unreadable, a titration was carried out. What is the HCl concentration if 58.4 mL of 0.250 M NaOH was required to titrate a 20.0 mL sample of the acid?
- 7.10** How many mL of 0.150 M NaOH are required to neutralize 50.0 mL of 0.200 M  $\text{H}_2\text{SO}_4$ ?
- 

**Review Problems** Nearly 1000 review problems are provided at the ends of chapters. These are classified by subject; in addition, there is a section of uncategorized problems for each chapter. Answers to selected review problems are given at the end of the book.

**PEDAGOGY**

**Goals** Each chapter begins with a brief introductory overview, followed by a list of goals for the student to keep in mind while studying.

**Marginal Definitions** Key terms are boldfaced in the text, and the definition of each term is repeated in the margin for easy review. In addition, a complete glossary of terms is provided at the end of the book.

**Summaries** All chapters end with clear, concise summaries that recapitulate the key points in the text, with important terms in boldface.

**Appendices** A review of exponential notation, a table of commonly used conversion factors, and a discussion of the concepts of accuracy and precision in measurement are provided in appendices.

**SUPPLEMENTS**

**Study Guide and Solutions Manual** A carefully prepared *Study Guide and Solutions Manual* accompanies this text. Written by Susan McMurry, this companion volume answers all in-text and end-of-chapter problems and explains in detail how the answers are obtained. In addition, study hints and self-test materials for each chapter are included.

**Instructor's Manual** The *Instructor's Manual*, written by the author, includes lecture suggestions and teaching tips, suggested readings, and approximately 500 test questions.

**Laboratory Manual** The *Laboratory Manual*, developed by Scott Mohr and his associates at Boston University, has been class tested for 12 years.

**Instructor's Manual to the Laboratory Manual** This supplement provides information on reagents and equipment needed for the laboratory experiments, along with answers to any questions in the *Laboratory Manual*.

**Transparency Set** A set of 60 transparencies of the most important figures and tables in the text is available free with adoptions of 100 or more copies.

For more information on supplements, contact your local Prentice Hall sales representative.

## ACKNOWLEDGMENTS

It's a pleasure to thank the many people whose help and suggestions were so valuable in preparing this book. First is my wife, Susan, herself a chemist, who not only read and improved the entire manuscript but also prepared the accompanying *Study Guide and Solutions Manual*. Next is the first-rate staff at Prentice Hall whose care and criticisms made this book so much better than it would otherwise have been—Dan Joraanstad, Elizabeth Foy, Eleanor Hiatt, Judy Matz-Coniglio, and especially Dan Schiller, for effort far beyond the call of duty. Finally, I thank the reviewers:

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Anonymous to me at the time they read the manuscript, the persons listed above provided many excellent suggestions that I gladly incorporated in the final product. Needless to say, they cannot be blamed for any errors that remain. I would be deeply grateful for any suggestions and corrections from users of this book.

*John McMurry*

# A Note to the Student

We have the same goals. Yours is to learn chemistry, and mine is to do everything possible to help you learn. It's going to take some work on your part, but the following suggestions should prove helpful.

**Don't read the text immediately.** As you begin each new chapter, look it over first. Read the introductory paragraphs and familiarize yourself with the chapter goals. Find out what topics will be covered, and then turn to the end of the chapter and read the summary. You'll be in a much better position to learn new material if you first have a general idea of where you're going.

**Work the problems.** There are no shortcuts here; working problems is the only way to learn chemistry. The sample problems show you how to approach the material, the in-chapter practice problems provide immediate practice, and the end-of-chapter problems provide additional drill. Answers to the in-chapter practice problems and selected review problems are given at the end of this book; full answers and explanations for all problems are given in the accompanying *Study Guide and Solutions Manual*.

**Use the study guide.** The *Study Guide and Solutions Manual* that accompanies this text gives complete solutions to all problems. It also provides chapter outlines, additional study hints, and self-test materials. This material can be extremely useful when you're working problems and when you're studying for an exam. Find out what's there now so you'll know where to find it when you need help.

**Ask questions.** Faculty members and teaching assistants are there to help you. Most of them will turn out to be genuinely nice people with a sincere interest in helping you learn.

Good luck. I sincerely hope you enjoy learning about chemistry and come to see the beauty and logic of its structure.

John McMurry

# Brief Contents

Preface	xv	
A Note to the Student	xxiii	
<b>1</b>	<b>Chemistry: Matter and Measurement</b>	<b>1</b>
<b>2</b>	<b>Matter and Molecules</b>	<b>27</b>
<b>3</b>	<b>The Structure of Matter: Chemical Bonds</b>	<b>46</b>
<b>4</b>	<b>Chemical Reactions</b>	<b>69</b>
<b>5</b>	<b>Solids, Liquids, and Gases</b>	<b>92</b>
<b>6</b>	<b>Solutions</b>	<b>112</b>
<b>7</b>	<b>Acids, Bases, and Salts</b>	<b>135</b>
<b>8</b>	<b>Introduction to Organic Chemistry: Alkanes</b>	<b>160</b>
<b>9</b>	<b>Alkenes, Alkynes, and Aromatic Compounds</b>	<b>184</b>
<b>10</b>	<b>Oxygen, Nitrogen, Sulfur, and Halogen Containing Compounds</b>	<b>208</b>
<b>11</b>	<b>Aldehydes and Ketones</b>	<b>230</b>
<b>12</b>	<b>Carboxylic Acids, Esters, and Amides</b>	<b>249</b>
<b>13</b>	<b>The Molecules of Life: Carbohydrates</b>	<b>273</b>
<b>14</b>	<b>The Molecules of Life: Lipids</b>	<b>295</b>
<b>15</b>	<b>The Molecules of Life: Amino Acids and Proteins</b>	<b>317</b>
<b>16</b>	<b>The Molecules of Life: Enzymes, Vitamins, and Hormones</b>	<b>339</b>
<b>17</b>	<b>The Molecules of Life: Nucleic Acids</b>	<b>364</b>
<b>18</b>	<b>Metabolism I: The Generation of Biochemical Energy</b>	<b>389</b>
<b>19</b>	<b>Metabolism II: Catabolic and Anabolic Pathways</b>	<b>407</b>
<b>20</b>	<b>Nuclear Chemistry</b>	<b>427</b>
	Appendix A Exponential Notation	447
	Appendix B Accuracy and Precision in Measurement	450
	Appendix C Conversion Factors	452
	Glossary	453
	Answers to In-Chapter Practice Problems	464
	Answers to Selected Review Problems	475
	Photo Credits and Acknowledgments	487
	Index	489

# Contents

Preface xv

A Note to the Student xxiii

## 1 Chemistry: Matter and Measurement 1

- 1.1 Matter 3
- 1.2 Physical Quantities 4
- 1.3 Mass and Its Measurement 6
- 1.4 Measuring Length 7
- 1.5 Measuring Volume 8
- 1.6 Measurement and Significant Figures 9
- 1.7 Scientific Notation 10
- 1.8 Rounding Off Numbers 12
- 1.9 Calculations: Converting a Quantity from One Unit to Another 13
- 1.10 Measuring Temperature 16
- 1.11 Heat and Energy 18
- 1.12 Density 19
  - An Application: Measuring Percent Body Fat 20
- 1.13 Specific Gravity 22
  - Interlude: Powers of 10 23
  - Summary 24
  - Review Problems 24

## 2 Matter and Molecules 27

- 2.1 Elements 28
- 2.2 Names and Symbols for Elements 29
- 2.3 Atomic Theory 30
- 2.4 The Structure of Atoms 33
- 2.5 Energy Levels of Electrons 33
- 2.6 Electron Configuration of Atoms 35
- 2.7 The Periodic Table 36
- 2.8 Group Characteristics of the Elements 37
  - An Application: Chernobyl and Cesium 39
- 2.9 Electron Configurations and the Periodic Table 40
- 2.10 Atoms and Molecules; Compounds and Mixtures 41
  - Interlude: Are Atoms Real? 42
  - Summary 42
  - Review Problems 43



### 3 The Structure of Matter: Chemical Bonds 46

- 3.1 The Octet Rule 48
- 3.2 Ions and Ionic Bonding 49
- 3.3 Ionic Compounds 50
- 3.4 Oxidation/Reduction Reactions 52
  - An Application: Biologically Important Ions 54
- 3.5 Covalent Bonds 54
- 3.6 Covalent Bonds Between Unlike Atoms 56
- 3.7 Covalent Bonds in Organic Molecules 58
- 3.8 Multiple Covalent Bonds 59
- 3.9 The Shapes of Covalent Molecules 60
- 3.10 Covalent Bonds in Polyatomic Ions 61
- 3.11 Naming Chemical Compounds 63
- 3.12 Summary 64
  - Interlude: Diamond and Graphite 65
  - Review Problems 66

### 4 Chemical Reactions 69

- 4.1 Chemical Equations 70
- 4.2 Balancing Chemical Equations 71
- 4.3 Avogadro's Number and the Mole 73
- 4.4 Gram/Mole Conversions 76
- 4.5 Reactions with Limiting Amounts of Reactants 78
- 4.6 Why Do Chemical Reactions Occur? 80
- 4.7 How Do Chemical Reactions Occur? 81
  - An Application: Mercury—Reactivity and Toxicity 82
- 4.8 Effect of Temperature, Concentration, and Catalysts on Reactions 84
- 4.9 Reversible Reactions and Chemical Equilibrium 86
- 4.10 Chemical Reactions in the Body 87
  - Interlude: Regulation of Body Temperature 88
  - Summary 88
  - Review Problems 89

### 5 Solids, Liquids, and Gases 92

- 5.1 States of Matter 93
- 5.2 Gases and the Kinetic Theory 94
- 5.3 Pressure 95
- 5.4 Partial Pressure; Dalton's Law 97
- 5.5 Gas Laws 97
- 5.6 The Universal Gas Law 102
  - An Application: Inhaled Anesthetics 104
- 5.7 Liquids 104
- 5.8 Solids 107
  - Interlude: Blood Pressure 108
  - Summary 108
  - Review Problems 109

## 6 Solutions 112

- 6.1 Mixtures 113
- 6.2 Solutions 114
- 6.3 Solubility 115
  - An Application: Gout and Kidney Stones: Problems in Solubility 117
- 6.4 Units for Expressing Concentration 117
- 6.5 Dilution 121
- 6.6 Water and Its Structure: Polar Covalent Bonds 123
- 6.7 Water as a Solvent 125
- 6.8 Hydration of Solids 126
- 6.9 Ions in Solution: Electrolytes 126
- 6.10 Equivalents, Milliequivalents, and Body Electrolytes 127
- 6.11 Osmosis and Osmotic Pressure 129
  - Interlude: Dialysis 131
  - Summary 131
  - Review Problems 132

## 7 Acids, Bases, and Salts 135

- 7.1 Acids 136
- 7.2 Bases 137
- 7.3 The Nature of Acids and Bases in Aqueous Solution 138
- 7.4 Reactions of Acid with Bases: Neutralization 139
- 7.5 Acid and Base Strength 143
- 7.6 The Acidity of Water 145
- 7.7 Measuring Acidity in Aqueous Solutions: pH 147
- 7.8 Laboratory Determination of Acidity 149
  - An Application: Ulcers and Antacids 150
- 7.9 Titration 151
- 7.10 Equivalents of Acids and Bases: Normality 153
- 7.11 Buffer Solutions 154
  - Interlude: Acid Rain 156
  - Summary 157
  - Review Problems 157

## 8 Introduction to Organic Chemistry: Alkanes 160

- 8.1 The Nature of Organic Molecules 162
- 8.2 Families of Organic Molecules: Functional Groups 163
- 8.3 The Structure of Organic Molecules:  
Alkanes and Their Isomers 166
- 8.4 Writing Organic Structures 169
- 8.5 The Shapes of Organic Molecules 170
  - An Application: Displaying Molecular Shapes 170
- 8.6 Naming Alkanes 172
- 8.7 Cyclic Organic Molecules 177
- 8.8 Drawing and Naming Cycloalkanes 177
- 8.9 Chemistry of Alkanes 179

Interlude: Occurrence and Uses of Alkanes: Petroleum	180
Summary	180
Review Problems	181

## **9** Alkenes, Alkynes, and Aromatic Compounds 184

9.1	Naming Alkenes and Alkynes	186
9.2	The Structure of Alkenes: Cis-Trans Isomerism	188
9.3	Chemical Reactions of Alkenes and Alkynes	191
	An Application: The Chemistry of Vision	192
9.4	How an Alkene Addition Reaction Occurs	197
9.5	Aromatic Compounds and the Structure of Benzene	198
9.6	Naming Aromatic Compounds	199
9.7	Chemical Reactions of Aromatic Compounds	201
9.8	Polycyclic Aromatic Compounds and Cancer	203
	Interlude: Alkene Polymers	204
	Summary	205
	Review Problems	205

## **10** Oxygen, Nitrogen, Sulfur, and Halogen Containing Compounds 208

10.1	Alcohols, Phenols, and Ethers	209
10.2	Occurrence and Uses of Alcohols, Phenols, and Ethers	210
10.3	Naming Alcohols, Phenols, and Ethers	211
10.4	Properties of Alcohols, Phenols, and Ethers	213
10.5	Acidity of Alcohols and Phenols	214
10.6	Chemical Reactions of Alcohols	215
10.7	Sulfur-Containing Compounds: Thiols and Disulfides	219
10.8	Nitrogen-Containing Compounds: Amines	220
10.9	Some Biologically Important Amines	221
10.10	Properties of Amines: Basicity	222
	An Application: Morphine Alkaloids	223
10.11	Halogen-Containing Compounds	225
	Interlude: Chlorofluorocarbons and the Ozone Hole	226
	Summary	226
	Review Problems	227

## **11** Aldehydes and Ketones 230

11.1	Kinds of Carbonyl Compounds	231
11.2	Uses of Aldehydes and Ketones	233
11.3	Naming Aldehydes and Ketones	234
11.4	Oxidation of Aldehydes	235
11.5	Reduction of Aldehydes and Ketones	236

- 11.6 Reaction with Alcohols: Acetal Formation 239  
An Application: Chemical Warfare Among the Insects 242
- 11.7 Aldol Reaction of Aldehydes and Ketones 242  
Summary 244  
Interlude: A Biological Aldol Reaction 245  
Review Problems 245

## **12** Carboxylic Acids, Esters, and Amides 249

- 12.1 An Overview of Carboxylic Acid, Ester, and Amide Reactions 250
- 12.2 Naming Carboxylic Acids, Esters, and Amides 251
- 12.3 Occurrence and Properties of Carboxylic Acids 253
- 12.4 Acidity of Carboxylic Acids 254
- 12.5 Reactions of Carboxylic Acids: Ester Formation 256
- 12.6 Occurrence and Properties of Esters 258
- 12.7 Reactions of Esters: Hydrolysis 258
- 12.8 Reactions of Esters: Claisen Condensation 260  
An Application: Thiol Esters—Biological Carboxylic Acid Derivatives 262
- 12.9 Occurrence and Properties of Amides 263
- 12.10 Preparation of Amides from Carboxylic Acids 263
- 12.11 Reactions of Amides: Hydrolysis 265
- 12.12 Phosphate Esters 267  
Interlude: Synthetic Polymers: Polyamides and Polyesters 269  
Summary 269  
Review Problems 270

## **13** The Molecules of Life: Carbohydrates 273

- 13.1 Classification of Carbohydrates 275
- 13.2 Handedness 276
- 13.3 Molecular Handedness: D and L Families of Sugars 277
- 13.4 The Structure of Glucose 280
- 13.5 Some Important Monosaccharides 283
- 13.6 Reactions of Monosaccharides 284
- 13.7 Some Important Disaccharides 285
- 13.8 Some Important Polysaccharides 287  
An Application: Cell-Surface Carbohydrates 288  
Summary 290  
Interlude: Sweetness 291  
Review Problems 292

## **14** The Molecules of Life: Lipids 295

- 14.1 Structure and Classification of Lipids 296
- 14.2 Waxes, Fats, and Oils 298
- 14.3 Hydrogenation of Fats and Oils 300
- 14.4 Hydrolysis of Fats and Oils: Soap 302