Brief Contents

1 Introduction 1

- 2 Atoms, Molecules, and Ions 29
- **3** Stoichiometry 60
- 4 Reactions in Aqueous Solutions 97
- 5 Gases 137
- 6 Energy Relationships in Chemical Reactions 178

Valle University. After doing possible weeks the

Williams College, where he has taugue

readers.

- 7 The Electronic Structure of Atoms 213
- 8 The Periodic Table 253
- 9 Chemical Bonding I: The Covalent Bond 287
- 10 Chemical Bonding II: Molecular Geometry and Hybridization of Atomic Orbitals 323
- 11 Introduction to Organic Chemistry 366
- 12 Intermolecular Forces and Liquids and Solids 402
- 13 Physical Properties of Solutions 439
- 14 Chemical Kinetics 469
- 15 Chemical Equilibrium 513
- 16 Acids and Bases 547
- 17 Acid-Base Equilibria and Solubility Equilibria 593
- 18 Thermodynamics 631

19 Redox Reactions and Electrochemistry 664
20 The Chemistry of Coordination Compounds 706
21 Nuclear Chemistry 730
22 Organic Polymers—Synthetic and Natural 762
Appendix 1 Units for the Gas Constant A-1
Appendix 2 Thermodynamic Data at 1 atm and 25°C A-2
Appendix 3 Mathematical Operations A-7
Appendix 4 Derivation of the Names of Elements A-9



List of Animations xvi Preface xvii A Note to the Student xxii

Introduction 1



CHAPTER

- 1.1 The Study of Chemistry 2
- **1.2** The Scientific Method 2
- **1.3** Classifications of Matter 4
- 1.4 Physical and Chemical Properties of Matter 7

chan Element 82.

Molecular Mass 66-1

The Mass Spectrometer 6

E8 sinepast batters 83

AG SHARE BEEN

Receptation Reactions 100

SAT aves Let EX Soft Fill

20000000000000000

A stand is a more and a long and the second is a stand

- 1.5 Measurement 8
- 1.6 Handling Numbers 13
- 1.7 Dimensional Analysis in Solving Problems 18

Key Equations 22 Summary of Facts and Concepts 22 Key Words 23 Questions and Problems 23

Atoms, Molecules, and Ions 29



2.1 The Atomic Theory 30

- 2.2 The Structure of the Atom 31
- 2.3 Atomic Number, Mass Number, and Isotopes 36
- 2.4 The Periodic Table 38
- 2.5 Molecules and lons 39
- 2.6 Chemical Formulas 41
- 2.7 Naming Compounds 45
- 2.8 Introduction to Organic Compounds 52

Summary of Facts and Concepts 54 Key Words 54 Questions and Problems 54





The Ideal Gas Equation 147



viii

Stoichiometry 60

3.1 Atomic Mass 61

- 3.2 Avogadro's Number and the Molar Mass of an Element 62
- 3.3 Molecular Mass 66
- 3.4 The Mass Spectrometer 68
- 3.5 Percent Composition of Compounds 70
- 3.6 **Experimental Determination of Empirical Formulas 72**

Sin votaimed) to vote self.

Et and during or allocated

A set of the set of th

Constant and the second

Participation to Organic Compounds 57

- 3.7 **Chemical Reactions and Chemical Equations 75**
- 3.8 Amounts of Reactants and Products 79
- 3.9 Limiting Reagents 83



Reaction Yield 86 3.10

> S borthe Method 2 **Key Equations 88** Summary of Facts and Concepts 88 Physical and Chemical Propentes Key Words 88 Questions and Problems 88 Main and a standard a familie

Reactions in Aqueous Solutions 97 Provident and Problems

- **General Properties of Aqueous Solutions 98** 4.1
- 4.2 **Precipitation Reactions 100**
- 4.3 Acid-Base Reactions 105
- 4.4 **Oxidation-Reduction Reactions 110**
- 4.5



Concentration of Solutions 119 CASE IN THE COMM

4.6 Solution Stoichiometry 123

> **Key Equations** 129 A sector and the property Summary of Facts and Concepts 129 Key Words 129 **Questions and Problems 130** A house for the second being of the second being of the second being of the second being of the second being of

CHAPTER

CHAPTER

Gases 137

- 5.1 Substances That Exist as Gases 138
- 5.2 Pressure of a Gas 139
- 5.3 The Gas Laws 142
- 5.4 The Ideal Gas Equation 147
- 5.5 Dalton's Law of Partial Pressures 153





ix

5.6 The Kinetic Molecular Theory of Gases 158 5.7 **Deviation from Ideal Behavior 165**

> Key Equations 167 Summary of Facts and Concepts 168 A CARLES AND A CARLES Key Words 169 Questions and Problems 169

> > BOS. VINERIA WARRAND

bendodd laolmeil Anthonede

Energy Relationships in Chemical Reactions 178



CHAPTER

- 6.1 The Nature of Energy and Types of Energy 179
- 6.2 **Energy Changes in Chemical Reactions 180**
- 6.3 Introduction to Thermodynamics 181
- 6.4 **Enthalpy of Chemical Reactions 187**
- 6.5 Calorimetry 193
- 6.6 **Standard Enthalpy of Formation** and Reaction 198

Key Equations 204 Summary of Facts and Concepts 204 Key Words 204 **Questions and Problems 205** States and the store of the states



CHAPTER

The Electronic Structure of Atoms 213

From Classical Physics to Quantum Theory 214 7.1

solaritati Change on a Lewis Structure 302

- 7.2 The Photoelectric Effect 218
- 7.3 Bohr's Theory of the Hydrogen Atom 220
- 7.4 The Dual Nature of the Electron 224
- 7.5 **Quantum Mechanics 227**
- 7.6 Quantum Numbers 228
- 7.7 Atomic Orbitals 230
- 7.8 **Electron Configuration 234**
- 7.9 The Building-Up Principle 241

Vite and One of the house have **Key Equations 244** Summary of Facts and Concepts 245 Key Words 245 Voorschie Erstellend Questions and Problems 246







X

Contents

The Periodic Table 253

- 8.1 Development of the Periodic Table 254
- 8.2 Periodic Classification of the Elements 255
- 8.3 Periodic Variation in Physical Properties 258
- 8.4 Ionization Energy 264
- 8.5 Electron Affinity 268
- 8.6 Variation in Chemical Properties of the Representative Elements 269

Key Equation 280 Summary of Facts and Concepts 280 Key Words 281

State State States



CHAPTER

Questions and Problems 281

Chemical Bonding I: The Covalent Bond 287

- 9.1 Lewis Dot Symbols 288
- 9.2 The lonic Bond 289
- 9.3 Lattice Energy of Ionic Compounds 291
- 9.4 The Covalent Bond 293
- 9.5 Electronegativity 295
- 9.6 Writing Lewis Structures 299
- 9.7 Formal Charge and Lewis Structure 302
- 9.8 The Concept of Resonance 305
- 9.9 Exceptions to the Octet Rule 307



9.10 Bond Enthalpy 312

Key Equation 316 Summary of Facts and Concepts 316 Key Words 316 Questions and Problems 317

CHAPTER 10

Chemical Bonding II: Molecular Geometry and Hybridization of Atomic Orbitals 323

10.1 Molecular Geometry 324
10.2 Dipole Moments 334
10.3 Valence Bond Theory 337





White Date water of the Electron 224

Trans man A seven there is a

Hybridization of Atomic Orbitals 339

10.5 Hybridization in Molecules Containing Double and Triple Bonds 348

Adression affects and Concebb

Molecular Orbital Theory 351 10.6

10.4

in the neise ine setti **Key Equations 359** Summary of Facts and Concepts 359 Here of Pressure on the Sol Key Words 360 Questions and Problems 360

Introduction to Organic Chemistry 366

CHAPTER

- **Classes of Organic Compounds 367** 11.1
- Aliphatic Hydrocarbons 367 11.2
- Aromatic Hydrocarbons 382 11.3
- Chemistry of the Functional Groups 385 11.4
- Chirality—The Handedness of Molecules 392 11.5

Summary of Facts and Concepts 396 Key Words 396 **Questions and Problems 396**



Intermolecular Forces and Liquids and Solids 402





12.1 The Kinetic Molecular Theory of Liquids and Solids 403

的。当然前了,但他们的问题。 第二章

- 12.2 **Intermolecular Forces 404**
- 12.3 **Properties of Liquids 410**
- 12.4 **Crystal Structure 413**
- 12.5 **Bonding in Solids 419**
- Phase Changes 423 12.6
- Phase Diagrams 430 12.7

Key Equations 431 Summary of Facts and Concepts 431 Key Words 432 **Questions and Problems** 432



xii

Physical Properties of Solutions 439

13.1 Types of Solutions 440

- **13.2** A Molecular View of the Solution Process 440
- **13.3** Concentration Units 443
- **13.4** Effect of Temperature on Solubility 446
- **13.5** Effect of Pressure on the Solubility of Gases 448
- **13.6** Colligative Properties 450

Key Equations 461 Summary of Facts and Concepts 461 Key Words 462 Questions and Problems 462



CHAPTER 14

Chemical Kinetics 469

14.1 The Rate of a Reaction 470

14.2 The Rate Laws 474

14.3 Relation Between Reactant Concentrations and Time 478

14.4 Activation Energy and Temperature Dependence of Rate Constants 487

- 14.5 Reaction Mechanisms 492
- 14.6 Catalysis 496

Key Equations 502 Summary of Facts and Concepts 502 Key Words 503



Questions and Problems 503

CHAPTER 15

Chemical Equilibrium 513

- **15.1** The Concept of Equilibrium 514
- 15.2 Ways of Expressing Equilibrium Constants 517

The solution should be the or to solution of the solution of the solution of the solution of the solution of the

ADA REARING FORMER FORCES 404

- 15.3 What Does the Equilibrium Constant Tell Us? 524
- 15.4 Factors That Affect Chemical Equilibrium 529
 - Key Equations 536 Summary of Facts and Concepts 537 Key Words 537 Questions and Problems 537





CHAPTER 16

Acids and Bases 547

- 16.1 **Brønsted Acids and Bases 548**
- 16.2 The Acid-Base Properties of Water 549
- 16.3 pH—A Measure of Acidity 551
- 16.4 Strength of Acids and Bases 554
- 16.5 Weak Acids and Acid Ionization Constants 558

EEN NOODES

Edd anountaine adda

State alter a simer were

CONSCIONS ON

- 16.6 Weak Bases and Base Ionization Constants 569
- The Relationship Between Conjugate Acid-Base 16.7 **Ionization Constants** 572
- Molecular Structure and the Strength of Acids 573 16.8
- 16.9 Acid-Base Properties of Salts 576



16.10 Acidic, Basic, and Amphoteric Oxides 581 16.11 Lewis Acids and Bases 583

> **Key Equations 585** Summary of Facts and Concepts 586 Key Words 586 **Questions and Problems 586**

CHAPTER 7

Acid-Base Equilibria and Solubility Equilibria 593

Contraction of the second s

- 17.1 Homogeneous Versus Heterogeneous Solution Equilibria 594
- 17.2 **Buffer Solutions 594**



- A Closer Look at Acid-Base Titrations 600 17.3
- 17.4 Acid-Base Indicators 606
- Solubility Equilibria 609 17.5
- The Common Ion Effect and Solubility 616 17.6
- Complex Ion Equilibria and Solubility 617 17.7
- **Application of the Solubility Product Principle** 17.8 to Qualitative Analysis 620 Maler adda

Key Equations 623 Summary of Facts and Concepts 623 Key Words 624 Questions and Problems 624 Containation Compounds



Geotheury of Cooldination Compounds 715

The solution of the second second second

Seethors of Coordination Compounds 723

CHAPTER 18

Thermodynamics 631

- The Three Laws of Thermodynamics 632 18.1
- 18.2 **Spontaneous Processes 632**
- 18.3 Entropy 633
- 18.4 The Second Law of Thermodynamics 638
- 18.5 Gibbs Free Energy 644
- 18.6 Free Energy and Chemical Equilibrium 650
- 18.7 Thermodynamics in Living Systems 654

Key Equations 656 Summary of Facts and Concepts 656 Key Words 656

Questions and Problems 656

E82 co258 bras abana server a server

Montopeneous Versus Heterog

solution Equilibria 594

Rev Monder SRG



xiv Contents

CHAPTER 19

Redox Reactions and Electrochemistry 664

- 19.1 **Redox Reactions 665**
- 19.2 Galvanic Cells 668
- 19.3 **Standard Reduction Potentials 670**
- Thermodynamics of Redox Reactions 676 19.4
- The Effect of Concentration on Cell Emf 679 19.5
- 19.6 **Batteries 683**
- 19.7 Corrosion 687
- 19.8 Electrolysis 690
- **Electrometallurgy 695** 19.9 GLORER LOOM STREED BASE



Key Equations 696 and spilling each had Summary of Facts and Concepts 697 Key Words 697 Questions and Problems 697



The Chemistry of Coordination Compounds 706

to ite allow the set of the set of the set of the set of the

Application of the Solubility Product Principle

- **Properties of the Transition Metals 707** 20.1
- 20.2 **Coordination Compounds 710**
- 20.3 **Geometry of Coordination Compounds 715**
- **Bonding in Coordination Compounds:** 20.4 **Crystal Field Theory 717**
- **Reactions of Coordination Compounds 723** 20.5
- **Coordination Compounds in Living Systems 724** 20.6



Section Section

Key Equation 725 Summary of Facts and Concepts 725 Key Words 726 Questions and Problems 726

Nuclear Chemistry 730

21.1 The Nature of Nuclear Reactions 731

- 21.2 Nuclear Stability 733
- 21.3 Natural Radioactivity 738
- 21.4 Nuclear Transmutation 742
- 21.5 Nuclear Fission 744



21.6 Nuclear Fusion 749

21.7 Uses of Isotopes 752

21.8 Biological Effects of Radiation 754

Key Equations 756 Summary of Facts and Concepts 756 Key Words 756 Questions and Problems 756



CHAPTER 21

Organic Polymers—Synthetic and Natural 762

22.1 Properties of Polymers 763
22.2 Synthetic Organic Polymers 763
22.3 Proteins 767
22.4 Nucleic Acids 775



Summary of Facts and Concepts 777 Key Words 778 Questions and Problems 778

Appendix 1Units for the Gas Constant A-1Appendix 2Thermodynamic Data at 1 atm
and 25°C A-2Appendix 3Mathematical Operations A-7Appendix 4Derivation of the Names
of Elements A-9

Glossary G-1 Answers to Even-Numbered Problems AP-1 Credits C-1 Index I-1

istand)) miting the