Contents

About the Authors xv		2-4	Atomic Weights 51
For the Instructor xvi		2-5	The Mole 51
For the	Student xxviii		CHEMISTRY IN USE: Avogadro's Number 55
The Foundations of Chemistry 1		2-6	Formula Weights, Molecular Weights, and Moles 56
1-1	Matter and Energy 4	2-7	Percent Composition and Formulas of Compounds 60
1-2 1-3	Chemistry—A Molecular View of Matter 5 States of Matter 9	2-8	Derivation of Formulas from Elemental Composition 61
1-4	Chemical and Physical Properties 10	2-9	Determination of Molecular Formulas 65
1-5 1-6	Chemical and Physical Changes 12 Mixtures, Substances, Compounds, and Elements 13	2-10	Some Other Interpretations of Chemical Formulas 67
1-7	CHEMISTRY IN USE: Names of the Elements 18	2-11	Key Terms 72
1-8	Units of Measurement 20		Exercises 73
1-9 1-10 1-11	The Unit Factor Method (Dimensional Analysis) 22 Percentage 26 Density and Specific Gravity 26	3	Chemical Equations and Reaction Stoichiometry 81
1-12	Heat and Temperature 29	3-1	Chemical Equations 82
1-13	Heat Transfer and the Measurement of Heat 31	3-2	Calculations Based on Chemical Equations 88
	Key Terms 35 Exercises 36	3-3	The Limiting Reactant (Reagent) Concept 91
	LAGI GISGS SU	3-4	Percent Yields from Chemical Reactions 95
2	Chamical Farmulae and Campacition	3-5	Sequential Reactions 96
4	Chemical Formulas and Composition Stoichiometry 43	3-6	Concentrations of Solutions 97
		3-7	Dilution of Solutions 102
2-1	Chemical Formulas 44	3-8	Using Solutions in Chemical Reactions 103
2-2	lons and Ionic Compounds 48		Key Terms 106

Exercises 106

2-3 Names and Formulas of Some Ionic Compounds 49

		CONTENTS	vi
4	The Structure of Atoms 115	CHEMICAL REACTIONS AND PERIODICITY	190
OUDAT		5-8 Hydrogen and the Hydrides 190	
	OMIC PARTICLES 116	5-9 Oxygen and the Oxides 193 Key Terms 201	
4-1	Fundamental Particles 116	Key Terms 201 Exercises 202	
4-2	The Discovery of Electrons 117		
4-3	Canal Rays and Protons 119	Some Types of Chemical	
4-4	Rutherford and the Nuclear Atom 120	Some Types of Chemical Reactions 207	
4-5	Atomic Number 121	Nouvillia 201	
4-6	Neutrons 122	6-1 Aqueous Solutions: An Introduction	208
4-7	Mass Number and Isotopes 123	6-2 Reactions in Aqueous Solutions 215	
4-8	Mass Spectrometry and Isotopic Abundance 124	NAMING SOME INORGANIC COMPOUNDS	217
4-9	The Atomic Weight Scale and Atomic Weights 126	6-3 Naming Binary Compounds 217	
	CHEMISTRY IN USE: Stable Isotope Ratio	6-4 Naming Ternary Acids and Their Salts	219
	Analysis 127	CLASSIFYING CHEMICAL REACTIONS 22	2
4-10	The Periodic Table: Metals, Nonmetals, and Metalloids 129	6-5 Oxidation–Reduction Reactions: Intro	duction 222
TUE EI	ECTRONIC STRUCTURES OF ATOMS 134	6-6 Combination Reactions 225	
		6-7 Decomposition Reactions 226	
4-11	Electromagnetic Radiation 134	6-8 Displacement Reactions 227	
4-12	The Photoelectric Effect 138	CHEMISTRY IN USE: Troublesome Disp	lacement
4-13	Atomic Spectra and the Bohr Atom 138	Reactions 230	
	ENRICHMENT: The Bohr Theory and the Balmer-Rydberg Equation 141	6-9 Metathesis Reactions 232	
4-14		6-10 Gas-Formation Reactions 237	
4-15	The Quantum Mechanical Picture of the Atom 146	6-11 Summary of Reaction Types 238	
	ENRICHMENT: The Schrödinger Equation 147	Key Terms 240	
4-16	Quantum Numbers 147	Exercises 241	
4-17	Atomic Orbitals 148		
4-18	Electron Configurations 153	Chemical Bonding 249	
4-19	The Periodic Table and Electron Configurations 159	7-1 Lewis Dot Formulas of Atoms 250	
4-20	Paramagnetism and Diamagnetism 161	IONIC BONDING 251	
	Key Terms 162	7-2 Formation of Ionic Compounds 251	
	Exercises 164	ENRICHMENT: Introduction to Energy	Relationships in
		Ionic Bonding 256	, , , , , , , , , , , , , , , , , , , ,
5	Chemical Periodicity 173	COVALENT BONDING 258	
5-1	More About the Periodic Table 174	7-3 Formation of Covalent Bonds 258	
		7-4 Bond Lengths and Bond Energies 2	59
DEDIO	CHEMISTRY IN USE: The Periodic Table 175	7-5 Lewis Formulas for Molecules and Po	lyatomic
	DIC PROPERTIES OF THE ELEMENTS 177	Ions 260	
5-2	Atomic Radii 177	7-6 Writing Lewis Formulas: The Octet Rul	e 261

5-3 Ionization Energy 179

5-4 Electron Affinity 182

5-7 Oxidation States 187

186

5-5 Ionic Radii 184

5-6 Electronegativity

7-7 Formal Charges 267

Rule 269

7-9 Resonance 274

7-8 Writing Lewis Formulas: Limitations of the Octet

VIII CONTENTS

7-10 Polar and Nonpolar Covalent Bonds 276

7-12 The Continuous Range of Bonding

7-11 Dipole Moments 278

	lypes 219
	Key Terms 280
	Exercises 281
8	Molecular Structure and Covalent Bonding Theories 287
8-1	A Preview of the Chapter 288
8-2	Valence Shell Electron Pair Repulsion Theory 290
8-3	Polar Molecules: The Influence of Molecular Geometry 292
8-4	Valence Bond Theory 293
MOLEC	JLAR SHAPES AND BONDING 294
8-5	Linear Electronic Geometry: AB ₂ Species (No Lone Pairs on A) 295
8-6	Trigonal Planar Electronic Geometry: AB_3 Species (No Lone Pairs on A) $$ 297
8-7	Tetrahedral Electronic Geometry: AB ₄ Species (No Lone Pairs on A) 299
8-8	Tetrahedral Electronic Geometry: AB_3U Species (One Lone Pair on A) 304
8-9	Tetrahedral Electronic Geometry: AB_2U_2 Species (Two Lone Pairs on A) 308
8-10	Tetrahedral Electronic Geometry: ABU_3 Species (Three Lone Pairs on A) 310
8-11	Trigonal Bipyramidal Electronic Geometry: AB_5 , AB_4U , AB_3U_2 , and AB_2U_3 310
8-12	Octahedral Electronic Geometry: AB_8 , AB_5U , AB_4U_2 314
8-13	Lone Pairs on the Central Atom—A Summary 315
8-14	Compounds Containing Double Bonds 317
8-15	Compounds Containing Triple Bonds 319
8-16	A Summary of Electronic and Molecular Geometries 320
	Key Terms 322 Exercises 323
9	Molecular Orbitals in Chemical Bonding 329
9-1	Molecular Orbitals 330

9-3	Bond	Order	and	Bond	Stability	335
-----	------	-------	-----	------	-----------	-----

- 9-4 Homonuclear Diatomic Molecules 335
- 9-5 Heteronuclear Diatomic Molecules 339
- 9-6 Delocalization and the Shapes of Molecular Orbitals 341 Key Terms 343

Key Terms 343 Exercises 344

Reactions in Aqueous Solutions I: Acids, Bases, and Salts 347

- 10-1 Properties of Aqueous Solutions of Acids and Bases 349
- 10-2 The Arrhenius Theory 349
- 10-3 The Hydronium Ion (Hydrated Hydrogen Ion) 350
- 10-4 The Brønsted-Lowry Theory 350
- 10-5 The Autoionization of Water 353
- 10-6 Amphoterism 354
- 10-7 Strengths of Acids 355
- 10-8 Acid—Base Reactions in Aqueous
 Solutions 358

 CHEMISTRY IN USE: Everyday Salts of Ternary
 Acids 360
- 10-9 Acidic Salts and Basic Salts 361
- 10-10 The Lewis Theory 363
- 10-11 The Preparation of Acids 365

 Key Terms 367

 Exercises 367

Reactions in Aqueous Solutions II: Calculations 375

AQUEOUS ACID-BASE REACTIONS 376

- 11-1 Calculations Involving Molarity 376
- 11-2 Titrations 380
- 11-3 Calculations for Acid—Base Titrations 382

OXIDATION-REDUCTION REACTIONS 386

- 11-4 Balancing Redox Equations 387
- 11-5 Adding H⁺, OH[−], or H₂O to Balance Oxygen or Hydrogen 388
- 11-6 Calculations for Redox Titrations 390

 Key Terms 393

 Exercises 393

9-2 Molecular Orbital Energy Level Diagrams 333

CONTENTS

(y	12		Kinetic-Molecula
	44	Theory 401	

- 12-1 Comparison of Solids, Liquids, and Gases 402
- 12-2 Composition of the Atmosphere and Some Common Properties of Gases 403
- 12-3 Pressure 403
- 12-4 Boyle's Law: The Volume—Pressure Relationship 405
 CHEMISTRY IN USE: The Greenhouse Effect and
 Climate Change 406
- 12-5 Charles's Law: The Volume—Temperature Relationship; The Absolute Temperature Scale 410
- 12-6 Standard Temperature and Pressure 412
- 12-7 The Combined Gas Law Equation 412
- 12-8 Avogadro's Law and the Standard Molar Volume 414
- 12-9 Summary of Gas Laws: The Ideal Gas Equation 415
- 12-10 Determination of Molecular Weights and Molecular Formulas of Gaseous Substances 419
- 12-11 Dalton's Law of Partial Pressures 420
- 12-12 Mass-Volume Relationships in Reactions Involving Gases 426
- 12-13 The Kinetic-Molecular Theory 428

 ENRICHMENT: Kinetic-Molecular Theory, the Ideal Gas
 Equation, and Molecular Speeds 431
- 12-14 Diffusion and Effusion of Gases 433
- 12-15 Deviations from Ideal Gas Behavior 435
 Key Terms 438
 Exercises 439

13 Liquids and Solids 449

- 13-1 Kinetic-Molecular Description of Liquids and Solids 450
- 13-2 Intermolecular Attractions and Phase Changes 451

THE LIQUID STATE 458

- 13-3 Viscosity 459
- 13-4 Surface Tension 460
- 13-5 Capillary Action 460
- 13-6 Evaporation 461
- 13-7 Vapor Pressure 462
- 13-8 Boiling Points and Distillation 464
- 13-9 Heat Transfer Involving Liquids 465
 ENRICHMENT: The Clausius—Clapeyron Equation 467

THE SOLID STATE 469

- 13-10 Melting Point 469
- 13-11 Heat Transfer Involving Solids 469
- 13-12 Sublimation and the Vapor Pressure of Solids 472
- 13-13 Phase Diagrams (P versus T) 472
- 13-14 Amorphous Solids and Crystalline Solids 475 ENRICHMENT: X-Ray Diffraction 476
- 13-15 Structures of Crystals 478
- 13-16 Bonding in Solids 481
- 13-17 Band Theory of Metals 489
 CHEMISTRY IN USE: Semiconductors 492
 Key Terms 494

Solutions 505

Exercises

THE DISSOLUTION PROCESS 506

- 14-1 Spontaneity of the Dissolution Process 506
- 14-2 Dissolution of Solids in Liquids 508
- 14-3 Dissolution of Liquids in Liquids (Miscibility) 510
- 14-4 Dissolution of Gases in Liquids 512
- 14-5 Rates of Dissolution and Saturation 513
- 14-6 Effect of Temperature on Solubility 514
- 14-7 Effect of Pressure on Solubility 515
- 14-8 Molality and Mole Fraction 516

COLLIGATIVE PROPERTIES OF SOLUTIONS 517

- 14-9 Lowering of Vapor Pressure and Raoult's Law 518
- 14-10 Fractional Distillation 522
- 14-11 Boiling Point Elevation 523
- 14-12 Freezing Point Depression 525
- 14-13 Determination of Molecular Weight by Freezing Point Depression or Boiling Point Elevation 526
- 14-14 Colligative Properties and Dissociation of Electrolytes 527
- 14-15 Osmotic Pressure 531

COLLOIDS 535

- 14-16 The Tyndall Effect 535
- 14-17 The Adsorption Phenomenon 535

CHEMISTRY IN USE: Water Purification and Hemodialysis 536

X CONTENTS

14-18	Hydrophilic and Hydrophobic Colloids 539	16-5	Collision Theory of Reaction Rates 638
	CHEMISTRY IN USE: Why Does Red Wine Go with Red	16-6	·
	Meat? 542	16-7	
	Key Terms 542		Expression 640
	Exercises 543	16-8	Temperature: The Arrhenius Equation 643
		16-9	Catalysts 647
15	Chemical Thermodynamics 551		CHEMISTRY IN USE: Ozone 654
HEAT (CHANGES AND THERMOCHEMISTRY 553		Key Terms 656
15-1	The First Law of Thermodynamics 553		Exercises 657
15-2	•	763	
15-3	Enthalpy Changes 556		Chemical Equilibrium 667
15-4	Calorimetry: Measurement of Heat Transfer 556	17-1	Basic Concepts 668
15-5	Thermochemical Equations 558	17-2	•
15-6	Standard States and Standard Enthalpy Changes 561	17-3	
15-7	Standard Molar Enthalpies of Formation, ΔH_f^0 562		Equation 673
15-8	Hess's Law 564	17-4	The Reaction Quotient 674
15-9	Bond Energies 568	17-5	Uses of the Equilibrium Constant, K _c 676
15-10	Changes in Internal Energy, ΔE 571	17-6	Disturbing a System at Equilibrium: Predictions 679
15-11	Relationship Between ΔH and ΔE 577	17-7	The Haber Process: A Commercial Application of
SPONT	ANEITY OF PHYSICAL AND CHEMICAL		Equilibrium 686
	CHANGES 578	17-8	a cyclem at Equition and additions 000
	The Two Aspects of Spontaneity 579	17-9	
15-13	Dispersal of Energy and Matter 580	17-10	Relationship between $K_{\rm p}$ and $K_{\rm c}$ 692
15-14	Entropy, S, and Entropy Change, ΔS 583	17-11	Heterogeneous Equilibria 694
15-15	The Second Law of Thermodynamics 589	17-12	Relationship between ΔG_{rxn}^0 and the Equilibrium
15-16	Free Energy Change, ΔG , and	17 19	Constant 695
15 17	Spontaneity 591	17-13	Evaluation of Equilibrium Constants at Different Temperatures 699
15-17	The Temperature Dependence of Spontaneity 594		Key Terms 700
	Key Terms 598 Exercises 599		Exercises 700
	2.0000000		
16	Chemical Kinetics 611	e 18	lonic Equilibria I: Acids and Bases 709
16-1	The Rate of a Reaction 613	10 1	A Deview of Change Et al. 1.1. 740
FACTOR	RS THAT AFFECT REACTION RATES 618		A Review of Strong Electrolytes 710
16-2	Nature of the Reactants 619	18-2	The Autoionization of Water 711
16-3	Concentrations of Reactants: The Rate-Law	18-3	The pH and pOH Scales 713
	Expression 619	18-4	Ionization Constants for Weak Monoprotic Acids and Bases 717
16-4	Concentration Versus Time: The Integrated Rate	18-5	Polyprotic Acids 729
	Equation 627	18-6	Solvolysis 732
	ENRICHMENT: Calculus Derivation of Integrated Rate Equations 633	18-7	Salts of Strong Bases and Strong Acids 733
	ENRICHMENT: Using Integrated Rate Equations to		Salts of Strong Bases and Weak Acids 733
	Determine Reaction Order 634		Salts of Weak Bases and Strong Acids 736

CONTENTS XI

	- · · · · · · · · · · · · · · · · · · ·		
18-10	Salts of Weak Bases and Weak Acids 737	ELECTROLYTIC CELLS 805	
	CHEMISTRY IN USE: Taming Dangerous Acids with Harmless Salts 738	21-3 The Electrolysis of Molten Sodium Chloride (The Downs Cell) 806)
18-11	Salts That Contain Small, Highly Charged	21-4 The Electrolysis of Aqueous Sodium Chloride 8	807
	Cations 740	21-5 The Electrolysis of Aqueous Sodium Sulfate 808	
	Key Terms 742 Exercises 742	21-6 Counting Electrons: Coulometry and Faraday's L Electrolysis 808	.aw of
19	lonic Equilibria II: Buffers and Titration Curves 749	CHEMISTRY IN USE: A Spectacular View of One I of Electrons 810	Mole
		21-7 Commercial Applications of Electrolytic Cells	811
19-1	The Common Ion Effect and Buffer Solutions 750	VOLTAIC OR GALVANIC CELLS 811	
19-2	Buffering Action 756	21-8 The Construction of Simple Voltaic Cells 812	
19-3	Preparation of Buffer Solutions 759	21-9 The Zinc-Copper Cell 813	
,,,,		21-10 The Copper-Silver Cell 815	
10.4	CHEMISTRY IN USE: Fun with Carbonates 762	STANDARD ELECTRODE POTENTIALS 816	
19-4	Acid-Base Indicators 763	21-11 The Standard Hydrogen Electrode 817	
	ION CURVES 765	21-12 The Zinc-SHE Cell 817	
19-5	Strong Acid/Strong Base Titration Curves 765	21-13 The Copper-SHE Cell 818	
19-6	Weak Acid/Strong Base Titration Curves 768	21-14 Standard Electrode Potentials 819	
19-7		21-15 Uses of Standard Electrode Potentials 821	
19-8	Summary of Acid—Base Calculations 771	21-16 Standard Electrode Potentials for Other Half-	
	Key Terms 772 Exercises 773	Reactions 823	
	LAGIGISES 113	21-17 Corrosion 825	
20	Landa Familiania TTT TI 0 1 199	21-18 Corrosion Protection 827	
20	lonic Equilibria III: The Solubility Product Principle 779	EFFECT OF CONCENTRATIONS (OR PARTIAL PRESSU ON ELECTRODE POTENTIALS 827	URES)
20-1	Solubility Product Constants 780	21-19 The Nernst Equation 827	
20-2 20-3	Determination of Solubility Product Constants 782 Uses of Solubility Product Constants 784	21-20 Using Electrochemical Cells to Determine Concentrations 832	
	ENRICHMENT: The Effects of Hydrolysis on	ENRICHMENT: Concentration Cells 834	
	Solubility 787	21-21 The Relationship of $m{\mathcal{E}}_{\text{cell}}^{0}$ to $\Delta m{\mathcal{G}}^{0}$ and $m{\mathcal{K}}_{\!\!\!\!\!\!\text{eq}}$ 835	
20-4	Fractional Precipitation; $Q_{sp} \ge K_{sp}$ 790	PRIMARY VOLTAIC CELLS 836	
20-5	·	21-22 Dry Cells 837	
	Compounds 792	SECONDARY VOLTAIC CELLS 838	
20-6	Dissolving Precipitates; $Q_{\rm sp} < K_{\rm sp}$ 795	21-23 The Lead Storage Battery 838	
	Key Terms 797	21-24 The Nickel-Cadmium (Nicad) Cell 840	
	Exercises 798	21-25 The Hydrogen—Oxygen Fuel Cell 840	
21	Electrochemistry 803	Key Terms 842 Exercises 843	

(4

21-1 Electrical Conduction 805

21-2 Electrodes 805

AII	***************************************		
- 00	1 01 054	FUNCTIONAL GROUPS 911	
e 22	Nuclear Chemistry 851	23-8 Organic Halides 911	
22-	1 The Nucleus 853	23-9 Alcohols and Phenols 913	
22-	2 Neutron–Proton Ratio and Nuclear Stability 853	CHEMISTRY IN USE: Developing	g More Environmentally
22-	3 Nuclear Stability and Binding Energy 854	Friendly Solvents 914	
22-	4 Radioactive Decay 857	23-10 Ethers 918	
22-	5 Equations for Nuclear Reactions 858	23-11 Aldehydes and Ketones 918	
22-	* ***	23-12 Amines 921	
	of Stability) 859	23-13 Carboxylic Acids 922	
22-	7 Neutron-Poor Nuclei (Below the Band of Stability) 859	CHEMISTRY IN USE: The Chem Pigments 924	istry of Artists'
22-	8 Nuclei with Atomic Number Greater Than 83 860	23-14 Some Derivatives of Carboxylic	
22-	9 Detection of Radiation 861	CHEMISTRY IN USE: Butter, Ma	argarine, and <i>trans</i>
22-1	O Rates of Decay and Half-Life 863	Fats 930 23-15 Summary of Functional Group	e 03N
22-1	1 Decay Series 865	FUNDAMENTAL CLASSES OF ORGA	
22-1	2 Uses of Radionuclides 865	23-16 Substitution Reactions 932	NO REACTIONS OF
	CHEMISTRY IN USE: Household Radon Exposure and	23-17 Addition Reactions 935	
	Lung Cancer 869	23-18 Elimination Reactions 937	
22-1	13 Artificial Transmutations of Elements 871	23-19 Polymerization Reactions 9	38
22-	14 Nuclear Fission 874	Key Terms 943	
22-	15 Nuclear Fission Reactors 876	Exercises 944	
22-	16 Nuclear Fusion 879		
	CHEMISTRY IN USE: Managing Nuclear Wastes 880 Key Terms 882	Organic Chemistry I Reactions, and Biopo	I: Shapes, Selected olymers 953
	Exercises 883	•	-
		SHAPES OF ORGANIC MOLECULES	954
2	Organic Chemistry I: Formulas,	24-1 Constitutional Isomers 954	
4	Names, and Properties 887	24-2 Stereoisomers 955	
CAT	URATED HYDROCARBONS 890	24-3 Conformations 959	
••••	3-1 Alkanes and Cycloalkanes 890	SELECTED REACTIONS 960	. Aside and Bases OCO
	3-2 Naming Saturated Hydrocarbons 895	24-4 Reactions of Brønsted-Lowry	
	SATURATED HYDROCARBONS 899	24-5 Oxidation-Reduction Reactio	
	3-3 Alkenes 899	CHEMISTRY IN USE: Chemica	
2.	CHEMISTRY IN USE: Petroleum 900	24-6 Formation of Carboxylic Acid	Derivatives 968
0.		24-7 Hydrolysis of Esters 969	
	3-4 Alkynes 905 DMATIC HYDROCARBONS 906	BIOPOLYMERS 970	
	3-5 Benzene 906	24-8 Carbohydrates 971	074
	3-5 Benzene 900 3-6 Other Aromatic Hydrocarbons 907	24-9 Polypeptides and Proteins	9/4
2		24-10 Nucleic Acids 978	
_	CHEMISTRY IN USE: Nanotechnology 908	CHEMISTRY IN USE: The Ceil	s' Drinking Straws 979
2	3-7 Hydrocarbons: A Summary 910	Key Terms 982	

Exercises 983

CONTENTS XIII

25	Coordination Compounds 000	THE AL	KALINE EARTH METALS (GROUP 2A) 1042
Z J	Coordination Compounds 989	27-4	Group 2A Metals: Properties and Occurrence 1042
25-1	Coordination Compounds 990	27-5	Reactions of the Group 2A Metals 1042
25-2	Ammine Complexes 993	27-6	Uses of Group 2A Metals and Their Compounds 1043
25-3	Important Terms 994	THE PO	ST-TRANSITION METALS 1045
25-4	Nomenclature 995	27-7	Group 3A: Periodic Trends 1045
25-5	Structures 998		CHEMISTRY IN USE: The Most Valuable Metal in the
ISOMEI	RISM IN COORDINATION COMPOUNDS 998		World 1047
25-6	Structural (Constitutional) Isomers 999	THE d-	TRANSITION METALS 1048
25-7	Stereoisomers 1000	27-8	General Properties 1049
BONDI	NG IN COORDINATION COMPOUNDS 1006	27-9	Oxidation States 1049
25-8	Crystal Field Theory 1006	27-10	Chromium Oxides, Oxyanions, and Hydroxides 1050
25-9	Color and the Spectrochemical Series 1008		CHEMISTRY IN USE: Our Love—Hate Relationship with
	Key Terms 1010		Mercury 1052
	Exercises 1011		Key Terms 1053 Exercises 1053
26	Metals I: Metallurgy 1017		
METAL		28	Some Nonmetals and Metalloids 1057
26-1	Occurrence of the Metals 1018	TUE N	ODLE CASES (CDOUD OA) 1050
	LURGY 1018		OBLE GASES (GROUP 8A) 1058
	Pretreatment of Ores 1019	28-1	
26-3	Reduction to the Free Metals 1021		Xenon Compounds 1059
26-4	5		ALOGENS (GROUP 7A) 1059
	LURGIES OF SPECIFIC METALS 1023		Properties 1060
26-5	Magnesium 1023	28-4	, ,
26-6	Aluminum 1024		Reactions of the Free Halogens 1062
26-7	Iron 1026		The Hydrogen Halides and Hydrohalic Acids 1063
26-8	Copper 1028	28-7	The Oxoacids (Ternary Acids) of the Halogens 1064
26-9	Gold 1029		R, SELENIUM, AND TELLURIUM 1065
	Key Terms 1030 Exercises 1030		Occurrence, Properties, and Uses 1065
	LAGICISES 1000	28-9	· ·
27	Motale II. Draparties and	28-10	·
41	Metals II: Properties and Reactions 1035	28-11	Group 6A Oxides 1068
		28-12	
THE A	LKALI METALS (GROUP 1A) 1036		GEN AND PHOSPHORUS 1070
27-1	Group 1A Metals: Properties and Occurrence 1036		Occurrence of Nitrogen 1071
27-2	Reactions of the Group 1A Metals 1037	28-14	-
	CHEMISTRY IN USE: Trace Elements and Life 1038	28-15	,
27-3	Uses of Group 1A Metals and Their Compounds 1041		CHEMISTRY IN USE: Nitrogen Oxides and Photochemical Smog 1075

XIV CONTENTS

28-16 Some Oxoacids of Nitrogen and Their Salts 1076		APPENDIX G	Ionization Constants for Weak Bases	
28-17 Phospi	norus 1077		at 25°C A-20	
SILICON 107	78	APPENDIX H	Solubility Product Constants for Some	
28-18 Silicon	and the Silicates 1078		Inorganic Compounds at 25°C A-21	
Key Tei Exercis		APPENDIX I	Dissociation Constants for Some Complex lons A-23	
APPENDIX A	Some Mathematical Operations A-1	APPENDIX J	Standard Reduction Potentials in Aqueous Solution at 25°C A-24	
APPENDIX B	Electronic Configurations of the Atoms of the Elements A-9	APPENDIX K	Selected Thermodynamic Values at 298.15 K A-27	
APPENDIX C	Common Units, Equivalences, and Conversion Factors A-12	(3) APPENDIX L	Answers to Selected Even-Numbered Numerical Exercises A-30	
APPENDIX D Physical Constants A-15		Index of Equations E-1		
APPENDIX E	Some Physical Constants for a Few Common Substances A-16	Glossary/Inde		
APPENDIX F	Ionization Constants for Weak Acids			