

# Contents

<b>Introduction</b> .....	<b>1</b>
About This Book .....	1
Conventions Used in This Book .....	2
Foolish Assumptions .....	2
Icons Used in This Book .....	3
Where to Go from Here .....	3
<b>Chapter 1: Matter and Energy: Exploring the Stuff of Chemistry</b> .....	<b>5</b>
Knowing the States of Matter and Their Changes .....	6
Solids, liquids, and gases .....	6
Solids .....	6
Liquids .....	7
Gases .....	7
Condensing and freezing .....	7
Melting and boiling .....	8
From solid to liquid .....	8
From liquid to gas .....	9
Skipping liquids: Sublimation .....	9
Pure Substances and Mixtures .....	10
Pure substances .....	10
Elements .....	10
Compounds .....	11
Throwing mixtures into the mix .....	11
Measuring Matter .....	12
Nice Properties You've Got There .....	13
Energy Types .....	14
Kinetic energy .....	14
Potential energy .....	15
Temperature and Heat .....	15
<b>Chapter 2: What's In an Atom?</b> .....	<b>17</b>
Subatomic Particles .....	17
Centering on the Nucleus .....	19
Locating Those Electrons .....	21
The quantum mechanical model .....	21
The principal quantum number $n$ .....	22
The angular momentum quantum number $l$ .....	23

The magnetic quantum number $m_l$ .....	25
The spin quantum number $m_s$ .....	25
Putting the quantum numbers together .....	25
Energy level diagrams .....	26
The dreaded energy level diagram .....	27
Electron configurations .....	29
Valence electrons: Clues about chemical reactions .....	30
Isotopes and Ions .....	30
Isotopes: Varying neutrons .....	31
Ions: Varying electrons .....	32
Gaining and losing electrons .....	32
Writing electron configurations .....	33
Predicting types of bonds .....	33
<b>Chapter 3: The Periodic Table .....</b>	<b>35</b>
Repeating Patterns: The Modern Periodic Table .....	35
Arranging Elements in the Periodic Table .....	38
Grouping metals, nonmetals, and metalloids .....	38
Metals .....	38
Nonmetals .....	40
Metalloids .....	40
Arranging elements by families and periods .....	41
<b>Chapter 4: Nuclear Chemistry .....</b>	<b>43</b>
Seeing How the Atom's Put Together .....	43
Dealing with a Nuclear Breakup: Balancing Reactions .....	44
Understanding Types of Natural Radioactive Decay .....	46
Alpha emission .....	47
Beta emission .....	48
Gamma emission .....	48
Positron emission .....	49
Electron capture .....	49
Half-Lives and Radioactive Dating .....	50
Calculating remaining radioactivity .....	51
Radioactive dating .....	51
Breaking Elements Apart with Nuclear Fission .....	52
Mass defect: Where does all that energy come from? .....	52
Chain reactions and critical mass .....	53
Coming Together with Nuclear Fusion .....	54

<b>Chapter 5: Ionic Bonding</b> .....	<b>55</b>
Forming Ions: Making Satisfying Electron Trades .....	55
Gaining and losing electrons .....	56
Losing an electron to become a cation: Sodium .....	56
Gaining an electron to become an anion: Chlorine .....	57
Looking at charges on single-atom ions .....	58
Seeing some common one-atom ions .....	58
Possible charges: Naming ions with multiple oxidation states .....	59
Grouping atoms to form polyatomic ions .....	61
Creating Ionic Compounds .....	62
Making the bond: Sodium metal + chlorine gas = sodium chloride .....	63
Figuring out the formulas of ionic compounds.....	63
Balancing charges: Magnesium and bromine .....	64
Using the crisscross rule.....	65
Naming ionic compounds .....	66
Dealing with multiple oxidation states .....	66
Getting names from formulas and formulas from names .....	67
Bonding Clues: Electrolytes and Nonelectrolytes.....	68
<b>Chapter 6: Covalent Bonding</b> .....	<b>69</b>
Covalent Bond Basics .....	69
Sharing electrons: A hydrogen example .....	69
Why atoms have to share.....	70
Representing covalent bonds .....	71
Comparing covalent bonds with other bonds .....	71
Dealing with multiple bonds .....	72
Naming Covalent Compounds Made of Two Elements .....	74
Writing Covalent Compound Formulas.....	75
Empirical formulas .....	75
Molecular or true formulas .....	75
Structural formulas: Dots and dashes.....	76
Basic bonds: Writing the electron-dot and Lewis formulas .....	77
Double bonds: Writing structural formulas for $C_2H_4O$ .....	79
Grouping atoms with the condensed structural formula .....	81

Electronegativities: Which Atoms Have More Pull? .....	82
Predicting the type of bond.....	82
Polar covalent bonding: Creating partial charges.....	84
Attracting other molecules: Intermolecular forces... ..	86
<b>Chapter 7: Chemical Reactions. ....</b>	<b>87</b>
Reactants and Products: Reading Chemical Equations .....	87
Collision Theory: How Reactions Occur .....	89
Hitting the right spot.....	89
Adding, releasing, and absorbing energy .....	90
Exothermic reactions: Releasing heat .....	90
Endothermic reactions: Absorbing heat .....	92
Types of Reactions .....	92
Combination reactions: Coming together .....	93
Decomposition reactions: Breaking down.....	93
Single displacement reactions:	
Kicking out another element .....	93
Using the activity series .....	94
Writing ionic and net-ionic equations.....	94
Double displacement reactions: Trading places .....	95
Precipitation reactions: Forming solids .....	95
Neutralization reactions: Forming water.....	97
Combustion reactions: Burning .....	97
Redox reactions: Exchanging electrons.....	97
Balancing Chemical Equations .....	98
Balancing the Haber process .....	99
Balancing the burning of butane.....	100
Knowing Chemical Equilibrium	
Backwards and Forwards.....	101
Matching rates of change in the Haber process .....	102
Constants: Comparing amounts	
of products and reactants .....	103
Le Chatelier's Principle: Getting More	
(or Less) Product .....	104
Changing the concentration.....	104
Changing the temperature.....	105
Changing the pressure .....	105
Chemical Kinetics: Changing Reaction Speeds .....	106
Seeing How Catalysts Speed Up Reactions.....	108
Heterogeneous catalysis: Giving reactants	
a better target.....	109
Homogeneous catalysis: Offering an easier path ....	110

**Chapter 8: Electrochemistry: Using Electrons . . . . . 111**

Transferring Electrons with Redox Reactions .....	111
Oxidation .....	112
Loss of electrons .....	112
Gain of oxygen .....	113
Loss of hydrogen .....	113
Reduction.....	113
Gain of electrons.....	113
Loss of oxygen .....	114
Gain of hydrogen .....	114
One's loss is the other's gain .....	114
Oxidation numbers.....	115
Balancing Redox Equations .....	117
Exploring Electrochemical Cells .....	121
Galvanic cells: Getting electricity from chemical reactions .....	121
Electrolytic cells: Getting chemical reactions from electricity .....	123
Having it both ways with rechargeable batteries....	123

**Chapter 9: Measuring Substances with the Mole. . . . . 125**

Counting by Weighing .....	125
Moles: Putting Avogadro's Number to Good Use .....	127
Defining the mole.....	127
Calculating weight, particles, and moles .....	128
Finding formulas of compounds .....	129
Chemical Reactions and Moles .....	130
Reaction stoichiometry.....	131
Percent yield .....	132
Limiting reactants.....	133

**Chapter 10: A Salute to Solutions. . . . . 135**

Mixing Things Up with Solutes, Solvents, and Solutions .....	135
How dissolving happens .....	136
Concentration limits.....	136
Saturated facts .....	137
Understanding Solution Concentration Units .....	138
Percent composition .....	138
Weight/weight percentage .....	139
Weight/volume percentage .....	139
Volume/volume percentage.....	140

Molarity: Comparing solute to solution.....	141
Diluting solutions to the right molarity.....	142
Molarity in stoichiometry: Figuring out how much you need.....	143
Molality: Comparing solute to solvent.....	143
Parts per million .....	144
<b>Chapter 11: Acids and Bases.....</b>	<b>145</b>
Observing Properties of Acids and Bases .....	145
The Brønsted-Lowry Acid-Base Theory .....	146
Understanding Strong and Weak Acids and Bases.....	147
Strong: Ionizing all the way .....	147
Hydrogen chloride and other strong acids....	148
Strong bases: Hydroxide ions .....	149
Weak: Ionizing partially.....	149
Acetic acid and other weak acids.....	150
Weak bases: Ammonia .....	152
Acid-Base Reactions: Using the Brønsted-Lowry System .....	152
Acting as either an acid or base: Amphoteric water .....	153
Showing True Colors with Acid-Base Indicators.....	154
Doing a quick color test with litmus paper .....	154
Phenolphthalein: Finding concentration with titration.....	155
Phun with the pH Scale .....	156
<b>Chapter 12: Clearing the Air on Gases.....</b>	<b>159</b>
The Kinetic Molecular Theory: Assuming Things about Gases .....	159
Relating Physical Properties with Gas Laws .....	162
Boyle's law: Pressure and volume.....	163
Charles's law: Volume and temperature.....	164
Gay-Lussac's Law: Pressure and temperature.....	165
The combined gas law: Pressure, volume, and temp.....	166
Avogadro's Law: The amount of gas .....	167
The ideal gas equation: Putting it all together.....	169
<b>Chapter 13: Ten Serendipitous Discoveries     in Chemistry.....</b>	<b>171</b>
Archimedes: Streaking Around .....	171
Vulcanization of Rubber.....	172
Molecular Geometry .....	172

141 ..... Mauve Dye ..... 172

142 ..... Kekulé: The Beautiful Dreamer ..... 173

143 ..... Discovering Radioactivity ..... 173

144 ..... Finding Really Slick Stuff: Teflon ..... 173

145 ..... Stick 'Em Up! Sticky Notes ..... 174

146 ..... Growing Hair ..... 174

147 ..... Sweeter Than Sugar ..... 174

**Index ..... 175**