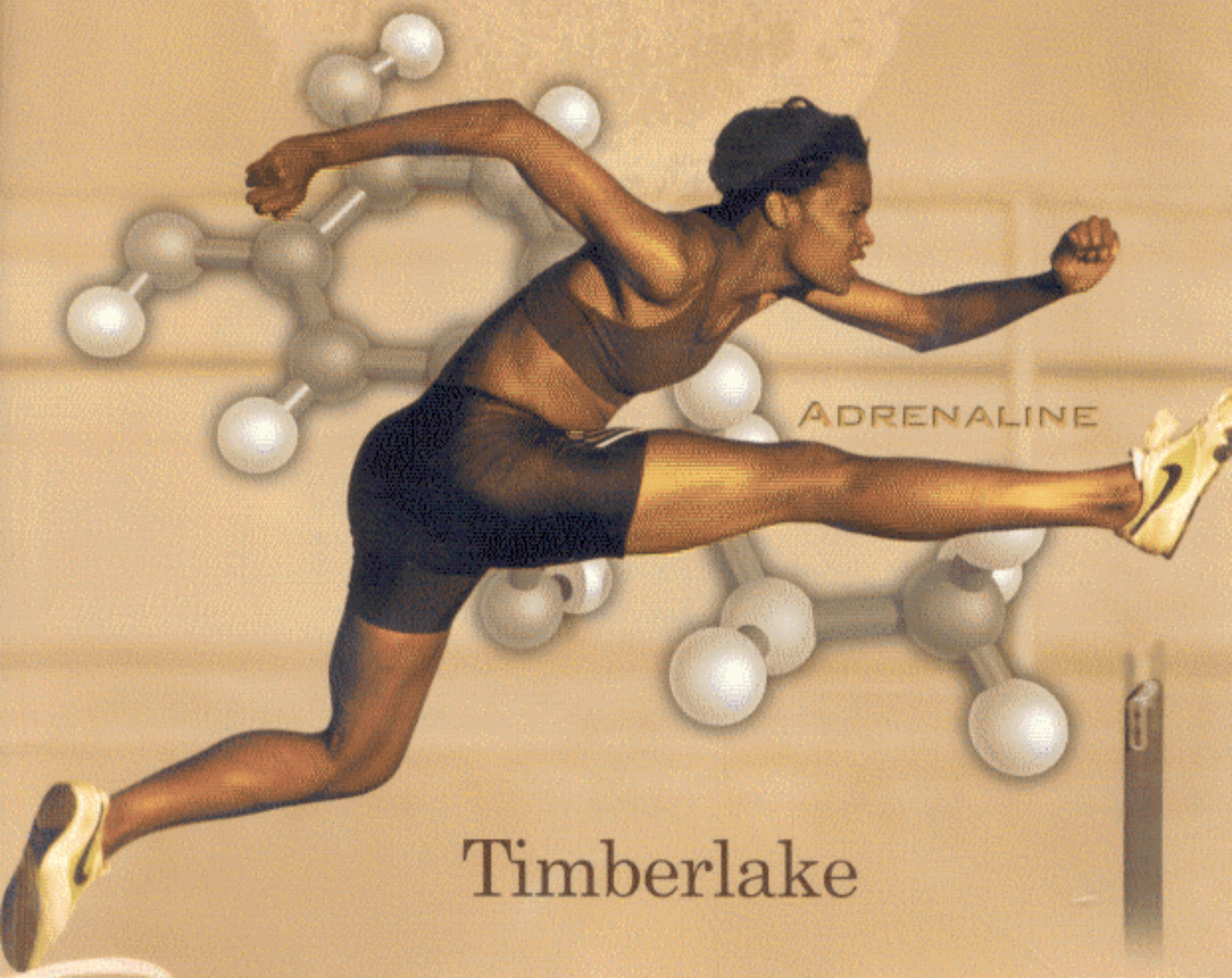


Eighth Edition

INTERNATIONAL
EDITION

Chemistry

An Introduction to
General, Organic, & Biological Chemistry



ADRENALINE

Timberlake

Contents

1 Measurements 2

- 1.1 Units of Measurement 4
 - EXPLORE YOUR WORLD
 - Units Listed on Labels 6
- 1.2 Measured Numbers and Significant Figures 8
- 1.3 Significant Figures in Calculations 11
- 1.4 Prefixes and Equalities 14
- 1.5 Problem Solving Using Conversion Factors 18
 - EXPLORE YOUR WORLD
 - SI and Metric Equalities on Product Labels 20
 - CAREER FOCUS
 - Veterinary Technician (VT) 24
- 1.6 Density 25
 - EXPLORE YOUR WORLD
 - Sink or Float? 28
 - HEALTH NOTE
 - Determination of Percentage of Body Fat 29
 - HEALTH NOTE
 - Specific Gravity of Urine 30
- 1.7 Temperature 30
 - CAREER FOCUS
 - Surgical Technologist 32
 - HEALTH NOTE
 - Variation in Body Temperature 33
 - Chapter Review 34
 - Key Terms 35
 - Additional Problems 35
 - Answers 36

2 Atoms and Elements 38

- 2.1 Elements and Symbols 40
 - HEALTH NOTE
 - Elements Essential to Health 42
- 2.2 The Periodic Table 43

HEALTH NOTE

Some Important Trace Elements in the Body 46

- 2.3 The Atom 48
 - EXPLORE YOUR WORLD
 - Repulsion and Attraction 50
- 2.4 Atomic Number and Mass Number 51
 - CAREER FOCUS
 - Optician 52
- 2.5 Isotopes 54
- 2.6 Electron Energy Levels 57
- Chapter Review 62
- Key Terms 62
- Additional Problems 63
- Answers 64

3 Nuclear Radiation 66

- 3.1 Radioactivity 68
 - HEALTH NOTE
 - Biological Effects of Radiation 70
- 3.2 Nuclear Equations 72
 - EXPLORE YOUR WORLD
 - Smoke Detectors 74
 - HEALTH NOTE
 - Beta Emitters in Medicine 75
- 3.3 Radiation Measurement 78
 - HEALTH NOTE
 - Radiation and Food 79
 - ENVIRONMENTAL NOTE
 - Radon in Our Homes 81
- 3.4 Half-Life of a Radioisotope 82
 - EXPLORE YOUR WORLD
 - Modeling Half-Lives 83
 - ENVIRONMENTAL NOTE
 - Dating Ancient Objects 84
- 3.5 Medical Applications Using Radioactivity 85
 - HEALTH NOTE
 - Radiation Doses in Diagnostic and Therapeutic Procedures 87

HEALTH NOTE

Other Imaging Methods 88

3.6 Nuclear Fission and Fusion 89

ENVIRONMENTAL NOTE

Nuclear Power Plants 91

Chapter Review 92

Key Terms 92

Additional Problems 93

Answers 94

4 Compounds and Their Bonds 96

4.1 Valence Electrons 97

4.2 Octet Rule and Ions 100

HEALTH NOTE

Some Uses for Noble Gases 101

HEALTH NOTE

Some Important Ions
in the Body 103

4.3 Ionic Compounds 104

CAREER FOCUS

Physical Therapist 106

4.4 Naming Ionic Compounds 107

4.5 Polyatomic Ions 111

HEALTH NOTE

Polyatomic Ions in Bones and
Teeth 113

ENVIRONMENTAL NOTE

Chemistry of Fertilizers 116

4.6 Covalent Compounds 116

4.7 Bond Polarity 122

4.8 Shapes and Polarity of Molecules 126

HEALTH NOTE

The Chemical Sense of Taste and
Smell 130

Chapter Review 131

Key Terms 131

Additional Problems 132

Answers 133

5 Chemical Reactions and Quantities 136

5.1 Chemical Changes 138

5.2 Chemical Equations 140

5.3 Types of Reactions 144

HEALTH NOTE

Smog and Health Concerns 147

5.4 Oxidation–Reduction Reactions 148

EXPLORE YOUR WORLD

Oxidation of Fruits
and Vegetables 150

5.5 The Mole 151

5.6 Molar Mass 153

EXPLORE YOUR WORLD

Calculating Moles
in the Kitchen 156

5.7 Mole Relationships in Chemical Equations 158

5.8 Mass Calculations for Reactions 162

CAREER FOCUS

Clinical Laboratory Scientist 163

Chapter Review 164

Key Terms 165

Additional Problems 165

Answers 166

6 Energy and Matter 168

6.1 Energy and Heat 169

ENVIRONMENTAL NOTE

Global Warming 171

6.2 Energy and Nutrition 173

HEALTH NOTE

Losing and Gaining Weight 175

EXPLORE YOUR WORLD

Counting Calories 175

6.3 States of Matter 176

6.4 Changes of State 178

CAREER FOCUS

Histologist 179

6.5 Energy in Chemical Reactions 184

HEALTH NOTE

Hot Packs and Cold Packs 185

6.6 Chemical Equilibrium 188

HEALTH NOTE

Oxygen–Hemoglobin Equilibrium
and Hypoxia 191

HEALTH NOTE

Oxygen, Hemoglobin, and Carbon
Monoxide Poisoning 192

Chapter Review 193

Key Terms 193

Additional Problems 194

Answers 195

7 Gases 198

- 7.1 Gases and Kinetic Molecular Theory 200
 - EXPLORE YOUR WORLD
 - Forming a Gas 201
- 7.2 Gas Pressure 201
 - HEALTH NOTE
 - Measuring Blood Pressure 203
- 7.3 Pressure and Volume (Boyle's Law) 204
 - HEALTH NOTE
 - Pressure–Volume Relationship in Breathing 207
- 7.4 Temperature and Volume (Charles' Law) 208
- 7.5 Temperature and Pressure (Gay-Lussac's Law) 211
 - CAREER FOCUS
 - Nurse Anesthetist 212
- 7.6 The Combined Gas Law 212
- 7.7 Volume and Moles (Avogadro's Law) 214
- 7.8 Partial Pressures (Dalton's Law) 217
 - HEALTH NOTE
 - Blood Gases 219
 - HEALTH NOTE
 - Hyperbaric Chambers 220
- Chapter Review 221
- Key Terms 222
- Additional Problems 222
- Answers 223

8 Solutions 226

- 8.1 Types of Solutions 228
 - HEALTH NOTE
 - Water in the Body 230
- 8.2 Formation of Solutions 231
 - EXPLORE YOUR WORLD
 - Like Dissolves Like 233
- 8.3 Solubility and Saturated Solutions 233
 - HEALTH NOTE
 - Gout and Kidney Stones: A Problem of Saturation in Body Fluids 234
 - EXPLORE YOUR WORLD
 - Preparing Solutions 235
- 8.4 Electrolytes 237

CAREER FOCUS

Orthopedic Physician Assistant 240

HEALTH NOTE

Electrolytes in Body Fluids 241

- 8.5 Percent Concentration 242
- 8.6 Molarity and Dilution 246
- 8.7 Colloids and Suspensions 252
 - HEALTH NOTE
 - Colloids and Solutions in the Body 253
- 8.8 Osmosis and Dialysis 255
 - EXPLORE YOUR WORLD
 - Everyday Osmosis 258
 - HEALTH NOTE
 - Dialysis by the Kidneys and the Artificial Kidney 259
- Chapter Review 260
- Key Terms 261
- Additional Problems 262
- Answers 262

9 Acids and Bases 266

- 9.1 Acids and Bases 267
- 9.2 Brønsted–Lowry Acids and Bases 270
- 9.3 Strengths of Acids and Bases 274
- 9.4 Ionization of Water 277
- 9.5 The pH Scale 279
 - EXPLORE YOUR WORLD
 - Using Vegetables and Flowers as pH Indicators 284
 - HEALTH NOTE
 - Stomach Acid, HCl 284
- 9.6 Reactions of Acids and Bases 285
 - ENVIRONMENTAL NOTE
 - Acid Rain 286
 - HEALTH NOTE
 - Antacids 287
- 9.7 Buffers 288
 - HEALTH NOTE
 - Buffers in the Blood 290
- Chapter Review 291
- Key Terms 292
- Additional Problems 292
- Answers 293

10 Introduction to Organic Chemistry 296

- 10.1 Organic Compounds 298
- 10.2 Bonding in Organic Compounds 300

- 10.3 Alkanes 302
 - 10.4 Naming Branched Alkanes 307
 - 10.5 Haloalkanes 313
 - HEALTH NOTE
 - Common Uses of Halogenated Alkanes 315
 - 10.6 Properties of Alkanes 316
 - HEALTH NOTE
 - Incomplete Combustion 319
 - 10.7 Functional Groups 319
 - CAREER FOCUS
 - Laboratory Technologist 320
 - ENVIRONMENTAL NOTE
 - Functional Groups in Familiar Compounds 324
 - HEALTH NOTE
 - Organic Compounds in Living Organisms 325
- Chapter Review* 326
Summary of Naming 326
Summary of Reactions 327
Key Terms 327
Additional Problems 327
Answers 329

11 Unsaturated Hydrocarbons 332

- 11.1 Alkenes and Alkynes 333
- 11.2 Naming Alkenes and Alkynes 335
 - EXPLORE YOUR WORLD
 - Ripening Fruit 335
 - ENVIRONMENTAL NOTE
 - Fragrant Alkenes 337
- 11.3 Cis-Trans Isomers 337
 - EXPLORE YOUR WORLD
 - Modeling Cis-Trans Isomers 339
 - ENVIRONMENTAL NOTE
 - Pheromones in Insect Communication 339
 - HEALTH NOTE
 - Cis-Trans Isomers for Night Vision 340
- 11.4 Addition Reactions 341
 - EXPLORE YOUR WORLD
 - Unsaturation in Fats and Oils 341
 - HEALTH NOTE
 - Hydrogenation of Unsaturated Fats 342
- 11.5 Polymers of Alkenes 344
 - EXPLORE YOUR WORLD
 - Polymers and Recycling Plastics 346

- 11.6 Aromatic Compounds 348
 - HEALTH NOTE
 - Aromatic Compounds in Health and Medicine 349
 - HEALTH NOTE
 - Polycyclic Aromatic Hydrocarbons (PAHs) 351
- Chapter Review* 351
Summary of Naming 352
Summary of Reactions 352
Key Terms 352
Additional Problems 353
Answers 354

12 Organic Compounds with Oxygen and Sulfur 356

- 12.1 Alcohols, Phenols, and Thiols 358
 - EXPLORE YOUR WORLD
 - Alcohols in Household Products 360
 - 12.2 Some Important Alcohols and Phenols 364
 - 12.3 Ethers 366
 - HEALTH NOTE
 - Ethers as Anesthetics 368
 - 12.4 Properties of Alcohols, Phenols, and Ethers 368
 - 12.5 Reactions of Alcohols and Thiols 371
 - CAREER FOCUS
 - Pharmacist 374
 - HEALTH NOTE
 - Oxidation of Alcohol in the Body 375
 - 12.6 Aldehydes and Ketones 377
 - 12.7 Some Important Aldehydes and Ketones 382
 - ENVIRONMENTAL NOTE
 - Vanilla 384
 - 12.8 Properties of Aldehydes and Ketones 385
 - 12.9 Chiral Molecules 389
 - HEALTH NOTE
 - Enantiomers in Biological Systems 394
- Chapter Review* 396
Summary of Naming 397
Summary of Reactions 398
Key Terms 398
Additional Problems 399
Answers 403

13

Carboxylic Acids, Esters, Amines, and Amides 408

- 13.1 Carboxylic Acids 410
 - HEALTH NOTE
 - Alpha Hydroxy Acids 413
- 13.2 Properties of Carboxylic Acids 413
- 13.3 Acidity of Carboxylic Acids 415
- 13.4 Esters 418
 - HEALTH NOTE
 - Salicylic Acid and Aspirin 421
- 13.5 Properties of Esters 423
 - ENVIRONMENTAL NOTE
 - Cleaning Action of Soaps 425
- 13.6 Amines 426
 - HEALTH NOTE
 - Amines in Health and Medicine 430
- 13.7 Properties of Amines 431
 - HEALTH NOTE
 - Synthesizing Drugs 434
 - HEALTH NOTE
 - Alkaloids: Amines in Plants 436
- 13.8 Amides 437
 - CAREER FOCUS
 - Clinical Laboratory Technologist 438
 - HEALTH NOTE
 - Amides in Health and Medicine 439

Chapter Review 442
Summary of Naming 442
Summary of Reactions 443
Key Terms 444
Additional Problems 445
Answers 447

14

Carbohydrates 452

- 14.1 Carbohydrates 453
- 14.2 Classification of Monosaccharides 455
- 14.3 D and L Notations from Fischer Projections 457
- 14.4 Structures of Some Important Monosaccharides 459
 - HEALTH NOTE
 - Hyperglycemia and Hypoglycemia 461
- 14.5 Cyclic Structures of Monosaccharides 463
- 14.6 Chemical Properties of Monosaccharides 466

HEALTH NOTE

Testing for Glucose in Urine 468

- 14.7 Disaccharides 470
 - EXPLORE YOUR WORLD
 - Sugar and Sweeteners 471
 - HEALTH NOTE
 - How Sweet
 - Is My Sweetener? 473
 - CAREER FOCUS
 - Phlebotomist 474
 - HEALTH NOTE
 - Blood Types and Carbohydrates 475
- 14.8 Polysaccharides 476
 - EXPLORE YOUR WORLD
 - Polysaccharides 478

Chapter Review 479
Summary of Carbohydrates 480
Summary of Reactions 480
Key Terms 481
Additional Problems 482
Answers 483

15

Lipids 486

EXPLORE YOUR WORLD

Solubility of Fats and Oils 487

- 15.1 Lipids 488
- 15.2 Fatty Acids 489
 - HEALTH NOTE
 - Omega-3 Fatty Acids in Fish Oils 493
- 15.3 Waxes, Fats, and Oils 496
- 15.4 Chemical Properties of Triacylglycerols 500
 - HEALTH NOTE
 - Olestra: A Fat Substitute 501
 - HEALTH NOTE
 - Trans Fatty Acids and Hydrogenation 502
 - EXPLORE YOUR WORLD
 - Types of Fats 504
- 15.5 Glycerophospholipids 505
 - CAREER FOCUS
 - Physical Therapist 507
- 15.6 Steroids: Cholesterol and Steroid Hormones 508
 - HEALTH NOTE
 - Anabolic Steroids 513
- 15.7 Cell Membranes 514
 - HEALTH NOTE
 - Transport Through Cell Membranes 516

Chapter Review 517
Key Terms 517
Additional Problems 518
Answers 519

16 Amino Acids, Proteins, and Enzymes 522

- 16.1 Functions of Proteins 523
- 16.2 Amino Acids 525
- 16.3 Amino Acids as Acids and Bases 528
- 16.4 Formation of Peptides 530
 - CAREER FOCUS
 - Rehabilitation Specialist 531
- 16.5 Levels of Protein Structure 532
 - HEALTH NOTE
 - Natural Opiates in the Body 535
 - HEALTH NOTE
 - Essential Amino Acids 538
 - HEALTH NOTE
 - Sickle-Cell Anemia 542
 - EXPLORE YOUR WORLD
 - Denaturation of Milk Protein 543
- 16.6 Enzymes 544
- 16.7 Enzyme Action 546
 - HEALTH NOTE
 - Isoenzymes as Diagnostic Tools 548
- 16.8 Factors Affecting Enzyme Activity 549
 - EXPLORE YOUR WORLD
 - Enzyme Activity 550
- 16.9 Enzyme Cofactors 555
 - Chapter Review* 559
 - Key Terms* 560
 - Additional Problems* 561
 - Answers* 563

17 Nucleic Acids and Protein Synthesis 568

- 17.1 Components of Nucleic Acids 570
- 17.2 Primary Structure of Nucleic Acids 574
 - CAREER FOCUS
 - Occupational Therapist 576
- 17.3 DNA Double Helix 576
- 17.4 RNA and the Genetic Code 580
- 17.5 Protein Synthesis: Translation 585
 - HEALTH NOTE
 - Many Antibiotics Inhibit Protein Synthesis 588

- 17.6 Genetic Mutations 589
 - EXPLORE YOUR WORLD
 - A Model for DNA Replication and Mutation 591
- 17.7 Viruses 593
 - HEALTH NOTE
 - Cancer 597
- Chapter Review* 598
- Key Terms* 599
- Additional Problems* 599
- Answers* 601

18 Metabolic Pathways and Energy Production 604

- 18.1 Metabolism and ATP Energy 606
 - HEALTH NOTE
 - ATP Energy and Ca^{2+} Needed to Contract Muscles 610
- 18.2 Digestion: Stage 1 611
 - EXPLORE YOUR WORLD
 - Carbohydrate Digestion 613
- 18.3 Important Coenzymes in Metabolic Pathways 615
 - HEALTH NOTE
 - Lactose Intolerance 618
- 18.4 Glycolysis: Stage 2 618
- 18.5 The Citric Acid Cycle: Stage 3 625
- 18.6 Electron Transport 629
 - HEALTH NOTE
 - Toxins: Inhibitors of Electron Transport 634
- 18.7 Oxidative Phosphorylation and ATP 634
 - HEALTH NOTE
 - ATP Synthase and Heating the Body 637
- 18.8 Oxidation of Fatty Acids 640
 - EXPLORE YOUR WORLD
 - Fat Storage and Blubber 642
 - HEALTH NOTE
 - Stored Fat and Obesity 643
 - HEALTH NOTE
 - Ketone Bodies and Diabetes 646
- 18.9 Degradation of Amino Acids 646
 - Chapter Review* 651
 - Summary of Key Reactions* 652
 - Key Terms* 654
 - Additional Problems* 655
 - Answers* 656

Credits C-1
Glossary/ Index I-1