CONTENTS

		Alamia Charatana 2
1	1.1	Atomic Structure 2
Structure and Bonding;	1.2	Atomic Structure: Electron Configurations 4
Acids and Bases	1.3	Development of Chemical Bonding Theory 5
Acius aliu bases	1.4	The Nature of Chemical Bonds 6
	1.5	Forming Covalent Bonds: Valence Bond Theory 9
	1.6	sp ³ Hybrid Orbitals and the Structure of Methane 10
	1.7	sp ³ Hybrid Orbitals and the Structure of Ethane 11
	1.8	Other Kinds of Hybrid Orbitals: sp ² and sp 12
	1.9	Polar Covalent Bonds: Electronegativity 15
	1.10	Acids and Bases: The Brønsted-Lowry Definition 18
	1.11	Organic Acids and Organic Bases 22
	1.12	Acids and Bases: The Lewis Definition 24
		INTERLUDE: Organic Foods: Risk versus Benefit 26
		Summary and Key Words 28 Exercises 29
	2.1	Functional Groups 39
	2.2	Alkanes and Alkyl Groups: Isomers 44
Alkanes: The Nature	2.3	Naming Branched-Chain Alkanes 49
of Organic Compounds	2.4	Properties of Alkanes 53
	2.5	Conformations of Ethane 54
	2.6	Drawing Chemical Structures 56
- T	2.7	Cycloalkanes 58
	2.8	Cis-Trans Isomerism in Cycloalkanes 60
2013	2.9	Conformations of Some Cycloalkanes 62
	2.10	Axial and Equatorial Bonds in Cyclohexane 64
	2.11	Conformational Mobility of Cyclohexane 65
		INTERLUDE: Where Do Drugs Come From? 68
		Summary and Key Words 69 Exercises 70
	3.1	Naming Alkenes and Alkynes 79
	3.2	Electronic Structure of Alkenes 83
Alkenes and Alkynes:	3.3	Cis-Trans Isomers of Alkenes 83
The Nature of Organic	3.4	Sequence Rules: The E,Z Designation 86
Reactions	3.5	Kinds of Organic Reactions 89
	******	▼

	3.6	How Reactions Occur: Mechanisms 91
	3.7	The Mechanism of an Organic Reaction: Addition of HCl to Ethylene 95
	3.8	Describing a Reaction: Transition States and Intermediates 98
	3.9	Describing a Reaction: Catalysis 101
		INTERLUDE: Terpenes: Naturally Occurring Alkenes 102
		Summary and Key Words 103
		Exercises 104
1	4.1	Addition of HX to Alkenes: Markovnikov's Rule 113
4	4.2	Carbocation Structure and Stability 116
Reactions of Alkenes	4.3	Addition of Water to Alkenes 117
and Alkynes	4.4	Addition of Halogens to Alkenes 120
	4.5	Reduction of Alkenes: Hydrogenation 122
	4.6	Oxidation of Alkenes: Epoxidation, Hydroxylation, and Cleavage 124
00	9 4.7	Addition of Radicals to Alkenes: Polymers 127
	4.8	Conjugated Dienes 130
0 0 0	4.9	Stability of Allylic Carbocations: Resonance 132
6 6 6	4.10	Drawing and Interpreting Resonance Forms 133
	4.11	Alkynes and Their Reactions 136
		INTERLUDE: Natural Rubber 141
		Summary and Key Words 142 Summary of Reactions 143
		Exercises 146
of grown had see 244s	5.1	Structure of Benzene 156
	5.2	Naming Aromatic Compounds 157
Aromatic Compounds	5.3	Electrophilic Aromatic Substitution Reactions: Bromination 159
	5.4	Other Electrophilic Aromatic Substitution Reactions 162
	5.5	The Friedel-Crafts Alkylation and Acylation Reactions 165
	5.6	Substituent Effects in Electrophilic Aromatic Substitution 166
	5.7	An Explanation of Substituent Effects 168
	5.8	Oxidation and Reduction of Aromatic Compounds 171
	5.9	Other Aromatic Compounds 172
	5.10	Organic Synthesis 174
		INTERLUDE: Aspirin, NSAIDs, and COX-2 Inhibitors 177
		Summary and Key Words 179 Summary of Reactions 179 Exercises 181

6	6.1	Enantiomers and the Tetrahedral Carbon 190
Stereochemistry	6.2	The Reason for Handedness in Molecules: Chirality 191
at Tetrahedral Centers	6.3	Optical Activity 195
at retrained at Centers	6.4	Pasteur's Discovery of Enantiomers 197
	6.5	Sequence Rules for Specifying Configuration 197
	6.6	Diastereomers 201
	6.7	Meso Compounds 204
	6.8	Racemic Mixtures and the Resolution of Enantiomers 206
0 0	6.9	A Brief Review of Isomerism 208
	6.10	Chirality in Nature and Chiral Environments 210
		INTERLUDE: Chiral Drugs 212
		Summary and Key Words 214
		Exercises 214
	n made	Naming Alfred Halidas 222
7	7.1	Naming Alkyl Halides 223
Organohalides:	7.2	Preparing Alkyl Halides 224
Nucleophilic Substitutions	7.3	Reactions of Alkyl Halides: Grignard Reagents 226
and Eliminations	7.4	Nucleophilic Substitution Reactions 227
and Liminations	7.5	Substitutions: The S _N 2 Reaction 230
	7.6	Substitutions: The S _N 1 Reaction 234
	7.7	Eliminations: The E2 Reaction 237
	7.8	Eliminations: The E1 and E1CB Reactions 240
	7.9	A Summary of Reactivity: S _N 1, S _N 2, E1, E1cB, and E2 241
	7.10	Substitution and Elimination Reactions in Living Organisms 242
		INTERLUDE: Naturally Occurring Organohalides 244
		Summary and Key Words 245
		Summary of Reactions 245
		Exercises 247
0	8.1	Naming Alcohols, Phenols, and Ethers 257
	8.2	Properties of Alcohols and Phenols: Hydrogen
Alcohols, Phenols, Ethers,		Bonding and Acidity 259
and Their Sulfur Analogs	8.3	Synthesis of Alcohols from Carbonyl Compounds 262
	8.4	Reactions of Alcohols 268
	8.5	Reactions of Phenols 274
	8.6	Reactions of Ethers 276
	8.7	Cyclic Ethers: Epoxides 277
	8.8	Thiols and Sulfides 278

and interest to the control of the c	April dan Seldangan La ta April	Summary and Key Words 282 Summary of Reactions 283 Exercises 286
	9.1	The Nature of Carbonyl Compounds 295
	9.2	Naming Aldehydes and Ketones 296
Aldehydes and Ketones:	9.3	Synthesis of Aldehydes and Ketones 298
Nucleophilic Addition	9.4	Oxidation of Aldehydes 299
Reactions	9.5	Nucleophilic Addition Reactions 300
TRE 3 shows the steem term Pretact	9.6	Nucleophilic Addition of Hydride and Grignard Reagents Alcohol Formation 302
	9.7	Nucleophilic Addition of Water: Hydrate Formation 305
	9.8	Nucleophilic Addition of Alcohols: Acetal Formation 30
	9.9	Nucleophilic Addition of Amines: Imine Formation 310
	9.10	Conjugate Nucleophilic Addition Reactions 311
		INTERLUDE: Vitamin C 313
		Summary and Key Words 314 Summary of Reactions 315 Exercises 316
10	10.1	Naming Carboxylic Acids and Derivatives 326
Carboxylic Acids and	10.2	Occurrence and Properties of Carboxylic Acids and Derivatives 330
Derivatives: Nucleophilic	10.3	Acidity of Carboxylic Acids 331
Acyl Substitution Reactions	10.4	Synthesis of Carboxylic Acids 334
	10.5	Nucleophilic Acyl Substitution Reactions 335
9 90	10.6	Carboxylic Acids and Their Reactions 339
00-04 21	10.7	Acid Halides and Their Reactions 342
0 0 0	10.8	Acid Anhydrides and Their Reactions 344
	10.9	Esters and Their Reactions 346
285 : 435 :	10.10	Amides and Their Reactions 349
	10.11	Nitriles and Their Reactions 351
	10.12	Biological Carboxylic Acid Derivatives: Thioesters and Acyl Phosphates 354
	10.13	Polymers from Carbonyl Compounds: Polyamides and Polyesters 356
		INTERLUDE: β-Lactam Antibiotics 358
		Summary and Key Words 360

Summary of Reactions 361

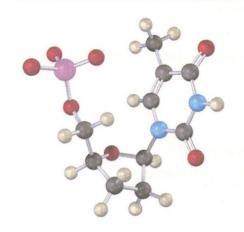
Exercises 363

INTERLUDE: Epoxy Resins and Adhesives 281

11	11.1	Keto-Enol Tautomerism 373
Carbonyl Alpha-Substitution	11.2	Reactivity of Enols: The Mechanism
Reactions and Condensation	11.3	of Alpha-Substitution Reactions 376 Alpha Halogenation of Aldehydes and Ketones 377
Reactions	11.4	Acidity of Alpha Hydrogen Atoms:
	1 1.00	Enolate Ion Formation 379
	11.5	Reactivity of Enolate Ions 382
	11.6	Alkylation of Enolate Ions 382
	11.7	Carbonyl Condensation Reactions 385
	11.8	Condensations of Aldehydes and Ketones: The Aldol Reaction 386
	11.9	Dehydration of Aldol Products: Synthesis of Enones 38
	11.10	Condensations of Esters: The Claisen Condensation Reaction 388
	11.11	Some Biological Carbonyl Reactions 391
		INTERLUDE: Barbiturates 392
		Summary and Key Words 394 Summary of Reactions 394 Exercises 395
12	12.1	Naming Amines 405
	12.2	Structure and Properties of Amines 407
Amines	12.3	Basicity of Amines 408
	12.4	Synthesis of Amines 411
6 0 P	12.5	Reactions of Amines 416
	12.6	Heterocyclic Amines 417
	12.7	Alkaloids: Naturally Occurring Amines 421
		INTERLUDE: Green Chemistry 422
		Summary and Key Words 423 Summary of Reactions 424 Exercises 425
		diploma ye hadan 💢 🔑 🚾 "
13	13.1	Mass Spectrometry 434
Structure Determination	13.2	Spectroscopy and the Electromagnetic Spectrum 435
Structure Determination	13.3	Infrared Spectroscopy of Organic Molecules 438
	13.4	Interpreting Infrared Spectra 439
	13.5	Ultraviolet Spectroscopy 442
	13.6	Interpreting Ultraviolet Spectra: The Effect of Conjugation 443
	13.7	Nuclear Magnetic Resonance Spectroscopy 445
	13.8	The Nature of NMR Absorptions 446

	13.9	Chemical Shifts 448
	13.10	Chemical Shifts in ¹ H NMR Spectra 450
	13.11	Integration of ¹ H NMR Spectra: Proton Counting 451
	13.12	Spin-Spin Splitting in ¹ H NMR Spectra 452
	13.13	Uses of ¹ H NMR Spectra 455
	13.14	¹³ C NMR Spectroscopy 456
		INTERLUDE: Magnetic Resonance Imaging (MRI) 458
		Summary and Key Words 459 Exercises 460
1/1		
1	14.1	Classification of Carbohydrates 470
Biomolecules: Carbohydrates	14.2	Depicting Carbohydrate Stereochemistry: Fischer Projections 472
9	14.3	D,L Sugars 474
0.20	14.4	Configurations of Aldoses 476
	14.5	Cyclic Structures of Monosaccharides: Hemiacetal Formation 478
	14.6	Monosaccharide Anomers: Mutarotation 480
	14.7	Reactions of Monosaccharides 482
	14.8	The Eight Essential Monosaccharides 487
70 00 900	14.9	Disaccharides 489
	14.10	Polysaccharides 490
	14.11	Cell-Surface Carbohydrates and Carbohydrate Vaccines 492
		INTERLUDE: Sweetness 494
		Summary and Key Words 495 Exercises 496
1 =		
	15.1	Structures of Amino Acids 504
Biomolecules: Amino Acids,	15.2	Isoelectric Points 509
Peptides, and Proteins	15.3	Peptides and Proteins 511
	15.4	Covalent Bonding in Peptides 513
	15.5	Peptide Structure Determination: Amino Acid Analysis 514
	15.6	Peptide Sequencing: The Edman Degradation 515
	15.7	Peptide Synthesis 517
	15.8	Protein Structure 521
	15.9	Enzymes and Coenzymes 524
	15.10	How Do Enzymes Work? Citrate Synthase 528
		INTERLUDE: X-Ray Crystallography 530
		Summary and Key Words 531 Exercises 532

Biomolecules: Lipids and Nucleic Acids



The Organic Chemistry of Metabolic Pathways

16.1	waxes, Fats, and Olls 539	
16.2	Soaps 542	
16.3	Phospholipids 544	
16.4	Steroids 546	
16.5	Nucleic Acids and Nucleotides 548	
16.6	Base Pairing in DNA: The Watson-Crick Model	552
16.7	Replication of DNA 554	
16.8	Transcription of DNA 555	
16.9	Translation of RNA: Protein Biosynthesis 557	
16.10	DNA Sequencing 560	
16.11	The Polymerase Chain Reaction 562	
	INTERLUDE: DNA Fingerprinting 563	
	Summary and Key Words 564 Exercises 565	

17.1 An Overview of Metabolism and Biochemical Energy Catabolism of Fats: β -Oxidation 575 17.2 Catabolism of Carbohydrates: Glycolysis 579 17.3

The Citric Acid Cycle 584 17.4

Catabolism of Proteins: Transamination 17.5

Some Conclusions about Biological Chemistry 590 17.6

> **INTERLUDE:** Statin Drugs 591 Summary and Key Words 592 Exercises 593

APPENDIX A: Nomenclature of Polyfunctional Organic Compounds A-1

APPENDIX B: Glossary A-7

APPENDIX C: Answers to Selected In-Chapter Problems A-22

INDEX 1-0-1-12