



Contents

Table of Contents	i
List of Figures	ix
List of Tables	xiii
B1 Foundations of Chemistry	1
B1.1 Introduction	1
B1.2 The Vocabulary of Chemistry	1
B1.3 Naming Inorganic Compounds	7
B1.4 Fundamental Units of Measurement for Chemistry	9
B1.5 Significant Figures	10
B1.6 Light	10
B1.7 Lewis Structures	11
B1.8 Procedure for Lewis Structures	13
B1.9 Procedure for Predicting Molecular Shape (VSEPR)	14
B1.10 The Equilibrium Constant	16
B1.11 Determining the pH for Solutions of Weak Acids and Weak Bases	17
B1.12 Henderson-Hasselbalch Equation	19
B1.13 Mathematics and Chemistry	20

B2 Gases	22
B2.1 Contents in Brief	22
B2.2 Introduction	22
B2.3 The Mercury Barometer and Pressure	23
B2.4 The Ideal Gas Law	26
B2.5 Density of Gases	31
B2.6 Dalton's Law of Partial Pressures	33
B2.7 Real Gases	39
B2.8 Summary	41
B2.9 Additional Exercises	42
B2.10 Answers to Exercises B2	47
B3 Reduction-Oxidation (Redox) Reactions	48
B3.1 Contents in Brief	48
B3.2 Introduction	48
B3.3 The Fundamentals of Redox Reactions	49
B3.4 Assigning Oxidation Numbers	51
B3.5 Balancing Redox Reactions in Acidic Solution	55
B3.6 Balancing Redox Reactions in Basic Solution	58
B3.7 Summary	61
B3.8 Additional Exercises	61
B3.9 Answers to Exercises B3	65
14 Chemical Equilibria	67
14.1 Contents in Brief	67
14.2 Introduction	67
14.3 The Equilibrium and Reaction Quotient Expressions	68
14.4 The Equilibrium Constant	72
14.5 Quantitative Data from the Equilibrium Expression	76
14.6 Le Châtelier's Principle	81
14.7 Summary	86
14.8 Additional Exercises	86
14.9 Answers to Exercises 14	90

15	First Law of Thermodynamics	92
15.1	Contents in Brief	92
15.2	Introduction	92
15.3	Kinetic Energy and Potential Energy	93
15.4	System and Surroundings	93
15.5	Specific Heat Capacity and Heat Capacity	95
15.6	Heat and Temperature	96
15.7	Work and Volume	99
15.8	First Law of Thermodynamics: Heat and Work	99
15.9	State Functions	101
15.10	Enthalpy	104
15.11	Heating, Cooling and Enthalpies of Phase Changes	105
15.12	Calorimetry	107
15.13	Summary	112
15.14	Additional Exercises	113
15.15	Answers to Exercises 15	116
16	Standard Reaction Enthalpies and Hess's Law	117
16.1	Contents in Brief	117
16.2	Introduction	117
16.3	Standard State and Standard Enthalpy Change	118
16.4	Thermochemical Equations and Enthalpy Diagrams	119
16.5	Hess's Law	123
16.6	Standard Enthalpy of Formation	125
16.7	Bond Enthalpies and Enthalpy of Reaction	131
16.8	Enthalpy Changes for Biological Processes	135
16.9	Summary	137
16.10	Additional Exercises	138
16.11	Answers to Exercises 16	142
17	Entropy: Second and Third Laws of Thermodynamics	143
17.1	Contents in Brief	143
17.2	Introduction	143

17.3	Entropy	144
17.4	Predicting Entropy Changes	147
17.5	Second Law of Thermodynamics	150
17.6	Third Law of Thermodynamics and $\Delta S_{\text{rxn}}^{\circ}$	153
17.7	Summary	160
17.8	Additional Exercises	161
17.9	Answers to Exercises 17	163
18	Gibbs Energy	164
18.1	Contents in Brief	164
18.2	Introduction	164
18.3	Gibbs Energy	165
18.4	Gibbs Energy and Temperature	166
18.5	Calculating ΔG°	170
18.6	Relationship between the Equilibrium Constant and Gibbs Energy	173
18.7	Gibbs Energy Change under Non-Standard Conditions	176
18.8	Summary	179
18.9	Additional Exercises	180
18.10	Answers to Exercises 18	182
19	Phase Equilibria and Partitioning of Compounds	183
19.1	Contents in Brief	183
19.2	Introduction	183
19.3	Liquid-Gas Phase Equilibria	184
19.4	Phase Diagrams	186
19.5	Liquid-Gas Two Component Mixtures	187
19.6	Multiple Component Mixtures: Partitioning of Compounds	191
19.7	Chromatography	194
19.8	Summary	196
19.9	Answers to Exercises 19	197

20	Electrochemistry	198
20.1	Contents in Brief	198
20.2	Introduction	198
20.3	Electrochemical Cells	199
20.4	Standard Half-Cell Potentials and Standard Cell Potentials	202
20.5	Calculating Standard Cell Potentials	205
20.6	Cell Potentials, Gibbs Energies and Spontaneity	208
20.7	Cell Potentials under Non-Standard Conditions	209
20.8	Summary	215
20.9	Additional Exercises	216
20.10	Answers to Exercises 20	218
21	Alkanes, Cycloalkanes and Functional Groups	219
21.1	Contents in Brief	219
21.2	Introduction	219
21.3	Saturated Hydrocarbons	220
21.4	Cycloalkanes	225
21.5	Functional Groups in Organic Chemistry	228
21.6	Rules for Systematic Naming of Hydrocarbon Compounds	230
21.7	Alkenes, Alkynes and Aromatics	235
21.8	Alcohols and Ethers	238
21.9	Aldehydes and Ketones	239
21.10	Carboxylic Acids and Esters	240
21.11	Amines and Amides	242
21.12	Chirality	242
21.13	Summary	248
21.14	Additional Exercises	248
21.15	Answers to Exercises 21	251
22	Spectroscopy	256
22.1	Contents in Brief	256
22.2	Introduction	256
22.3	Ultraviolet and Visible (UV/Vis) Spectroscopy	257

22.4	Infrared Spectroscopy (IR)	262
22.5	Nuclear Magnetic Resonance (NMR) Spectroscopy	265
22.6	Chemical Equivalence and Non-Equivalence	270
22.7	Summary	272
22.8	Answers to Exercises 22	273
23	Introduction to Chemical Reactions	274
23.1	Contents in Brief	274
23.2	Introduction	274
23.3	Reactions of Organic Compounds	275
23.4	S _N 2 Substitution Reactions	275
23.5	Addition Reactions of Lithium Reagents	280
23.6	Diels-Alder Reactions	284
23.7	Summary	286
23.8	Answers to Exercises 23	287
24	Rates of Chemical Reactions	288
24.1	Contents in Brief	288
24.2	Introduction	288
24.3	Average Rate of Reaction	289
24.4	Instantaneous Rate of Reaction	293
24.5	Rate Law	294
24.6	Integrated Rate Laws for First Order Reactions	300
24.7	Half-Life for First Order Reactions	302
24.8	Integrated Rate Law for Second Order Reactions	304
24.9	Radioactive Decay	305
24.10	Summary	312
24.11	Additional Exercises	313
24.12	Answers to Exercises 24	316
25	Reaction Mechanisms and Catalysis	317
25.1	Contents in Brief	317
25.2	Introduction	317

25.3	Mechanisms of Reactions	318
25.4	Temperature and the Rate of Reaction	322
25.5	Catalysis	324
25.6	Summary	328
25.7	Additional Exercise	328
25.8	Answers to Exercises 25	329
26	Proteins and Peptides: Biopolymers of Amino Acids	330
26.1	Contents in Brief	330
26.2	Introduction	330
26.3	Amino acids	331
26.4	Peptides and Proteins	335
26.5	Protein Structure	337
26.6	Enzyme Catalysis	339
26.7	Summary	342
26.8	Additional Exercises	342
26.9	Answers to Exercises 26	345
27	Synthetic Polymers	347
27.1	Contents in Brief	347
27.2	Introduction	347
27.3	Monomers and Polymers	348
27.4	Sizes of Polymers	349
27.5	Physical Properties of Polymers	351
27.6	Structure-Property Relations in Polymers	351
27.7	Addition Polymerization (Radical)	353
27.8	Step Growth Polymerization (Condensation)	357
27.9	Summary	359
27.10	Answers to Exercises 27	360
Index		363