

APPLIED CHEMISTRY



Dr. Raman Rani Mittal

APPLIED CHEMISTRY-I

(A Textbook for 1st Semester Diploma Students of Polytechnics)

By

Dr. Raman Rani Mittal

Lecturer in Chemistry

Govt. Polytechnic College for Girls

Patiala (Punjab)

S.K. KATARIA & SONS®

Publisher of Engineering and Computer Books

4885/109, Prakash Mahal, Dr. Subhash Bhargav Lane,

Opposite Delhi Medical Association, Daryaganj, New Delhi-110002

Phone: +91-11-23243489, +91-11-23269324; Telefax: +91-11-23243489

e-mail: katarabooks@yahoo.com; katarabook@gmail.com

Website : www.skkatariaandsons.com

Contents

SECTION – A

1. BASIC CONCEPTS OF CHEMISTRY	3—52
1.1 Introduction	3
1.2 Unit	3
1.3 Dimensions	5
1.4 Principle of Homogeneity of Dimensions	7
1.5 Matter and its Classification	8
1.6 Symbols and Formulae	11
1.7 Symbol	11
1.8 Valency	13
1.9 Radical	13
1.10 Formula	15
1.11 Aatomic Mass and Molecular Mass	18
1.12 Atomic Mass	18
1.13 Molecular Mass	19
1.14 Mole Concept	21
1.15 Solutions	31
1.16 Methods of Expressing Concentration of a Solution	31
1.17 Chemical Equations	36
1.18 Balancing of Chemical Equations	38
1.19 Thermochemical Equations	44
1.20 Stoichiometric Calculations	45
<i>Objective Type Questions</i>	47
<i>Subjective Questions</i>	50
<i>Answers</i>	52
2. ATOMIC STRUCTURE.....	53—89
2.1 Introduction	53
2.2 Cathode Rays—The Discovery of Electrons	53
2.3 Anode Rays—The Discovery of Protons	56
2.4 Thomson Model of Atom	57
2.5 Rutherford's Scattering Experiment	57
2.6 Discovery of the Neutron	59

2.7 Atomic Number and Mass Number	60
2.8 Isotopes and Isobars	63
2.9 Electronic Structure of Atom	63
2.10 Various Types of Spectra	65
2.11 Planck's Quantum Theory	67
2.12 Bohr's Model of Atom	67
2.13 The Dual Nature of Matter	71
2.14 Heisenberg's Uncertainty Principle	71
2.15 Quantum Mechanical Model of Atom	72
2.16 Quantum Numbers	73
2.17 Pauli's Exclusion Principle	76
2.18 Shapes of Orbitals	78
2.19 Rules for Filling of Orbitals in an Atom	79
2.20 Electronic Configurations of Atoms	81
<i>Objective Type Questions</i>	82
<i>Subjective Questions</i>	86
<i>Answers</i>	88
3. PERIODIC TABLE	90—107
3.1 The Need for Classification	90
3.2 Earlier Attempts to Classify Elements	90
3.3 Mendeleev's Periodic Table	91
3.4 Modern Periodic Law	94
3.5 Cause of Periodicity	94
3.6 Long Form of the Periodic Table	95
<i>Objective Type Questions</i>	101
<i>Subjective Questions</i>	104
<i>Answers</i>	106
4. CHEMICAL BONDING	108—136
4.1 Introduction	108
4.2 Cause of Chemical Combination	108
4.3 Types of Bonds	109
4.4 Ionic or Electrovalent Bond	110
4.5 Covalent Bond	112
4.6 Bonding Parameters	118
4.7 Concept of Hybridisation	119
4.8 Co-ordinate or Dative Bond	123
4.9 Metallic Bonding	124
<i>Objective Type Questions</i>	130
<i>Subjective Questions</i>	133
<i>Answers</i>	135

5. WATER	137—169
5.1 Sources of Water	137
5.2 Impurities in Water	138
5.3 Hard and Soft Water	139
5.4 Types of Hardness	139
5.5 Degree of Hardness	140
5.6 Estimation of Hardness of Water by EDTA Method	144
5.7 Disadvantages of Hard Water	147
5.8 Boiler Feed Water	148
5.9 Softening of Hard Water	152
5.10 Desalination of Sea Water by Reverse Osmosis Method	156
5.11 Drinking Water	158
5.12 Chemical Analysis of Water	158
<i>Objective Type Questions</i>	163
<i>Subjective Questions</i>	166
<i>Answers</i>	168
6. GAS LAW AND THERMODYNAMICS.....	170—197
6.1 Introduction	170
6.2 Measurable Properties of Gases	170
6.3 Boyle's Law	172
6.4 Charles' Law	174
6.5 Avogadro's Law	176
6.6 Combined Gas Law or Ideal Gas Equation	177
6.7 Ideal and Real Gases	180
6.8 Introduction	181
6.9 Some Important Terms	181
6.10 Types of System	181
6.11 Macroscopic Properties	182
6.12 State of System	182
6.13 Thermodynamic Processes	183
6.14 Path.....	183
6.15 Spontaneous and Non-spontaneous Processes	183
6.16 Internal Energy E	184
6.17 Enthalpy, (H)	185
6.18 Entropy, (S)	186
6.19 Free Energy, G.....	187
6.20 Zeroth Law of Thermodynamics	189
6.21 First Law of Thermodynamics	190

6.22 Second law of Thermodynamics	190
6.23 Third Law of Thermodynamics	190
6.24 Applications of Free Energy Change Criteria	191
<i>Objective Type Questions</i>	191
<i>Subjective Questions</i>	195
<i>Answers</i>	197
7. EQUILIBRIUM, ACIDS AND BASES	198—229
7.1 Introduction	198
7.2 Irreversible and Reversible Reactions	198
7.3 Chemical Equilibrium	199
7.4 Law of Chemical Equilibrium and Equilibrium Constant	201
7.5 Factors Influencing Chemical Equilibrium	204
7.6 Ionic Equilibrium	206
7.7 Ionisation of an Electrolyte in Aqueous Solution	206
7.8 Ionic Equilibrium in Aqueous Solution	207
7.9 Self Ionisation of Water-Ionic Product of Water	209
7.10 Expressing Hydrogen ion Concentration-pH Scale	211
7.11 Acids and Bases	215
7.12 Strength of Acids and Bases	219
7.13 Neutralisation	219
7.14 Acid-base Titrations	219
7.15 Buffer Solutions	221
<i>Objective Type Questions</i>	223
<i>Subjective Questions</i>	227
<i>Answers</i>	229
8. ELECTROCHEMISTRY	230—264
8.1 Introduction	230
8.2 Classical Concept of Oxidation and Reduction	230
8.3 Electronic Concept of Oxidation and Reduction	230
8.4 Oxidation and Reduction Go Side by Side	231
8.5 Classification of Redox Reactions	232
8.6 Electrolytes and Non-Electrolytes	235
8.7 Electrolysis	235
8.8 Faraday's Laws of Electrolysis	237
8.9 Applications of Electrolysis	242
8.10 Electrode Potential	244

8.11 Cell Potential or EMF of a Cell	244
8.12 Standard Electrode Potential	245
8.13 Electrochemical Series	247
8.14 Applications of the Electrochemical Series	248
8.15 Electrochemical Cell or Galvanic Cell	250
8.16 Commercial Cells	251
8.17 Applications of Electrolytes and Chrome Electroplating in Industry	258
<i>Objective Type Questions</i>	258
<i>Subjective Questions</i>	262
<i>Answers</i>	264
9. ORGANIC CHEMISTRY	265—296
9.1 Introduction	265
9.2 Organic Chemistry as Separate Branch of Chemistry	266
9.3 Tetravalency of Carbon	266
9.4 Catenation	267
9.5 Structural and Condensed Formulae of Organic Compounds	268
9.6 Homologous Series	268
9.7 Functional Group	269
9.8 Classifications of Organic Compounds	270
9.9 Nomenclature of Organic Compounds	271
9.10 Nomenclature of Aliphatic Hydrocarbons	273
9.11 Rules for Naming Hydrocarbons	275
9.12 Nomenclature of Compounds Containing Functional Groups	278
9.13 Rules for Naming Organic Compounds Containing a Functional Group	284
9.14 Writing Structural Formula from the Name of the Compound	285
9.15 Isomerism	286
9.16 Types of Organic Reactions	288
<i>Objective Type Questions</i>	290
<i>Subjective Questions</i>	293
<i>Answers</i>	295
SECTION – B	
Practical Chemistry	299—308
SECTION – C	
Experiments	309—356
Question Papers	357—364
Index	365—366

Index

A

- Atomic Mass and Molecular Mass, 18
 Acid-base Titrations, 219
 Acids and Bases, 215
 Anode Rays—The Discovery of Protons, 56
 Applications of Electrolysis, 242
 Applications of Electrolytes and Chrome Electroplating in Industry, 258
 Applications of Free Energy Change Criteria, 191
 Applications of the Electrochemical Series, 248
 Atomic Mass, 18
 Atomic Number and Mass Number, 60
 Avogadro's Law, 176

B

- Balancing of Chemical Equations, 38
 Bohr's Model of Atom, 67
 Boiler Feed Water, 148
 Bonding Parameters, 118
 Boyle's Law, 172
 Buffer Solutions, 221

C

- Catenation, 267
 Cathode Rays—The Discovery of Electrons, 53
 Cause of Chemical Combination, 108
 Cause of Periodicity, 94
 Cell Potential or EMF of a Cell, 244
 Charles' Law, 174
 Chemical Analysis of Water, 158
 Chemical Equations, 36
 Chemical Equilibrium, 199
 Classical Concept of Oxidation and Reduction, 230
 Classification of Redox Reactions, 232
 Classifications of Organic Compounds, 270
 Combined Gas Law or Ideal Gas Equation, 177
 Commercial Cells, 251
 Concept of Hybridisation, 119
 Co-ordinate or Dative Bond, 123
 Covalent Bond, 112

D

- Degree of Hardness, 140
 Desalination of Sea Water by Reverse Osmosis Method, 156
 Dimensions, 5
 Disadvantages of Hard Water, 147
 Discovery of the Neutron, 59
 Drinking Water, 158

E

- Earlier Attempts to Classify Elements, 90
 Electrochemical Cell or Galvanic Cell, 250
 Electrochemical Series, 247
 Electrode Potential, 244
 Electrolysis, 235
 Electrolytes and Non-Electrolytes, 235
 Electronic Concept of Oxidation and Reduction, 230
 Electronic Configurations of Atoms, 81
 Electronic Structure of Atom, 63
 Enthalpy (H), 185
 Entropy, (S), 186
 Estimation of Hardness of Water by EDTA Method, 144
 Expressing Hydrogen ion Concentration-pH Scale, 211

F

- Factors Influencing Chemical Equilibrium, 204
 Faraday's Laws of Electrolysis, 237
 First Law of Thermodynamics, 190
 Formula, 15
 Free Energy, G, 187
 Functional Group, 269

H

- Hard and Soft Water, 139
 Heisenberg's Uncertainty Principle, 71
 Homologous Series, 268

I

- Ideal and Real Gases, 180
 Impurities in Water, 138

- Internal Energy E, 184
 Introduction, 53
 Ionic Equilibrium in Aqueous Solution, 207
 Ionic Equilibrium, 206
 Ionisation of an Electrolyte in Aqueous Solution, 206
 Irreversible and Reversible Reactions, 198
 Isomerism, 286
 Isotopes and Isobars, 63
- L**
- Law of Chemical Equilibrium and Equilibrium Constant, 201
 Long Form of the Periodic Table, 95
 Ionic or Electrovalent Bond, 110
- M**
- Macroscopic Properties, 182
 Matter and its Classification, 8
 Measurable Properties of Gases, 170
 Mendeleev's Periodic Table, 91
 Metallic Bonding, 124
 Methods of Expressing Concentration of a Solution, 31
 Modern Periodic Law, 94
 Mole Concept, 21
 Molecular Mass, 19
- N**
- Neutralisation, 219
 Nomenclature of Aliphatic Hydrocarbons, 273
 Nomenclature of Compounds Containing Functional Groups, 278
 Nomenclature of Organic Compounds, 271
- O**
- Organic Chemistry as Separate Branch of Chemistry, 266
 Oxidation and Reduction Go Side by Side, 231
- P**
- Path, 183
 Pauli's Exclusion Principle, 76
 Planck's Quantum Theory, 67
 Principle of Homogeneity of Dimensions, 7
- Q**
- Quantum Mechanical Model of Atom, 72
 Quantum Numbers, 73
- R**
- Radical, 13
 Rules for Filling of Orbitals in an Atom, 79
- Rules for Naming Hydrocarbons, 275
 Rules for Naming Organic Compounds Containing a Functional Group, 284
 Rutherford's Scattering Experiment, 57
- S**
- Second law of Thermodynamics, 190
 Self Ionisation of Water-Ionic Product of Water, 209
 Shapes of Orbitals, 78
 Softening of Hard Water, 152
 Solutions, 31
 Some Important Terms, 181
 Sources of Water, 137
 Spontaneous and Non-spontaneous Processes, 183
 Standard Electrode Potential, 245
 State of System, 182
 Stoichiometric Calculations, 45
 Strength of Acids and Bases, 219
 Structural and Condensed Formulae of Organic Compounds, 268
 Symbol, 11
 Symbols and Formulae, 11
- T**
- Tetravalency of Carbon, 266
 The Dual Nature of Matter, 71
 The Need for Classification, 90
 Thermochemical Equations, 44
 Thermodynamic Process, 183
 Third Law of Thermodynamics, 190
 Thomson Model of Atom, 57
 Types of Bonds, 109
 Types of Hardness, 139
 Types of Organic Reactions, 288
 Types of System, 181
- U**
- Unit, 3
- V**
- Valency, 13
 Various Types of Spectra, 65
- W**
- Writing Structural Formula from the Name of the Compound, 285
- Z**
- Zeroth Law of Thermodynamics, 189